Deliver to

NAME _____

Div/Sec _____

Mail Stop _____

Compressed Gas Cylinder Safety

The material included in this handout must be read and understood before the training session. You also need to read the table of contents under the heading **Required Reading** that will guide you through the study material you need to read and understand to pass the test. A closed book test is administered in class that requires an 80% passing grade to get credit for the course

Course FN 000213 **Revision 12/2013**

Compressed Gas Cylinder Safety Course

Required Reading For Test Purposes

1. Compressed Gas Cylinder Safety - at the beginning of book
2. Compressed Gas Cylinder Shoulder Markings and Interpretations (1 page)
3. Safety Bulletin (SB-8-1998) Use of Oxy-Fuel Gas Welding
4. Safety Bulletin (SB-12-1998) Use of Regulator Pressure Gauges
5. Safety Advisory (SA-2-1996) Acetylene Safety Alert

The remaining inserts in this booklet are for your information. This booklet is yours to keep as a reference.

BRING A #2 PENCIL AND AN ERASER TO CLASS FOR TEST TAKING

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Course Format

In class, the instructor will show a 27 min video produced by the Compressed Gas Association titled " Safe Storage and Handling of Compressed Gases".

After the video there will be a question and answer period.

Afterwards a test will be administered consisting of multiple-choice questions based on the information contained in this booklet (see above). You need to obtain a grade of 80 percent or better to get credit for the course.

After completing the test, students will be given a course critique sheet that can be filled and turned in after the course or can be sent via internal mail to R. Coll/Mail-Stop: 119.

It is not necessary to bring the handout to class, but it is recommended.

The study material sent to you is for you to keep and use as a reference.

Bring a #2 pencil and an eraser to class

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COMPRESSED GAS CYLINDER SAFETY

(Training Study Material)

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INTRODUCTION:

This study guide will give you the practical information needed to handle compressed gas cylinders safely. You should be trained before using compressed gas cylinders. This training program is designed to give you the information necessary to handle compressed gas cylinders safely and to minimize possible risks. Handling compressed gas cylinders can potentially be dangerous, it is important that you understand handling procedures of compressed gas cylinders. It is also important that you be aware of hazardous conditions that can lead to or cause accidents. There are three main sources for the information contained in this study guide, the Fermilab ES&H Manual, the Code of Federal Regulations and the Compressed Gas Association P-1 standard- Safe Handling of Compressed Gases in Containers.

LEARNING OBJECTIVES:

You will be administered a test in order to check comprehension and understanding of proper techniques for using and handling compressed gas cylinders. By choosing the correct answers on the quiz you will demonstrate the degree of knowledge gained from the printed material and from the training video produced by the Compressed Gas Association that will be shown in class. You need to score at least 80% to successfully pass the test.

Without references you should be able to:

1 . Identify safe work practices for handling compressed gas cylinders.
2. Identify safe work practices for storing compressed gas cylinders.
3. Identify safe work practices for using compressed gas cylinders.
4. Identify the characteristics of oxidizers, inert, flammable and poisonous gases.
5. Identify the elements of external cylinder inspection, indicating that cylinders are in safe condition.

Consider these questions when watching the videotape in class:

1. How should compressed gas cylinders be lifted?
2. How should compressed gas cylinder be moved?
3. How are leaks located on a cylinder?
4. Should cylinders be repainted?
5. What needs to be done in an emergency?

Definitions

Charging - Synonym sometimes used by regulatory agencies for the word filling.
Corrosive gas- Gas that when in contact with living tissue causes destruction of the tissue by chemical action.

Cryogenic liquid container- Pressurized, double-walled, insulated container used to hold either cryogenic liquefied gas or refrigerated liquefied gas.

Cryogenic liquid Refrigerated- Liquefied gas having a boiling point colder than -90 ·C (-130 ·F) at 101.3 kPa, abs (14.7 psia).

Cylinder - Generally a compressed gas container having a maximum water capacity of 454 kg (1000 Ib).

Flammable gas- Gas that at ambient temperature and pressure forms a flammable mixture with air at a concentration of 12 percent (or less) by volume.

Handling- Moving, connecting, or disconnecting a compressed or liquefied gas container under normal conditions of use.

Inert gas- Variety of gases that are practically inactive at standard conditions.

Nesting - Method of securing flat-bottom cylinders upright in a tight mass using a contiguous three-point contact system whereby all cylinders within a group have a minimum of three points of contact with other cylinders, walls, or bracing.

Nonrefillable cylinder- Cylinder designed and constructed in accordance with DOT or TC regulations and, by those regulations, can be filled and discharged only once

Normal temperature and pressure- Temperature of 21 °C (70 °F) and an absolute pressure of

Oxidizing Gas- Gas that in the presence of an ignition source and a fuel supports and can vigorously accelerate combustion.

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

Pressure relief device - Pressure and/or temperature-activated device used to prevent the pressure from rising above a predetermined maximum, and thereby preventing rupture of a normally charged container when subjected to a standard fire test required by DOT or TC regulations.

NOTE-The term pressure relief device (PRD) is synonymous with safety relief device as used in DOT and TC regulations.

Transfilling- Transfer of cryogenic liquid and/or compressed gas from one container to another.

Valve protection cap - Rigid removable cover provided for container valve protection during handling, transportation, and storage.

Safe Work Practices For Handling Compressed Gas Cylinders (General Precautions).

The following shall apply to users when using or handling compressed gas containers:

Identify the content of the cylinder only by the label placed on the cylinder by the transfiller. Color shall not be used to identify the content of the container. ONLY medical gases are identified by color in accordance with *CGA C-9- Standard Color Marking of Compressed Gases Intended for Medical Use.*

Compressed gas cylinders shall not be used as rollers, supports, or for any purpose other than to contain and use the contents as received. There is one minor exception to "rolling" a cylinder. A cylinder may be rolled on its bottom edge but never dragged when moved short distances.

Containers shall not be placed where they might become part of an electrical circuit. When compressed gas containers are used in conjunction with electric welding, they shall not be grounded or used for grounding. These precautions prevent the container from being damaged by the electric welding arc;

Compressed gas containers shall not be exposed to temperature extremes. High temperatures can result in excessive pressure. Never apply a flame or heat directly to any part of a compressed gas container or allow it to come in contact with an electrically energized system. High temperatures also can damage the physical integrity of the container. If ice or snow accumulates on a container, thaw at room temperature or with water at a temperature not exceeding 125 °F (51.7 °C).

If compressed gas containers have been exposed to fire, contact the gas supplier immediately. Do not ship these containers unless authorized by the gas supplier.

Containers shall not be subjected to artificially created low temperatures without the approval of the gas supplier. Many steels undergo significantly decreased impact resistance and ductility at low temperatures;

Some non-cryogenic liquefied gases have relatively low vapor pressures at low ambient temperatures. These products might require the use of check valves to prevent back flow into the container;

Leaking or defective components (valve caps, seals, pressure relief devices, cylinders etc.) shall not be offered for shipment. Consult the gas supplier for advice under these circumstances;

When a container or valve is noticeably corroded, dented, cut, damaged or involved in an accident (dropping, struck etc.) notify the gas supplier and follow the instructions.

Compressed gas streams should not be directed toward any person. This could cause serious injury to the eyes or body; and

Non refillable cylinders shall not be refilled with any material after use of the original contents. After usage, dispose of such cylinders in accordance with the cylinder manufacturer's recommendations.

Use cranes, derricks and cradles, boats or other suitable platforms to lift cylinders. Do not use slings, or magnets.

Valve protection caps should not be used for lifting a cylinder from one vertical position to another. Do not use bars to pry a cylinder loose if it is frozen to the ground.

All compressed gas cylinders in service or in storage at user locations shall be secured to prevent falling or rolling.

Cryogenic liquid cylinders shall always be stored upright.

Cryogenic liquids can cause thermal burns upon contact with the body. When handling cryogenic liquids, wear eye protection such as a face shield and either safety glasses or safety goggles to protect against the extremely cold liquid and gas. Wear hand protection such as insulated gloves to prevent contact with cold liquid, cold gas, and cold equipment or piping. Gloves should be loose fitting so they can be readily removed if liquid splashes into them. Wear long-sleeved shirts and cuffless trousers over (outside) high-topped shoes to prevent spills from being trapped in shoes or allowed to contact the feet.

Transportation in passenger vehicles- The transportation of compressed gas cylinders in unsuitable vehicles or in closed-bodied vehicles can present serious safety hazards and should be discouraged. Refer to CGA PS-7, CGA *Position Statement* on *the Safe Transportation of Cylinders in Passenger Vehicles,* for additional guidance (included with this booklet).

- Leaks can develop for a variety of reasons. Container leaks can be due to corrosion, cracking, poor maintenance and care, or damage. Valve leaks can be due to improper blocking or securing of cylinders or inadequate valve protection. leaks from safety relief devices can occur from extended confinement in an enclosed compartment
(trunk or passenger compartment) that is subjected to excessive heating by the sun;
- Leaking flammable gases can present a serious fire and/or explosion hazard. Transport liquefied flammable gas cylinders in the upright position. The PRD always shall be in direct communication with the gas phase. Never put cylinders in trunks of cars or unventilated areas of passenger vehicles;
- Oxidizing gases, while not flammable themselves, present additional hazards. In the presence of an ignition source and fuel, they can support and vigorously accelerate combustion in an enclosed vehicle;

- Inert gases can cause asphyxiation in an enclosed vehicle by displacing the oxygen in air that is necessary to sustain life; and,

- Shipping compartments should be adequately ventilated and not allowed to exceed 125 °F (51.7 °C). The trunk and passenger area of a vehicle can reach temperatures in excess of 125°F (51.7°C) quite easily on a warm or sunny day especially when the vehicle is parked in the sun.

Simple Housekeeping Procedures

The following are housekeeping items to remember when working with all compressed gas cylinders:

When you're unsure about the proper handling of a compressed gas cylinder or its content, consult the manufacturer or supplier. Information about the gas is available from your Senior Safety Officer, or on the Safety Data Sheet (SDS), kept in the Right-to-Know folder in your work area. It contains the material's identity, hazardous ingredients and the name, address, and phone number of the manufacturer. The person handling the cylinder and connections is responsible for checking the identity of the gas by reading the label or other markings on the cylinder before using it. If the content is not clearly marked, do not use it. Return it to the supplier as soon as possible. If a foreign substance enters a cylinder or the valves are damaged, notify the owner or manufacturer. Be prepared to provide details about the incident and serial number of the cylinder involved.

Keep oily substances away from cylinders, valves, coupling hoses and other apparatus. Valves on empty cylinders should be kept closed at all times.

Keep valve protection caps in place when cylinders are moved or not in use. Screw the protection cap all the way down.

Close cylinder valves when the job is finished.

When transporting compressed gas cylinders outside your work area:
• make sure the valves are closed,
• remove the regulators,
• make sure the protection cap is in place and
• secure the cylinder on a cylinder cart.

NEVER use compressed gases to dust off clothing or skin, as this may cause serious injury to the eyes and/or body in the form of an air embolism in the bloodstream which can lead to heart failure. Compressed air used for cleaning purposes must be reduced to less than 30 psig (pounds per square inch gauge, 204 kPa). Compressed air used for cleaning is only permitted with effective chip guarding and personal protective equipment to protect the operator and other employees from the hazards of the release of compressed air and flying debris.

Transporting Dewars and Cylinder In Enclosed Elevators

Chapter 5032.3 of the Fermilab ES&H Manual describes the procedure for moving dewars and cylinders in enclosed elevators. Refer to this section if you need more information on pressurized gas safety.

This procedure is to be followed when transporting dewars not clearly empty., whether open or closed mouth crygenic dewars, in enclosed elevators. Open wide mouth (a.k.a. open-flask style) dewars are not to be used to transport liquid in elevators.

Before placing the dewar on the elevator, inspect it for the following:

1) No frost, sweating, or venting of dewar contents may be present when transporting a dewar.
2) Close the pressure building valve on any dewar transported in an elevator.
3) The pressure of the dewar must be less than 1/2 of the pressure setting of the dewar's main relief valve.

When moving the dewar:

1). Personnel are only permitted to ride on an elevator carrying clearly empty dewars.Only trained personnel may accompany dewars in elevators.

2). Not more than two people will be allowed on the elevator with the dewar.

3) In Wilson Hall elevators, the operator will use a lockout key to prevent the elevator from stopping, except on the desired floor. The key can be obtained from the Communications Center.

4). Not more than two dewars containing liquid may be moved on an elevator at a time.

This procedure is to be used for moving all gas cylinders in enclosed elevators:

The valve protection cap must be securely in place.
Cylinders should be belted or chained to an approved cylinder cart.

Safe Work Practices for Storing Compressed Gas Cylinders

A material safety data sheet (MSDS) must be available for each type of compressed gas used or stored. The MSDS is an excellent source of information on hazardous chemicals.

Store gas cylinders secured and in an upright position with the cylinder cap on at all times. Racks containing small cylinders must be secured with special attachments. Fuel gas cylinders must be stored with valve end up. Liquefied gases should also be stored and shipped with the valve end up.

Empty and full cylinders must be segregated within a rack. Empty cylinders must be clearly marked within a storage area. Storage areas must be labeled for each specific gas. Storage areas must be well ventilated and away from combustible materials.

No Smoking signs must be posted and clearly visible. This is a precaution against fires and explosion. Ventilation protects workers from asphyxiation since practically all gases displace oxygen in the air.

Flammable gas cylinders and oxidizer cylinders must be separated by 20 feet or by a non-combustible barrier 5 feet high with a fire resistance rating of at least one half hour. Provide fire resistant shields. Do not allow ignition sources such as torches or cigarette lighters, or lighted cigarettes in the area. Sparks or flames should never be permitted to come in contact with any part of a compressed gas cylinder.

Store cylinders in an assigned place away from radiators, elevators, stairs or gangways. These areas should protect cylinders from being knocked over, damaged by falling objects, tampering or anything that could ground electrical circuits.

Exits should never be blocked for any **reason.**

Temperatures

Cylinder storage areas should be maintained at a constant temperature. Cylinders containing compressed gases should not be subjected to a temperature above 125° F. Many steels undergo decreased ductility at low temperatures. Cylinders should not be subjected to artificially created low temperatures without the supplier's approval.

Safe Work Practices For Using Compressed Gases

A ruptured compressed gas cylinder can cause severe damage and serious injuries. This hazard can be avoided with proper handling techniques. Always handle cylinders carefully and never roughly. Do not drop cylinders, bang safety devices or valves.

Cylinders without fixed hand wheels must have keys, handles or non-adjustable wrenches on valve stems while in service. Use one key (or handle) for each manifold on multiple cylinder installations.

Avoid complete removal of the stem from cylinder valves. This is necessary to quickly close a cylinder valve in case of an emergency.

If there is an operational problem with a compressed gas cylinder, send it back to the manufacturer. Do not use a hammer or wrench to open a cylinder valve. Never tamper with or repair cylinder valves.

NOTE: Do not mix gases in a cylinder.

When using a non-liquefied compressed gas from a container (except acetylene), the pressure should not be reduced below the operating pressure of the system or not less than 20 psig (138 kPa) to prevent the backflow of atmospheric air or other contaminants into the container.

Stand to the side when opening a cylinder, always open cylinder valves slowly.

Before connecting a regulator, open the cylinder valve slightly and close it immediately. This will clear any foreign matter from the opening. Never open or clear a regulator near a source of ignition.

Connect an oxygen regulator to the valve on an oxygen cylinder before using it, unless it is connected to a manifold.

Do not put anything on top of an acetylene cylinder, when in use, which may prevent the quick closing of the valve. An acetylene cylinder valve must not be opened more than 1 1/2 turns of the spindle, and preferably no more than 3/4 of a turn.

Never bring a compressed gas cylinder into a confined space.

If a compressed gas cylinder is leaking follow these precautions:

- Move it outdoors well away from any source of ignition.
- Plainly tag the cylinder to warn others.
- A regulator may be used temporarily to stop a leak through the valve seat.
- Open the cylinder slightly to allow the gas to release slowly.
- Keep the area free of visitors.
- Notify the gas supplier and follow his recommendations.
- Notify the fire department.

Residual Container Pressure- When using a non-liquefied compressed gas from a container (except acetylene), the pressure should not be reduced below the operating pressure of the system or not less than 20 psig (138 kPa) to prevent the backflow.

Acetylene shall never be used in its free state at pressures in excess of 15 psig (103 kPa). The container valve shall be closed hand tight to retain this residual pressure.

Removing the pressure regulator- Before a regulator is removed from a container, close the container valve and relieve the regulator of gas pressure.

Characteristics of Oxidizers, Inert, Flammable and Poisonous Gases

Before using a highly toxic or Poisonous gas read all the information on the container label and the Material Safety Data Sheet (MSDS) associated with the product. Take all precautions recommended on the MSDS.

Flammable gases

Some gases become flammable when mixed with air in small amounts (13% or less by volume).

Examples of flammable gases include acetylene, butadiene, carbon monoxide, ethane, ethylene, hydrogen, hydrogen sulfide, the liquefied petroleum gases, methane, methyl acetylene propadiene, and vinyl chloride.

Carbon monoxide is odorless, colorless, toxic, and flammable. It is important to wear the personal protective equipment (PPE). Because of these characteristics, all leaks must be eliminated before a system is placed in operation.

Acetylene is a highly reactive flammable gas and can be stored safely only in cylinders specially designed for acetylene service. Handling procedures for flammable gases:

Prevent fires by eliminating all leakage of flammable gases, proper ventilation and by storing gases in accordance with safe practices.

Never use fuel gas from cylinders through torches or other devices equipped with shut off valves without a pressure reduction device. Attach a suitable regulator to the cylinder valve or manifold. Always make special wrenches available for use. When those wrenches are required, leave them in position on the valve stem so that the fuel gas flow can be quickly turned off while the cylinder is in use.

Acetylene containers should be stored with the valve end up (the container axis may be inclined as much as 45 degrees from the vertical) to lessen the possibility of solvent being discharged. Cylinders are designed to be used in an upright position. All other cylinders may be inclined up to 45 degrees from the vertical and still be considered to be in an upright position. There are some cylinders that are designed to be used in a horizontal position such as propane cylinders in forklifts but those are clearly identified.

Inert gases

Inert gases such as argon, carbon dioxide, helium, krypton, neon nitrogen, and xenon are simple asphyxiants that can displace oxygen in the air, and can cause suffocation. When the normal amount of oxygen in the air is reduced by displacement with an inert gas, it is a potential hazard to employees. Reduced concentration of oxygen in the air causes sleepiness, fatigue or loss of physical coordination, even death.

Poisonous Gases

Storage of highly toxic or poisonous gases must be outdoors, or in a separate non-combustible building without any other occupancy. Poison gases such as arsine, diborane, methyl bromide, nitric oxide, nitrogen dioxide, phosgene, and phosphine can cause potential hazards to personnel and requires special handling.
These products must never be handled except by specially trained personnel who are fully aware of the potential hazards involved and who are equipped with such special personal safety gear as is necessary in the handling of these products.

Oxidizing gases

Oxygen and gas mixtures containing large quantities of oxygen react chemically with organic materials to produce heat. Keep all flammable materials and possible sources of ignition away from oxygen or gas mixtures containing high concentrations of oxygen. The manufacturer or supplier must specifically clean all equipment used for oxygen service. This includes oxygen gases or liquids. All traces of oils, greases or gas mixtures containing a high concentration of oxygen must be completely removed.

External Indicators of Compressed Gas Cylinder Condition

Never force regulator-to-cylinder connections that do not fit. Make sure the valve connections are properly mated; otherwise the threads may be stripped. Threads on regulator connections or other auxiliary equipment must be the same as those on the cylinder valve outlet.

Inspect compressed gas cylinders for the following defects:

- Defective valves and safety devices

Pressure relief devices should prevent the pressure from rising above a pre-determined maximum. It should also prevent a rupture in a normally charged cylinder when subjected to a standard fire test.

Make sure safety devices are assembled correctly and valve handles are not bent or stiff.

- Leaking

Look for defects in a welded or brazed seam, at a threaded opening or sharp dents, digs, gouges or pits.

- External corrosion

A cylinder must be condemned when the tare weight is less than 90% of the original stamped weight. Excessive pitting affects wall thickness. Look for crevice corrosion more than 3 inches long.

- Bulging

Cylinders have a symmetrical shape. Cylinders with visible bulges must be removed from service and evaluated.

- Dents

Sharp, defined dents or dents near a weld should be rejected.

- Other overheating (fire, arc burns)

Burned base metal, or a hardened heat affected zone will create brittleness. Look for deposits of weld metal or displacement of base metal. Be aware of charred or burned paint (or other protective coatings), distorted cylinders, melted-out fuse plugs, burned or melted valves.

- Unauthorized or improper repair

Cylinders in need of repair should be returned to the manufacturer.

Internal inspections of compressed gas cylinders require special equipment. Cylinders returned to the manufacturer are inspected for the following:

- Internal deposits
- Internal corrosion
- Metal fatigue
- Manufacturing defects

Warnings should be placed on cylinder with leaking fuse plugs or safety devices (plainly tag). Notify the supplier about cylinder defects. Return defective cylinders promptly to the supplier.

Each cylinder must bear the Interstate Commerce Commission (ICC) label required for the compressed gas contained, except under certain specified conditions established in ICC regulations. Do not deface or remove any markings, labels, decals, tags and stencil marks used for identification of content attached by the supplier. Cylinders must be marked to indicate:

1) Manufacturing specifications,
2) Service pressure design,
3) Manufacturer's serial number,
4) Inspector's symbol,
5) Manufacturer's symbol.

These markings are stamped into the shoulder of the cylinder. (See the markings insert in this booklet).

Never identify the type of gas contained in a cylinder by the color of the cylinder. Do not repaint cylinders unless authorized by the owner.

Transfilling

The transfer of compressed gases from one container to another should be performed only by the gas supplier or by personnel:

- who are trained and qualified with the proper transfill equipment and written operating procedures; and ,

- who are familiar with the precautions necessary to avoid the hazards of the product being transfilled and with the procedures necessary to comply with all government standards and regulations.

SUMMARY

Cylinders must be secured.

Racks containing small cylinders must be secured by special attachments.

Storage areas must be labeled for the specific gases to be stored in those areas.

NO SMOKING signs must be posted and clearly visible.

Flammable gas cylinders and oxidizer cylinders must be separated by 20 feet or by a non-combustible barrier 5 feet high having a fire resistance rating of at least one half-hour. No ignition sources are allowed in the area.

Cylinders of all gases must be stored upright with the cylinder cap in place.

Empty and full cylinders must be segregated in the rack or otherwise clearly marked.

Cylinder storage areas must not be placed next to combustible materials or obstruct exit routes.

Storage areas must be well ventilated.

Take care in handling and storing compressed gas cylinders. If you have any questions about particular gases check the MSDS, or speak to the manufacturer or senior safety officer in your area. Following safety procedures will minimize the risks involved with handling compressed gas cylinders.

Compressed Gas Cylinder Shoulder Markings and Interpretations

Under the Department of Transportation (DOT) and Transport Canada (TC) regulations, each cylinder must be marked with the following information

- The specification under which they were made
- The service pressure for which they were designed
- A serial number of the manufacturer
- The symbol of the inspector (if required)
- A symbol indicating the manufacturer

These markings are stamped on the shoulder of the cylinder (the part sloping up to the neck or into the valve guard ring welded to the cylinder.

The markings of a typical cylinder might be arranged as follows on one side of the shoulder:

DOT-3A1800
1234
XYZ
AB 5-95

Or;

DOT-3A1800-1234-XY
AB 5-95

DOT-3A = specification number
1800 = service pressure Cylinders stamped DOT-3 or DOT-3E without pressure markings are filled to a service pressure of 1800 psig
1234 = manufacturers serial number
XY = symbol of manufacturer
AB = inspector's mark
5-95 = date of test

1) The DOT specification marking must appear first, followed immediately by the service pressure. For example, DOT-3A1800.
2) The serial number must be placed just below or immediately following the DOT specification marking. For example, 1234.
3) A symbol (letters) must be placed just below, immediately before or following the serial number. For example, XY. Other variations in sequence of markings are authorized only when necessitated by a lack of space. The symbol and numbers must be those of the manufacturer. The manufacturers symbol is registered with DOT. Duplications are not authorized.
4) The inspector's official mark and date of test (such as 5-95 for May 1995) must be placed near the serial number. This information must be placed so that dates of subsequent tests can be easily added.

Additional required marking must be applied to the cylinder as follows:
The word "spun"' or "plug"' must be placed near the DOT specification marking when an end closure in the finished cylinder has been welded by the spinning process, or effected by plugging.

Marking exceptions:

A DOT 3E cylinder is not required to be marked with the inspector mark.

Inspection Markings

Normally inspection markings are placed opposite to the cylinder markings or adjacent. The inspection mark will show the month and the last two digits of the year. For example 10-01 meaning October 2001. A (+) after the test date on specifications 3A, 3AX, 3AA, 3AAX or 3T means that the cylinder is authorized for charging up to 10 percent in excess of the marked service pressure.

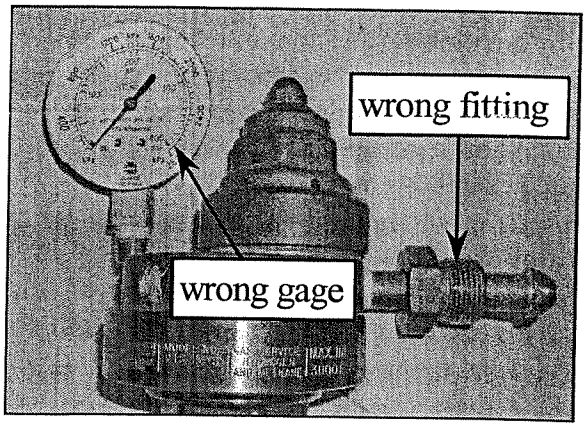
For specification DOT-3A or DOT-3AA cylinders, if a five pointed star is stamped after the most recent test date (or following the plus mark, if applied) it indicates that the cylinder may be retested every ten years instead of every five years.

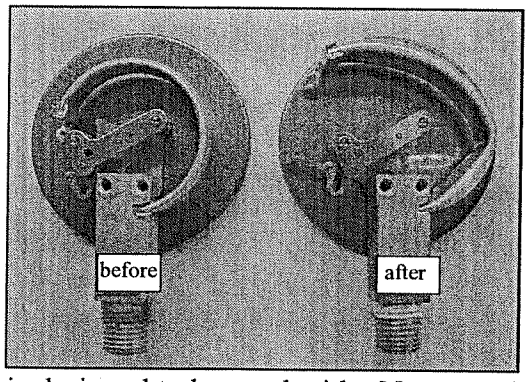
Fermilab ES&H Safety Flyer – Draft 2
Dan Olis
March 11, 2003

Pressure Regulator Safety

Hisss…POP! Doinggg…

The trap was sprung but, fortunately, nobody was hurt. Some Fermilab employee unwittingly set a booby trap by changing components on this gas regulator. Modifying two-stage regulators for use on compressed gas cylinders is unsafe and violates Fermilab safety rules. This regulator's 3000 PSI pressure gage was replaced with a 400 PSI gage. Also, the regulator's fitting was changed to allow a regulator manufactured for hydrogen and methane gas to be used on a nitrogen bottle.





The improperly rated gage was destroyed when an unsuspecting co-worker tried to use the regulator. The gage on the right shows how the gage deformed after being attached to a 2200 PSI gas bottle.

The fitting on the regulator is meant to ensure that it is being used safely. The regulator manufacturer installs a fitting style on the regulator to match the style on the gas bottle it is designed to be used with. Never replace the stem from one regulator with another to 'make it work' on the bottle you are using. By changing fittings, a person risks using the regulator at a pressure or with a gas it wasn't designed for. High pressures and incompatible gases can present explosion risks. Even a less dramatic failure that results in a gas leak can be dangerous. Gases themselves may be toxic or create an oxygen deficiency hazard by displacing breathable air.

Remember, gas under pressure is stored energy. Accidentally releasing this energy can have consequences similar to accidentally lighting explosives; people and property are put at risk. Be mindful if you work with pressure components and systems. Too often people use what they find in a drawer or on a shelf without considering whether it is safe.

When selecting a two-stage regulator, make sure it is the right type and doesn't appear damaged or tampered with. Do not attempt to repair or modify these regulators. Chapter 5031.3 of Fermilab's Environment, Safety, and Health Manual specifically addresses gas

regulator safety. It states, "No regulator is to be dismantled or altered in any fashion without specific approval of the ES&H Section Head." Instead, get the right regulator from the stockroom. FESHM 5031.3 lists the types of regulators available in Fermi stock.

When working with pressure systems, keep the following safety points in mind:

- Pressure systems should be shown the same level of caution given to electrical systems.
- Fermilab employees and users working with pressure systems should have appropriate training. If you haven't had the training or are uncomfortable with a system, ask your supervisor to review your Individual Training Needs Assessment (ITNA).
- Keep training handouts and review them when questions arise.
- Refer to the Fermilab ES&H web page for safety information and rules.
- Address unanswered questions to your supervisor or safety officer.

When in doubt, find out:

If you have any question about the safety of what you are doing, stop work and get answers.

Safery Bulletin 8 - Use of Oxy-Fuel Gas Weldir

Safety Bulletin

SB-8— 1998

USE OF OXY-FUEL GAS WELDING AND CUTTING APPARATUS

Oxy-fuel gas welding and cutting apparatus can be used safely. However, FAILURE TO TAKE BASIC SAFETY PRECAUTIONS CAN RESULT IN SERIOUS PERSONAL INJURY AND MATERIAL LOSS.

Following the DOs and DO NOTs listed here could reduce the chance of a serious accident.

DOs

DO carefully read the equipment manufacturer's operating instructions before using the equipment. If you do not have the operating instructions, get a copy from the equipment's manufacturer or its local distributor or get a copy of general instructions. Some general instructions may be found in the additional information sources at the end this document.

DO have a qualified person demonstrate the proper operating procedures before attempting to install or use the equipment unless you are already familiar with the equipment.

DO follow the equipment manufacturer's operating instructions at all times. Deviation from these instructions could result in injury and/or property damage.

DO inspect oxygen regulators before installing them on cylinders. Inlet connections shall be clean. If there is evidence of oil, grease, or other contaminants on the nut, nipple, or filter, have the regulator inspected and cleaned by a qualified repair facility before use.

DO inspect the oxygen cylinder valve outlet connection before attaching the regulator to ensure that there is no oil, grease, or other contaminants present. Return the cylinder to the supplier if any contamination is evident or if the valve is damaged.

DO back off the pressure adjusting screw of the regulator to release spring force before opening the cylinder valve.

DO open the cylinder valves very slowly. Opening oxygen valves quickly could result in a violent reaction if contaminants are present.

DO stand with the cylinder between yourself and the regulator (cylinder valve outlet facing away) when opening the cylinder valve.

DO use protective clothing and appropriate eye protection when operating oxy-fuel gas apparatus. Severe injury can result from sparks, splashing metal, and intense light.

DO purge hose lines individually before lighting the torch tip. This will ensure that no oxy-fuel gas mixture is present in the hoses, which could cause an explosion or fire when the torch is ignited.

DO ensure that the work area is kept free of combustible materials. Sparks can ignite materials such as paper, rags, wood, and plastic and cause serious fire damage. Sparks can fly 35 ft (10.7 m) or more.

DO ensure that the work area is adequately ventilated. Welding, cutting, and heating processes can enrich or deplete the oxygen concentration of the air. An oxygen-deficient atmosphere can cause suffocation in seconds while an oxygen-enriched atmosphere is a severe risk for accelerated fire or explosion. See publication 5 under additional information.

DO have equipment inspected periodically and have repairs made by a qualified repair facility.

DO ensure that hose line check valves and flash arrestors are inspected and tested at the regular interval recommended by the manufacturer so that they function as intended.

DO NOTs

DO NOT handle oxygen regulators, oxygen cylinders, valves, or any other equipment with oily or greasy hands or gloves. Oxygen reacts with oil and grease in a manner that will easily result in fire or explosion.

DO NOT attempt to repair or substitute parts on equipment, particularly regulators. Special tools, cleaning procedures, and techniques are needed to safely repair oxy-fuel gas welding and cutting apparatus. Qualified personnel should make repairs using the parts and procedures specified by the equipment manufacturer.

DO NOT change regulators from one gas service to another or replace a pressure gauge with one taken from any other service. Contamination that results in a fire or explosion can occur.

DO NOT use oxygen in place of compressed air to supply pneumatic equipment, tools, hoses, or blow guns. A serious fire or explosion can result.

DO NOT blow dirt off clothing with oxygen. The fabric can become saturated and burst into flames if touched off by an ignition source such as a spark, flame, or cigarette.

DO NOT enter an unventilated confined space without first ensuring that the oxygen concentration is at a safe level. Use an oxygen analyzer to measure the concentration.

DO NOT use acetylene at operating pressures above 15 psig (103 kPa). This is the maximum working pressure permitted by federal regulations.

DO NOT empty an oxygen cylinder below 25 psig to 50 psig (172 kPa to 345 kPa). If the oxygen cylinder is allowed to become completely empty, it will lose its positive pressure, and fuel gas or other contamination may enter the cylinder creating a hazardous situation.

DO NOT transfill or refill oxygen or fuel gas cylinders. Return them to the gas supplier for proper testing and filling. Special procedures and requirements are necessary to safely fill cylinders.

DO NOT leave pressure in a regulator when it is not in use. Close the cylinder valve, drain the hose in a safe location, and back off the regulator pressure adjusting screw to release spring force.

DO NOT smoke when oxygen or fuel gases are present. Smoking can be an uncontrolled source of ignition causing fire or explosion.

Additional information

1. Publication No. 78-138, *Safety and Health in Arc Welding and Gas Welding and Cutting*, National Institute for Occupational Safety and Health, 4676 Columbia Parkway, Cincinnati, OH 45226.

2. ANSI/AWS C4.2, *Operator's Manual, Oxyfuel Gas Cutting*, American Welding Society, 550 N.W. LeJeune Road, Miami, FL 33126.

3. ANSI/AWS Z49.1, *Safety in Welding, Cutting and Allied Processes*, American Welding Society, 550 N.W. LeJeune Road, Miami, FL 33126.

4. CSA W117.2, *Safety in Welding, Cutting and Allied Processes*, Canadian Standards Association, 178 Rexdale Boulevard, Etobicoke, ON CANADA M9W 1R3.

5. CGA P-14, *Accident Prevention In Oxygen-Rich and Oxygen-Deficient Atmospheres*, Compressed Gas Association, 1725 Jefferson Davis Highway, Suite 1004, Arlington, VA 22202.

6. CGA TB-3, *Hose Line Flashback Arrestors*, Compressed Gas Association, 1725 Jefferson Davis Highway, Suite 1004, Arlington, VA 22202.

7. CGA SB-11, *Use of Rubber Welding Hose*, Compressed Gas Association, 1725 Jefferson Davis Highway, Suite 1004, Arlington, VA 22202.

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Safety Bulletin 10 - Correct Labeling and Prope

Safety Bulletin

SB-10— 1998

CORRECT LABELING AND PROPER FITTINGS ON COMPRESSED GAS CONTAINERS

It is essential that any person handling a container of compressed gas or cryogenic liquid be certain of the contents before the container is connected to a system. Discharging a gas or cryogenic liquid into a system not intended for the material could cause a fire, explosion, equipment failure, gas leak, or other hazard resulting in a serious or fatal injury.

Before attempting to connect a container to a system, be certain of the following:

– Personnel using the container are trained and knowledgeable regarding the product, container, fittings, equipment, and proper connection procedures.

– The container is clearly and properly marked or labeled with the identification of the contents, and there are no conflicting markings, labels, or coloring. *Do not rely solely on on the color of the container to identify the contents.* If there is any conflict or doubt about the contents, do not use the container.

– The labeled contents are the correct product for use in the system.

– The container has the proper outlet connection(s) for its contents according to ANSI/CGA V-1, *American National, Compressed Gas Association Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections* [1].

– The connection(s) on the container and the system fit together properly without being too loose or too tight. A proper connection will go together smoothly. Do not use adapters or excessive force.

See CGA P-1, *Safe Handling of Compressed Gases in Containers*, and CGA C-7, *Guide to the Preparation of Precautionary Labeling and Marking of Compressed Gas Containers*, for additional information [2, 3].

***WARNING**: Failure to follow these precautions has caused fatalities.*

[1] ANSI/CGA V-1 *American National, Compressed Gas Association Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections*, Compressed Gas Association, Inc., 1725 Jefferson Davis Hwy., Suite 1004, Arlington, VA 22202.

[2] CGA P-1, *Safe Handling of Compressed Gases in Containers*, Compressed Gas Association, Inc., 1725 Jefferson Davis Hwy., Suite 1004, Arlington, VA 22202.

[3] CGA C-7, *Guide to the Preparation of Precautionary Labeling and Marking of Compressed Gas Containers*, Compressed Gas Association, Inc., 1725 Jefferson Davis Hwy., Suite 1004, Arlington, VA 22202.

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Compressed Gas Association

Safety Bulletin

SB-12— 1998

USE OF REGULATOR PRESSURE GAUGES

General precautions

Oxygen and hydrocarbons (oil and grease are common hydrocarbons) under certain conditions can react violently, resulting in explosions, fire, and damage or injury to personnel and property. Never allow oil or grease to come in contact with any external or internal part of the threaded fitting or internal portion of the pressure element assembly of oxygen gauges. Even a minute amount of hydrocarbon can be hazardous in the presence of oxygen.

Regulator gauges should be installed or replaced only by qualified personnel who have been properly instructed.

Installation precautions

DO maintain the pressure element assembly and connection cleanliness level required for the intended application.

DO refer to the manufacturer's instruction manual for the correct pressure ranges to be used.

DO use the wrench flats provided on the gauge connection and the proper size wrench to secure the gauge to the regulator.

DO use only the thread sealant recommended by the regulator manufacturer for the specific application.

DO NOT install a low pressure gauge into the high pressure port on a regulator.

DO NOT use the gauge case for wrenching.

DO NOT interchange gauges from one gas application to another.

DO NOT exchange gauges from one regulator to another.

DO NOT conduct calibration verification using air from shop air lines, oil, or a contaminated pressure source.

DO NOT remove the restrictor installed in the gauge connection. The restrictor limits gas flow and aids in limiting temperature rise due to adiabatic compression.

Operation precautions

Gauges can fail during operation and the energy contained in the compressed gases can produce violent effects should the pressure element assembly rupture.

DO always apply cylinder pressure slowly. Heat due to adiabatic compression can cause ignition.

DO use safety glasses or provide eye protection.

DO stand with the cylinder between yourself and the regulator (cylinder valve outlet facing away) when opening the cylinder valve.

DO read CGA Safety Bulletin SB-8, *Use of Oxy-Fuel Gas Welding and Cutting Apparatus.*

DO NOT stand in front of or behind the pressure gauges when applying cylinder pressure to the regulator. This will reduce the possibility of injury from flying parts should the pressure element assembly rupture.

DO NOT operate regulators without eye protection.

Related documents*

ASME B40.1	*Gauges—Pressure Indicating Dial Type—Elastic Element* *The American Society of Mechanical Engineers* *345 East 47th Street* *New York, NY 10017*
CGA SB-8	*Use of Oxy-Fuel Gas Welding and Cutting Apparatus* *Compressed Gas Association, Inc.* *1725 Jefferson Davis Highway* *Arlington, VA 22202-4102*
CGA E-4	*Standard for Gas Pressure Regulators* Compressed Gas Association, Inc. 1725 Jefferson Davis Highway Arlington, VA 22202-4102

UL 404	*Gauges, Indicating Pressure, for Compressed Gas Service* *Underwriters Laboratories, Inc.* *333 Pfingsten Road* *Northbrook, IL 60062*
UL 252A	*Compressed Gas Regulator Accessories* Underwriters Laboratories, Inc. 333 Pfingsten Road Northbrook, IL 60062
AWS C-4.2	*Operator's Manual for Oxy-Fuel Cutting* American Welding Society P.O. Box 351040 Miami, FL 33135
ANSI/ASC Z49.1	*Safety in Welding and Cutting* *American National Standards Institute* *11 West 42nd Street* *New York, NY 10036*

* Related documents are the most current versions

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SECOND EDITION: 1998

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Safety Bulletin

SB-15— 1998

AVOIDING HAZARDS IN CONFINED WORK SPACES DURING MAINTENANCE, CONSTRUCTION, AND SIMILAR ACTIVITIES

Many workplaces contain spaces that are considered to be "confined" because they are small and have configurations that make it difficult for workers to enter and work in the spaces. In many instances employees and/or contractors working in confined spaces also face an increased risk of exposure to serious injury from hazards including hazardous atmospheres.

Examples of confined spaces are tanks, vessels, acetylene generators, silos, pits, boilers, large-diameter pipe and other enclosed areas. Since 90% of all incidents in confined spaces can be attributed to atmospheric conditions, it is important to know and understand the hazards.

Atmospheric hazards include:

– oxygen concentrations below 19.5% or above 23.5%;
– high concentrations of asphyxiants/inert gases;
– flammable levels in excess of 10% of the lower explosion limit (LEL) or lower flammability limit (LFL);
– toxic levels above their permissible exposure limits (PEL);
– airborne combustible dust at a concentration that meets or exceeds its LFL; and
– any other atmospheric condition that is immediately dangerous to life and health (IDLH).

Other hazards that may be present or introduced and must also be properly controlled are:

– hot work activities;
– engulfment hazards such as catalyst, perlite, etc.;
– solvent and epoxy use;
– working from an elevation; and
– entrapment by the configuration of the space.

To protect personnel while working in confined spaces you should:

– Provide proper training for attendants, entrants, permit issuers, and rescue personnel;
– Identify all hazard areas and hazards;

– Take measures to control or eliminate all hazards;
– Isolate the space;
– Ventilate the space as necessary;
– Continuously monitor the atmosphere for applicable hazards;
– Provide the proper personal protective equipment (PPE) and other safety equipment;
– Provide an attendant outside the space;
– Plan for any necessary rescue activities; and
– Use a permit to work system for confined space entry work.

In addition it is essential to maintain safe entry conditions for the duration of the entry.

This bulletin is intended to give general guidance when working in a confined space. Refer to CGA SB-2, *Oxygen-Deficient Atmospheres*, and CGA P-14, *Accident Prevention in Oxygen-Rich and Oxygen-Deficient Atmospheres*, concerning specific physical effects of oxygen-deficient or oxygen rich atmospheres [1, 2]. Most work performed in confined spaces must be conducted in accordance with the OSHA requirements defined in 29 CFR 1910.146 [3]. Local regulations may also apply.

NOTE—Oxygen content above 23.5% is considered a hazard due to accelerated combustion in such an atmosphere. Do not enter such an area without observing all precautions regarding oxygen-rich atmospheres.

References

[1] CGA SB-2, *Oxygen-Deficient Atmospheres*, Compressed Gas Association, Inc., 1725 Jefferson Davis Hwy., Suite 1004, Arlington, VA 22202.

[2] CGA P-14, *Accident Prevention in Oxygen-Rich and Oxygen-Deficient Atmospheres*, Compressed Gas Association, Inc., 1725 Jefferson Davis Hwy., Suite 1004, Arlington, VA 22202.

[3] *Code of Federal Regulations*, Title 29 CFR Part 1910 (Labor), Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

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Docket 96-26

Position Statement

PS-2–1990

CGA POSITION STATEMENT ON ESTABLISHING AN INDUSTRY STANDARD COLOR CODE FOR COMPRESSED GAS CYLINDERS

Question

Should a uniform, industry-wide color standard be established to identify by the color of the cylinder, the gas contained?

Answer

The Compressed Gas Association does not recommend a uniform color code for identifying cylinder contents.

Reasons

1. There are in excess of 100 different gases being commercially transported in this country today. From a color point of view, there are seven primary colors plus black and white in existence, so that provides nine colors to choose from, and over 100 commodities to identify, the only way of using colors would be to go into some program of striping or segmental painting of packages using different colors, and different shades of the same color. If this is done, then the color code, becomes another form of communication or language that is only understandable to one trained in that color code.

2. There are a sizable number of employees working in industrial establishments today that are either partially or completely color blind.

3.Industrial establishments today have many variations of atmospheric composition which often can have an effect on the color of paint on a piece of equipment.

4. The appearance of a single color can often change substantially if it is moved from daylight to various types of industrial lighting.

5. Cylinders used in industrial applications, are often subject to considerable abuse, and the

paint on their surface can frequently be largely obliterated from wear, thereby making identification of the color originally in use difficult.

6. The many years of transition, while older compressed gas packages of varying color combinations are emptied and returned to a source for filing and application of a new color code, would be a major source of confusion.

7. Labels, placards and/or markings already provide identification of each gas by means of color, symbol and text.

8. Color coding does not improve the means of identifying the content of compressed gas packages.

Summary

It has long been and continues to be CGA's position that the best means of identification of the content of any gas cylinder is by some form of the printed word. It is for this reason, that we have recommended for years the use of product labels or tags affixed to the shoulders of compressed gas cylinders at the time of filling, indicating the content.

On September 30, 1976, the Department of Transportation (DOT), Materials Transportation Bureau (MTB) published in the Federal Register, an Advance Notice of Proposed Rule Making to establish a system of Color Coding of Compressed Gas Packages.

On October 5, 1978, the DOT published in the Federal Register a Termination of Docket, stating

"Upon additional analysis and consideration of comments received, the Materials Transportation Bureau has concluded that further consideration of color coding of compressed gas packages is not justified."

The staff conclusions of the MTB on the major economic and public safety issues state,

"A uniform, nation-wide system of color coding compressed gas cylinders as a means of preventing serious cylinder accidents in the normal, routine environment characterizing the workplace or households is felt to be of little or marginal value as a safety measure: and the adoption of such a system may increase rather than decrease serious accidents involving such cylinders."

There were no comments received supporting the proposal. Joining the Compressed Gas Association and several member companies in submitting negative comments were the American Trucking Association, The National Society for the Prevention of Blindness, Inc., The Fire Equipment Manufacturers Association, Inc., the Florida State Fire Marshall's Office, the California Division of Industrial Safety, the Safety Department of the University of Wisconsin, and the Deputy Assistant Secretary to the Department of Labor.

Accordingly, the Compressed Gas Association does not recommend a system of color coding compressed gas containers to identify the contents in the U.S. and Canada.

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Reaffirmed by SEA Council, December, 1995

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Position Statement 7 - Safe Transportation of C

Position Statement

PS-7—1996

CGA POSITION STATEMENT ON THE SAFE TRANSPORTATION OF CYLINDERS IN VEHICLES

Question

What is the safe way to transport cylinders in vehicles?

Answer

Transporting cylinders in unsuitable vehicles has led to a considerable number of accidents, many of them resulting in death.

All compressed gases pose additional hazards when transported. As an example, flammable gas from a leaking container in the trunk of a car can be ignited by a spark from a brake light, tail light or turn signal.

As a second example, an unsecured or improperly secured cylinder could become dislodged during transport creating a hazard to vehicle occupants. Other hazards could be present such as asphyxiation, exposure to toxic / corrosive ingredients, high pressure or oxygen enrichment.

The preferred method of transporting compressed gas cylinders is with the supplier's truck. Alternatively, the customer can pick up, or arrange for pick up, in a suitable vehicle.

A suitable vehicle is one which:

- has adequate ventilation in the event of a product leak

AND

- has an adequate method of securing the cylinder during transportation

RECOMMENDED PRACTICES

1. All compressed gas cylinders or cryogenic liquid containers should be adequately secured in the vehicle before transporting. Adequately secured means the cylinder or container is not free to move while the vehicle is in motion. Member companies should not offer any cylinder or container for transport that cannot be adequately secured in an adequately ventilated area.
2. Specialized vehicles (e.g., ambulances, home liquid delivery vans / trucks) may be used to transport the products / containers for which they have been designed or modified to handle.
3. Products and containers must meet applicable Department of Transportation/Transport Canada requirements for labeling, marking and placarding, container specifications and shipping.
4. Table 1 shows the recommended maximum weight, or volume, of products that will be offered for transportation in each type of vehicle.

SUPPLIER RESPONSIBILITY

The following practices are recommended in cases where customers intend to use their vehicles:

1. Inform the customer of the potential hazards and appropriate regulations which apply to transportation of cylinders. Make written support information available (including the attached "NOTICE TO CUSTOMERS WHO WISH TO TRANSPORT CYLINDERS").
2. When required by regulation, make sure the valve outlet of the cylinder to be transported is sealed with a plug or cap. Valves must always be protected by a valve protective collar, a valve protection cap or other suitable means.
3. Ensure that cylinder is in good condition.
4. Check that a proper warning label(s) is affixed to the cylinder.
5. Provide applicable shipping papers and emergency response information to the customer.

NOTICE TO CUSTOMERS WHO WISH TO TRANSPORT CYLINDERS

The preferred method is to have the supplier deliver and pick up cylinders.

If you intend to transport a cylinder in your vehicle, please read this document outlining safety precautions that apply.

Compressed and liquefied gases are potentially hazardous for one or more of the following reasons:

- flammability
- oxygen enrichment
- toxic / poison exposure
- corrosivity
- cryogenic exposure (cold liquid or gas)
- asphyxiation
- pressure

Always read the product label to make sure you know what risks are present with the product you are transporting.

The following action steps are recommended for minimizing your risk during transportation:

CUSTOMER RESPONSIBILITY

1. Read the product label to confirm that you have the proper product and to identify the related hazards prior to loading the cylinder. Listen for leaks. Visually inspect the cylinder for dents, gouges or pits. Ensure that valve protection, where provided, remains in place until the cylinder is ready for use.
2. Make sure the cylinder is secured so that it will not move relative to the vehicle.
3. Maintain maximum ventilation in the area where the cylinder is stored (e.g., by keeping windows or storage compartments securely open).
4. DO NOT SMOKE when handling or transporting these products.
5. Take a route which is most direct – no intermediate stops. If possible, avoid routes with heavy traffic.
6. Be aware that environmental conditions (e.g., heat exposure) may cause the temperature of the cylinder to rise to excessive levels (even if the ambient temperature is relatively low) which could lead to a release of product.
7. When the destination is reached, immediately remove the cylinder from the vehicle.
8. Follow the equipment supplier's instructions for proper use and storage for the cylinder.
9. When returning the cylinder, follow the same precautions specified above.

While these safety precautions are based on portions of Title 49, CFR and Transport Canada, Transportation of Dangerous Goods Regulations and industry practices they should not be considered complete interpretations of all applicable regulations.

Please Note

Recognizing that homecare patients will have the need to transport oxygen in their personal vehicles, the spirit and philosophy of this position paper should be followed wherever practical. Please consult this and any detailed instructions provided by your oxygen supplier to cover this situation.

TABLE 1

RECOMMENDED MAXIMUM AMOUNT THAT WILL BE OFFERED FOR TRANSPORTATION

	Propane	Acetylene	Other Flammables Pyrophorics	Toxic	Oxidizers	Inerts	Cryogenic Liquids*
Passenger Car	20 lbs.	X	X	X	150 cu. ft.	150 cu. ft.	X
Station Wagon	20 lbs.	X	X	X	150 cu. ft.	150 cu. ft.	X
Passenger Van	20 lbs.	X	X	X	150 cu. ft.	150 cu. ft.	X
Commercial			✓	✓			✓

Van	_	_	^	^	_	_	^
Pickup Truck	_	_	X	X	_	_	_
Truck or Tractor Trailer (permanently separated cab)	_	_	_	_	_	_	_

* excluding personal medical requirement

X will not be offered for transportation in vehicle shown

_ no maximum (limited by size of vehicle)

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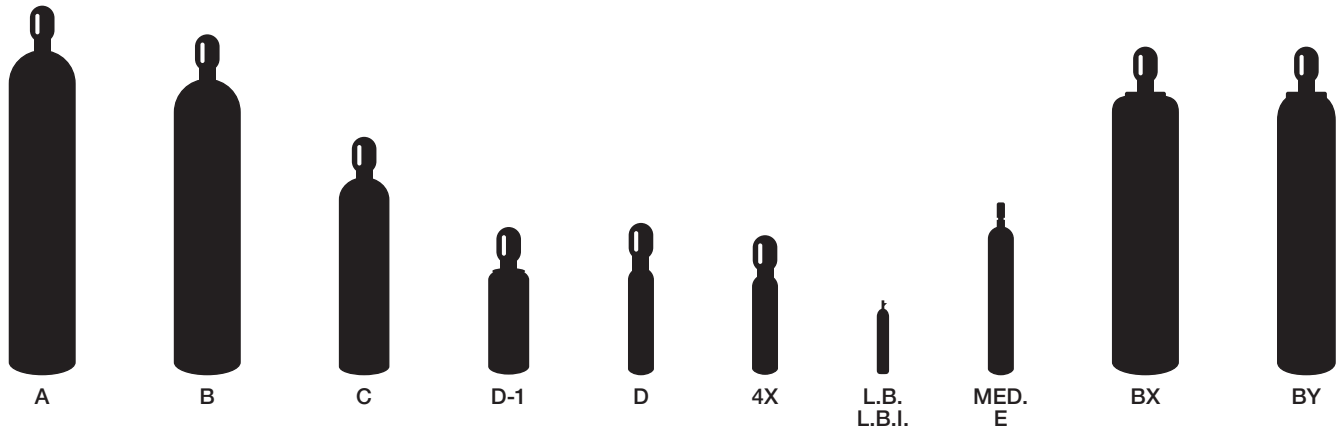
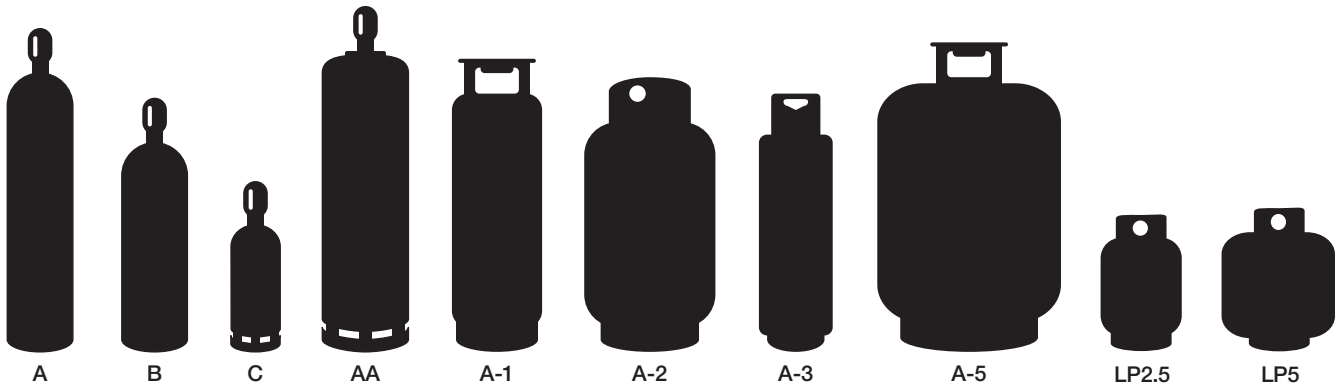
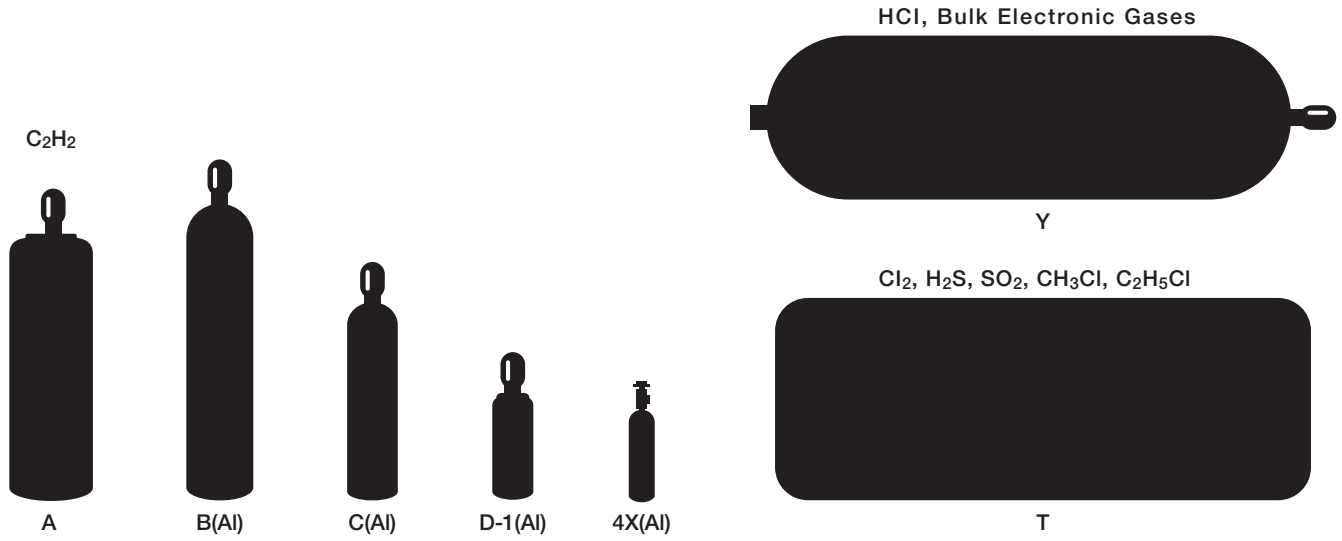
Specialty Gas Cylinder Information

High-Pressure



Low-Pressure





Specialty Gas Cylinder Dimensions

Size	Product Number Description Digits	DOT Specification	Nominal* Dimensions (Excluding Valve and Cap) in	(cm)	Average Tare Weight lb	(kg)	Average Internal Volume ft^3	(L)
High Pressure								
A	01	3AA2400	9 x 55	(23 x 140)	137	(62)	1.76	(49.8)
B	02	3AA2265	9 x 51	(23 x 130)	119	(54)	1.55	(43.9)
C	03	3A2015	7 x 33	(18 x 84)	57	(26)	0.56	(15.9)
D-1	04	3A2015	7 x 19	(18 x 48)	26	(12)	0.26	(7.4)
D	05	3AA2015	4 x 17	(10 x 43)	9	(4)	0.10	(2.8)
4X	46	3AA2015	4 x 13	(10 x 33)	6.6	(3)	0.075	(2.12)
L.B.I.	X6	3E1800	2 x 12	(5 x 30)	2	(0.7)	0.015	(0.43)
L.B.	06	3E1800	2 x 12	(5 x 30)	2	(0.9)	0.015	(0.43)
Medical E	07	3AA2015	4 x 26	(10 x 66)	14	(6)	0.16	(4.5)
BX	88	3AA6000	10 x 51	(25 x 130)	300	(136)	1.49	(42.2)
BY	89	3AA3500	9 x 51	(23 x 130)	187	(85)	1.53	(43.3)
Low Pressure								
A	09	3A480	10 x 49	(25 x 124)	85	(39)	1.93	(54.7)
B	10	3A480	10 x 36	(25 x 91)	90	(41)	1.28	(36.2)
C	11	3A480	8 x 22	(20 x 56)	33	(15)	0.53	(15.0)
AA	08	4AA480	15 x 52	(38 x 132)	160	(73)	4.46	(126.3)
A-1	91	4BW240	16 x 50	(41 x 127)	75	(34)	3.83	(108.5)
A-2	90	4BW240	22 x 48	(56 x 122)	167	(76)	7.64	(216.4)
A-3	92	4BA240	12 x 45	(30 x 114)	48	(22)	2.31	(65.4)
A-5	81	4BW240	30 x 57	(76 x 145)	315	(143)	16.00	(453.0)
LP2.5	92	4B240	9 x 17	(23 x 43)	14	(6)	0.4	(11.3)
LP5	93	4B240	12 x 18	(30 x 46)	18	(8)	0.77	(21.8)
C_2H_2								
A	18	8/8AL	12 x 41	(30 x 104)	185	(84)	2.36	(66.8)
HCl, Bulk Electronic Gases								
Y	37	3A1800	24 x 90	(61 x 229)	1,108	(503)	15.83	(448)
H_2S								
T	38	106A800X	30 x 82	(76 x 208)	2,254	(1,022)	25.82	(731)
SO_2, C_2H_5Cl, Cl_2, CH_3Cl								
T	45	106A500X	30 x 82	(76 x 208)	1,400	(635)	25.64	(726)
Aluminum								
A(Al)	31	3AL2216	10 x 52	(25 x 132)	90	(41)	1.64	(46.4)
B(Al)	28	3AL2015	8 x 48	(20 x 122)	48	(22)	1.04	(29.5)
C(Al)	29	3AL2216	7 x 33	(18 x 84)	32	(15)	0.56	(15.8)
D-1(Al)	30	3AL2216	7 x 16	(18 x 41)	15	(7)	0.21	(5.9)
4X(Al)	34	3AL1800	4 x 10	(10 x 26)	3.3	(1.6)	0.057	(1.61)
Nickel								
B	61	3BN400	7 x 45	(18 x 14)	88	(40)	0.65	(18.4)
D-1	56	3BN400	7 x 22	(18 x 56)	48	(22)	0.28	(8.0)
D-2	58	3BN400	5 x 15	(12 x 38)	10	(4)	0.10	(2.9)
Stainless Steel								
55 gallon	52	UN1A1	24 x 45	(61 x 114)	175	(79)	7.35	(208.2)
10 gallon	50	UN1A1	14 x 29	(35 x 74)	50	(23)	1.34	(37.8)
5 gallon	51	UN1A1	9 x 24	(23 x 61)	25	(11)	0.67	(18.9)

*These dimensions are not exact. They should not be used for engineering drawings or equipment specifications.

Specialty Gas Cylinder Size Comparison Chart

Approximate Dimensions (inches)	Air Products	AGA	Airgas	BOC (Airco)	Alphagaz (Liquid Air)	Praxair	Matheson	MG	Solkatronics	Scott Specialty Gases
High Pressure Steel										
24 x 90	Y	—	—	—	—	TO	—	—	—	—
9 x 55	A	049	300	300	49	T	1L	300	49	K
9 x 51	B	044	200	200	44	K	1A	200	44	A
7 x 33	C	016	80	80	16	Q	2	80	16	B
7 x 19	D-1	007	35	30	7	G	3	35	7	C
4 x 17	D	003	7	12	3	F	4	10	3	D
2 x 12	L.B.	LBR	L.B.	L.B.	L.B.	L.B.	L.B.	L.B.	—	L.B.
4 x 26	E	005	E	E	MEDE	ANE	3L	E	—	ER
10 x 51	BX	485	3HP	500	44H	6K	1U	3HP	—	—
9 x 51	BY	—	—	—	44H	3K	1H	2HP	—	—
Aluminum										
10 x 52	A(Al)	—	—	—	AT	—	—	—	—	—
8 x 48	B(Al)	A31	150A	150A	30AL	AS	1R	150AL	29A	AL
7 x 33	C(Al)	A16	80A	80A	22AL	AQ	2R	80AL	—	BL
7 x 16	D-1(Al)	A07	33A	30A	7AL	AG	3R	33AL	—	CL
M size cylinder 7 x 43 inches										

Additional Supply Modes — Bulk Specialty Gases and Chemicals

Many Air Products specialty gases and chemicals can be supplied in bulk quantity. Products available in bulk quantity are identified throughout the catalog by the symbols shown below:

Tank trucks are used for over-the-road transportation of cryogenic liquids. Liquid product is then transfilled to cryogenic storage tanks at customer locations.

Tube trailers (T.T.) provide over-the-road shipment of high-pressure gases, gaseous chemicals, and gas mixtures. The trailers serve as on-site storage systems at customer locations.

Cryogenic liquids such as nitrogen and helium are supplied in dewars (low-pressure cryogenic tanks) for larger requirements near customers' point of use.

If you are considering bulk supply, a representative from Air Products can discuss your requirements and the economics of alternate supply systems.

Cylinder Identification

Packaging and Color

Air Products uses a unicolor paint scheme to identify specialty gas cylinders. Here are the highlights of our cylinder packaging and color codes.

- Virtually all steel cylinder bodies are painted uniformly dark blue and covered with a protective plastic diamond mesh.
- A cylinder neck ring is permanently fixed below the base of the valve. Each cylinder neck ring is color-coded to help identify cylinder contents and gas category (e.g., yellow for corrosive, red for flammables).
- A color-coded shoulder label indicates the product's shipping name and identification number. On pure products, a grade label is also applied to the cylinder shoulder. The color-coded label border correlates with neck ring color for product identification. The shoulder label also specifies gas grade information.
- Some cylinders are painted with a vertical stencil identifying cylinder contents.

Markings

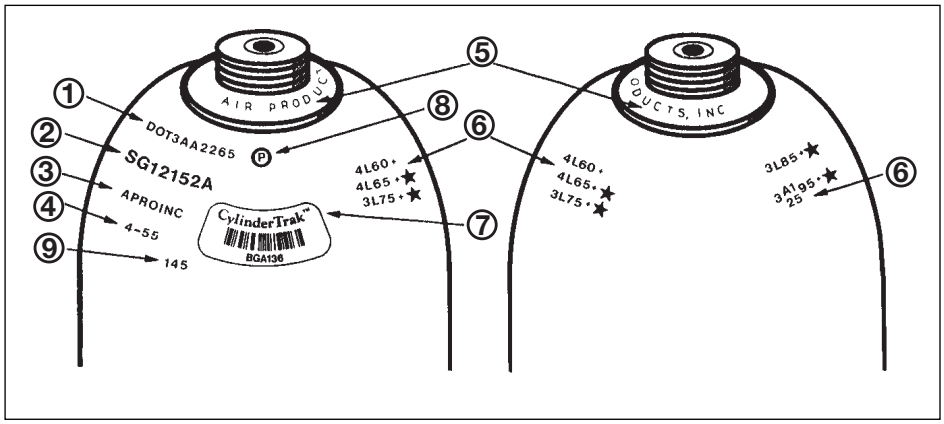
Air Products specialty gas cylinders are stamped with markings designed to indicate ownership, specifications, pressure ratings, and other important data. Air Products also utilizes a bar code label for product identification and tracking.

1. Cylinder Specification:

- DOT—Department of Transportation (previously ICC – Interstate Commerce Commission), which is the regulatory body that governs the use of cylinders.
- Specification of the cylinder type of material of construction (e.g., 3AA).
- Service or working pressure in pounds per square inch (e.g., 2,265 psi).

2. Cylinder Serial Number:

- The letters SG precede the serial numbers for Specialty Gas cylinders.



3. Registered Owner Symbol:

- Symbol used to indicate the original owner of the cylinders.
- APROINC is a Registered Owner Symbol for Air Products.

4. Date of Manufacture:

- This date (month-year) also indicates the original hydrostatic test.

5. Neck Ring Identification:

- The cylinder neck ring displays the name of the current owner of the cylinder.

6. Retest Markings:

- The format for a retest marking is: Month – Facility – Year – Plus Rating – Star Stamp.
- The + symbol (Plus Rating) indicates that the cylinder qualifies for 10% overfill.
- The ★ symbol (Star Stamp) indicates that the cylinder meets the requirements for 10-year retest.

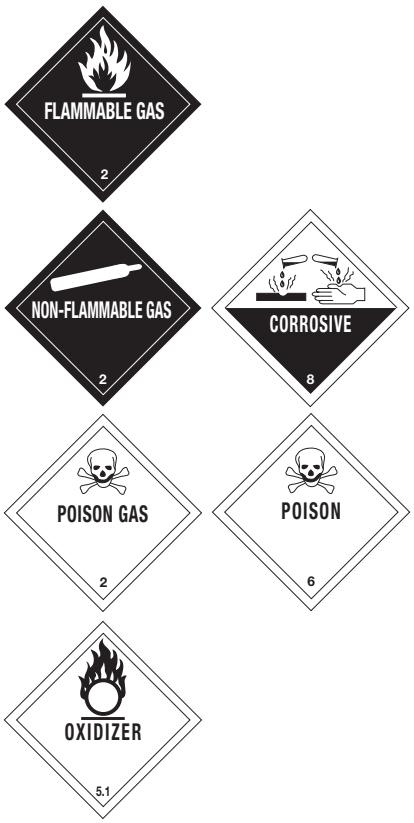
7. CylinderTrak™ Bar Code Label:

- The CylinderTrak bar code label provides a unique cylinder identifier and is used by computer systems to track cylinders throughout the fill process. As an optional service, we have the capability of tracking cylinders to and from customers.

8. Cylinder Manufacturer's Inspection Marking

9. Cylinder Tare (Empty) Weight:

- This value is preceded by the letters TW.



COMPRESSED GAS ASSOCIATION, INC.

SA-2—1996
Reaffirmed 2001

SAFETY ALERT

4221 WALNEY ROAD, 5TH FLOOR
CHANTILLY, VA 20151
703-788-2700
cga@cganet.com

ACETYLENE SAFETY ALERT

This bulletin is intended to communicate the dangers of using acetylene for anything other than its intended purposes.

Over the years, there have been a number of reported incidents involving acetylene being used improperly. In 1994 alone, there were two documented incidents brought to the attention of the Compressed Gas Association. In both cases individuals were using acetylene to inflate either balloons or plastic shopping bags. The inflated bags or balloons were then to be ignited to produce a large bang. In one case, an individual was burned over 50% of his body. In the other case, a father was not only killed by the shock wave in front of his children, but some of his children suffered injuries too. Both incidents resulted in a significant amount of property damage as well. Damage ranged from windows and doors being blown out of a warehouse to windows being shattered in the neighborhood.

The same properties that make acetylene an attractive gas for cutting and welding also make it an extremely dangerous gas to abuse in this manner. In CGA G-1, *Acetylene*, it is stated, **"Never, under any circumstances, attempt to transfer the acetylene from one cylinder to another, to refill acetylene cylinders, or to mix any other gas with acetylene in a cylinder."** Any effort to transfill acetylene as stated in CGA G-1, or into a foreign container such as a balloon or plastic bag is highly dangerous.

Even under circumstances where a "knowledgeable" person thinks he or she can do it safely, "playing" with acetylene is a very high risk activity. Acetylene can easily be ignited by static electricity. It is because of this fact that plastic piping is not used in the transmission of acetylene.

Engaging in any practices such as these is extremely hazardous. Not only can one be severely burned by acetylene's high heat content, but one can also be killed or severely injured by the intense shock wave that may be created by a small quantity of gas when ignited.

Please use this bulletin to communicate the hazards of acetylene abuse to your employees and customers.

January 1996

CGA GRANTS PERMISSION TO REPRODUCE THIS SAFETY ALERT

PLEASE NOTE:

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A listing of all publications, audiovisual programs, safety and technical bulletins, and safety posters is available via the Internet at our website at www.cganet.com. For more information contact CGA at Phone: 703-788-2700, ext. 799. E-mail: customerservice@cganet.com.

Docket 00-79
Acetylene Committee

REAFFIRMED: 2001
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Compressed Gas Association

Technical Bulletin

TB-3—1998

HOSE LINE FLASHBACK ARRESTORS

Hose line flashback arrestors are devices designed to prevent a flashback, which is a rapid flame propagation, from passing through the device and progressing into upstream equipment.

Various models are available for installation at either the torch inlet or the regulator outlet connections. Such devices often combine several functions within a common housing. They may employ a reverse flow check valve, pressure relief valve, excess flow cut-off valve, excess pressure cut-off valve, excess temperature cut-off valve, flame barrier, or other safety device in conjunction with the means to quench a flashback flame.

Many years of field experience have shown that various oxy-fuel gas torches are reliable and safe apparatus when operated in accordance with instructions recommended by the manufacturer. Under certain circumstances, the user's failure to follow these instructions can cause the backflow (reverse flow) of unwanted gas and/or a flashback into the upstream equipment.

A flashback arrestor can provide a certain measure of protection against the hazards of flashback. To maintain this protection and to ensure that the arrestor has not become damaged or inoperative during use, a routine inspection program should be followed as specified in the instructions provided by the manufacturer.

It is the user's responsibility to ensure that the flashback arrestor model chosen is designed for the intended pressure, gas service, and flow requirements necessary to safely accomplish the intended task. Large cutting tips, heating tips, and other devices require large volumes of gases that may exceed the flow capacity of some flashback arrestors. Undersized flashback arrestors create flow restrictions, which can contribute to overheating and flashback.

Threaded connections of hose line flashback arrestors should conform to the requirements of CGA E-1, *Standard Connections for Regulator Outlets, Torches and Fitted Hose for Welding and Cutting Equipment*, or ISO 3253, *Hose connections for equipment for welding, cutting and related processes* [1, 2].

Helium Safety

Inhaling Helium: Party Fun or Deadly Menace?

By Henry G. Wickes, Jr.

What could be hazardous about a helium-filled party balloon, you ask? After all, balloons are supposed to be fun, right? The answer may surprise you.

Public Awareness

Most people simply do not have the information available to help them understand hazards associated with inhaling helium. Several years ago, I was asked to investigate the death of a teenager who died while inhaling helium from a balloon-filling system. During this investigation, I discovered the true nature of these severe—and potentially fatal— hazards. The discussion here is intended to help readers make informed decisions that will prevent future loss of life .

Inhaling Helium From A Balloon

A little-known aspect of inhaling helium is how quickly you may lose consciousness due to asphyxia (oxygen deprivation). During the exchange of gases in the normal breathing process, the blood stream absorbs oxygen from air in the lungs, while carbon dioxide passes from the blood to the air. When you hold your breath, the exchange of gases slows, as "stale" air in the lungs is no longer replaced by "fresh" air.

Inhaling Helium From a Commercial System

Attempting to inhale helium from a commercial helium balloon filling system poses a greater hazard than does inhaling helium from a balloon. Beyond the risk of passing out, the potential for fatal injury is present. Unfortunately, several young people have been killed while inhaling helium from such a system.

How can a healthy young person be killed by a seemingly harmless substance, you ask? Postmortem examinations of victims explain what occurs, while engineering analysis explains how.

Chemical reaction does not cause fatal injuries. Rather, the pressure of gas inside the lungs is the agent that can kill instantly. Autopsies show that the alveoli (air sacs) in the lungs have been ruptured. Death follows immediately, as the victims literally drown in their own blood. Under such circumstances, cardiopulmonary resuscitation is of no avail.

Gas Flow vs. Lung Capacity

Gas flow rate of 5 cfm is equivalent to 2.36 liters per second. Although individual lung capacity varies, a reasonable estimate for total lung capacity in an adult female is 4.5 liters. This capacity is used in the calculations

This process does not stop instantly, however. Some time will pass before you start to experience serious physical distress. For example, you would likely have time to pick up and put down an object, walk across a room, or find a chair and sit down before feeling compelled to breathe again.

However, when the lungs are filled with helium, a different process takes over. Oxygen is actually removed from the blood stream during the exchange of gases. Depending on how completely oxygen is replaced by helium, you may lose consciousness quickly and without warning—you may literally pass out while still standing. The usual result is an uncontrolled fall that can cause serious injury, even if normal breathing resumes before brain damage occurs due to lack of oxygen.

Commercial Balloon-Filling Systems

Helium balloon-filling systems have become popular in recent years, and are frequently found in supermarkets, party supply stores, and variety stores. The "commercial" type system is generally operated by a store employee rather than by a customer. Sometimes the system is loaned or leased to the customer—a practice that led to the fatality mentioned earlier. A typical commercial system consists of a helium cylinder, shut-off valve, pressure flow regulator, and tilt valve with balloon adapter.

Such a system is designed to fill balloons rapidly. Typically, it delivers a maximum helium gas flow rate of approximately five cubic feet per minute (cfm). Maximum flow rate is determined by the pressure/flow regulator and cylinder pressure—normally several that follow.

According to human physiology references, prolonged exposure to a difference of 30 millimeters (mm) of mercury between intrapulmonary pressure and surrounding body pressure can be fatal. If pressure is increased to 80 to 100 mm, immediate fatality is expected . A pressure of 80 to 100 mm of mercury is equivalent to 1.5 to 1.9 psi. For calculation purposes, a mid-range value of 1.7 psi (above atmospheric pressure) is used as the critical value. Furthermore, assume a rigid container with a volume of gas that must be added in order to increase pressure by 1.7 psi.

Calculations show that additional volume required is .52 liters. The minimum length of time required to add this amount (thereby increasing pressure by 1.7 psi) from a balloon-filling system is determined by dividing additional volume (.52 liters) by maximum flow rate (2.36 liters per second). The result is 0.22 seconds.

Since lungs are not a rigid container, actual time to reach 1.7 psi may be slightly longer than 0.22 seconds. However, calculations clearly show that, given the flow rate and pressure available from a helium balloon-filling system, human lungs can be fatally overpressured in a fraction of a second. Victims simply do not have time to react.

Henry G. Wickes Jr., P.E., CSP, is a consultant with and professional associate of Madeley Safety Engineers in Bryan, Tex. 979-693-2041.

This article is excerpted from the December, 1996, issue of *Professional Safety* magazine with permission of the publisher and the author .

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hundred pounds per square inch (psi).

Article provided by the Compressed Gas Association, Inc. For more information on industrial gas safety call 703-788-2700, **ext. 799.**

HELIUM SAFETY PRECAUTIONS

Read all of the following precautions prior to using this cylinder.

HANDLE WITH CARE

THIS IS A HIGH PRESSURE CYLINDER

DO NOT allow anyone to inhale helium from the filling equipment or from balloons. Rapid suffocation can take place by reducing the concentration of oxygen in the air necessary to support life. Inhaling directly from filling equipment can also cause serious lung damage, WHICH COULD RESULT IN DEATH!

DO NOT allow children to touch the cylinder or to operate the balloon filling equipment.

SECURE THE CYLINDER TO PREVENT IT FROM FALLING OVER.

DO NOT leave this cylinder unattended in a public area or where children or unauthorized personnel can gain access to it.

NEVER open the cylinder valve before attaching a balloon-filling regulator to it. Tighten the regulator connection to the cylinder valve with a wrench. Do not use leaky equipment.

DO NOT store or use the cylinder in a closely confined or poorly ventilated area. Leaking helium can reduce the amount of oxygen in the air and produce asphyxiation.

DO NOT store or use the cylinder in hot areas (over 130 °F) or near flames or electrical devices.

DO NOT attempt to transfer helium from this cylinder into any other cylinder or container.

SHUT OFF the cylinder valve after each use and when empty. Remove the balloon filling regulator and replace the cylinder cap prior to returning the cylinder to your supplier.

REMEMBER: DO NOT remove the cylinder cap until the cylinder is secured. If the cap is stuck or jammed, return the cylinder to the supplier.

Information provided by the Compressed Gas Association, Inc. For more information on industrial gas safety call 703-788-2700, ext. 799.

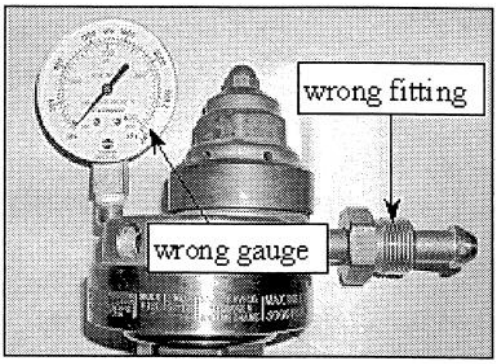
CGAnet Up Purchase Publications Member Web-site

ES&H UPDATE

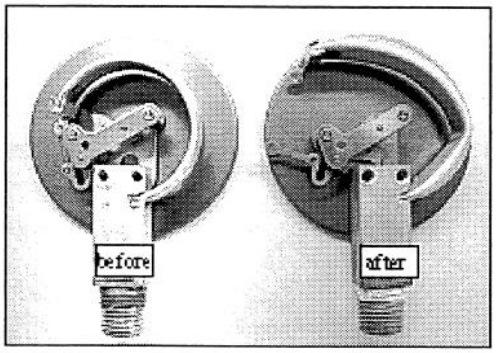
Author: Dan Olis
Editor: Tim Miller

05/2003

What's Wrong With... *Pressure Regulator Modification?*



The trap was sprung but, fortunately, nobody was hurt. Some Fermilab employee unwittingly set a booby trap by changing components on this gas regulator. Modifying two-stage regulators for use on compressed gas cylinders is unsafe and violates Fermilab safety rules. This regulator's 3000 PSI pressure gauge was replaced with a 400 PSI gauge. Also, the regulator's fitting was changed to allow a regulator manufactured for hydrogen and methane gas to be used on a nitrogen bottle. The improperly rated gauge was destroyed when an unsuspecting co-worker tried to use the regulator. The gauge **pictured below** on the right shows how the internal mechanism deformed after being attached to a 2200 PSI gas bottle.



Hisss...POP! Doinggg...

The fitting on a regulator is meant to ensure that it is being used safely. The regulator manufacturer installs a fitting style on the regulator to match the style on the gas bottle with which it is designed to be used. Never replace the stem from one regulator with another to *make it work* on the bottle you are using. By changing fittings, a person risks using the regulator at a pressure or with a gas it isn't designed for. Higher pressures and incompatible gases can present explosion risks. Even a less dramatic failure such as a gas leak can be dangerous; gases themselves may be toxic or create an oxygen deficiency hazard by displacing breathable air.

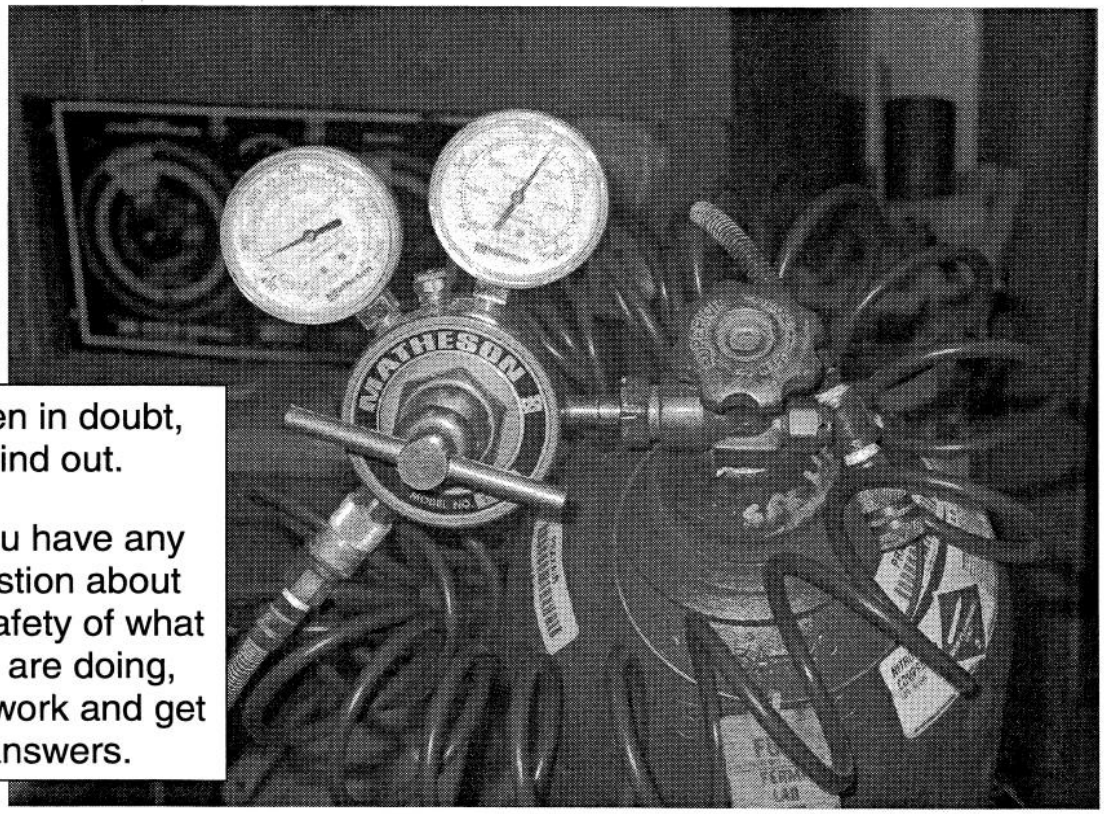
When selecting a two-stage regulator, make sure it is the right type and doesn't appear to be damaged or tampered with. Do not attempt to repair or modify such regulators. Chapter 5031.3 of Fermilab's ES&H Manual specifically addresses gas regulator safety. *No regulator is to be dismantled or altered in any fashion without specific approval of the ES&H Section Head.*

Remember, gas under pressure is a form of stored energy. Accidental release of this energy can have serious consequences to people and property. Be mindful when working with pressurized components and systems. Don't use what you find in a drawer or on a

shelf without considering whether it is appropriate for the job. The Fermilab stockroom carries appropriate pressure system components such as regulators and fittings that are commonly used on site.

When working with pressure systems, it is a good idea to keep the following safety points in mind:

- Pressure systems must be treated with respect, similar to that shown for electrical systems.
- Fermilab employees and users who work with cylinders and cylinder regulators should have cylinder training (FN000213). If you haven't had this training, or are uncomfortable with use of pressurized systems, ask your supervisor to review your Individual Training Needs Assessment (ITNA) with you.
- Keep training handouts and refer to them when questions arise.
- Use the Fermilab ES&H web page for safety information and rules.
- Address unanswered questions with your supervisor or Senior Safety Officer.



When in doubt, find out.

If you have any question about the safety of what you are doing, stop work and get answers.

Regulator left pressurized after use

This message should be distributed to all employees via delivery of un-addressed copies to Fermilab mail stations. Suggestions for ES&H message topics should be directed to Mary Logue at grace@fnal.gov or X6329.

Safetygram-16

Safe Handling of Cryogenic Liquids

Introduction

A cryogenic liquid is defined as a liquid with a normal boiling point below –240°F (–150°C). The most commonly used industrial gases that are transported, handled, and stored in the liquid state at cryogenic temperatures are argon, helium, hydrogen, nitrogen, and oxygen.

There are a number of general precautions and safe practices that must be observed because of the extremely low temperatures and high rates of conversion into gas of all the cryogenic liquids. There are also specific precautions that must be followed where a particular liquid may react with contaminants or may present other hazards associated with that particular product such as asphyxiation or flammability.

The user of any cryogenic liquid covered in this Safetygram should be familiar with both the general and specific precautions outlined. Safetygrams for individual cryogenic liquids are available and should be consulted for additional information. Please consult www.airproducts.com/productstewardship to determine which Safetygrams may be of assistance. As always, end users should have and be thoroughly familiar with the Material Safety Data Sheet (MSDS) for their specific product. All operators must be familiar with the instructions provided with the equipment to be used with the cryogenic liquid.

General Safety Precautions

Many of the safety precautions observed for gases in the gaseous state also apply to the same gases in the liquid state. However, each cryogenic liquid has its own unique properties. Also, all cryogenic liquids involve potential hazards that stem from the following properties:

1. All cryogenic liquids are extremely cold. Cryogenic liquids and their vapors can rapidly freeze human tissue and can cause many common materials such as carbon steel, rubber, and plastics to become brittle or even break under stress. Cryogenic liquids in containers and piping at temperatures at or below the boiling point of liquefied air [–318°F (–194°C)] can actually condense the surrounding air and can cause a localized oxygen-enriched atmosphere. Extremely cold cryogens such as hydrogen and helium can even freeze or solidify the surrounding air.
2. All cryogenic liquids produce large volumes of gas when they vaporize. For example, one volume of liquid nitrogen at atmospheric pressure vaporizes to 694 volumes of nitrogen gas at 68°F (20°C). A cryogenic liquid cannot be indefinitely maintained as a liquid even in well-insulated containers. If these liquids are vaporized in a sealed container, they can produce enormous pressures that could rupture the container. For this reason pressurized cryogenic containers are normally protected with multiple devices for over-pressure prevention. Common pressure-relief devices are a pressure-relief valve for primary protection and a rupture disc for secondary protection. All sections of equipment that may allow for the liquid to become trapped must be protected by a pressure-relief device as shown in Fig. 1. The product vented by these relief devices should be routed to a safe outdoor location.

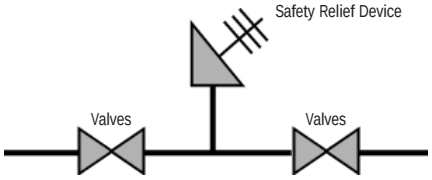


Fig. 1 Potential for trapping liquid between valves.

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Special Hydrogen Precautions

Do not permit smoking or open flames in any area where liquid hyrdrogen is stored or handled. All major stationary equipment should be properly grounded. All electrical equipment and wiring should be in accordance with National Fire Protection Association Pamphlet 50B and/or National Electrical Code, Article 500. Boil-off gas from closed liquid hydrogen containers used or stored inside buildings must be vented to a safe location.

Liquid hydrogen should not be poured from one container to another, or transferred in an atmosphere of air. If this is done, the oxygen in the air will condense in the liquid hydrogen, presenting a possible explosion hazard. Liquid hydrogen also has the potential of solidifying air which can block safety relief devices and other openings, which may lead to rupture of the container. Dewars and other containers made of glass are not recommended for liquid hydrogen service. Breakage makes the possibility of explosion too hazardous to risk.

Every effort must be made to avoid spills, regardless of the rate of ventilation, because it is impossible to avoid creating a flammable vapor cloud.

Containers

Cryogenic liquids are stored, shipped, and handled in several types of containers, depending on the quantity required by the user. The types of containers in use are the dewar, cryogenic liquid cylinder, and cryogenic storage tank. Storage quantities vary from a few liters to many thousands of gallons. Since heat leak is always present, vaporization takes place continuously. Rates of vaporization vary depending on design of the container, ambient conditions, and the volume of stored product.

Containers are designed and manufactured according to the applicable codes and specifications for the temperatures and pressures involved.

Dewars

Fig. 2 illustrates a typical, vacuum-jacketed dewar. A loose-fitting dust cap over the outlet of the neck tubes prevents atmospheric moisture from plugging the neck and allows gas produced from vaporized liquid to escape. This type of container is non-pressurized. The most common unit of measure for the capacity of a dewar is the liter. Five- to 200-liter dewars are available. Product may be removed from small dewars by pouring, while larger sizes will require a transfer tube. Cryogenic liquid cylinders which are pressurized vessels are sometimes incorrectly referred to as dewars.

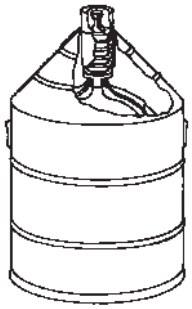

Fig. 2 A typical dewar.

Cryogenic Liquid Cylinders

Fig. 3 shows a typical cryogenic liquid cylinder. Cryogenic liquid cylinders are insulated, vacuum-jacketed, pressure vessels. They come equipped with safety relief valves and rupture disks to protect the cylinders from excessive pressure build-up. These containers operate at pressures up to 350 psig and have capacities between 80 and 450 liters of liquid.

Product may be withdrawn as a gas by passing liquid through an internal vaporizer or as a liquid under its own vapor pressure. For more details on the construction and operation of cryogenic liquid cylinders consult Air Products' Safetygram-27, Cryogenic Liquid Containers.

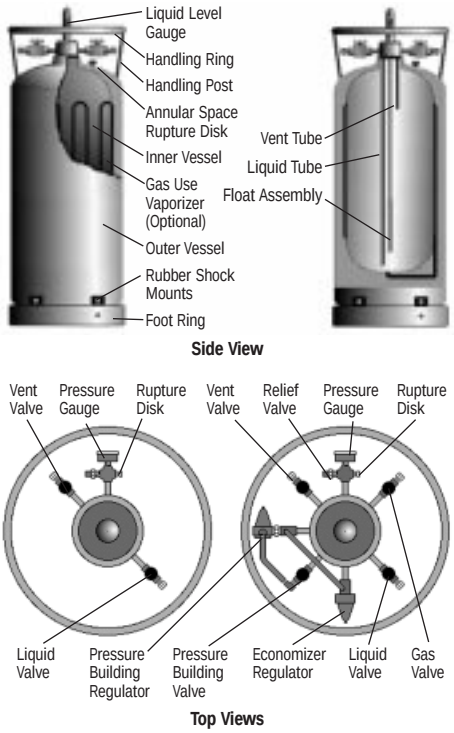

Fig. 3 Internal Cylinder Configuration, top. Overhead view of low pressure liquid withdraw, bottom left. Overhead view of liquid and high pressure gas withdraw, bottom right.

Cryogenic Storage Tanks

A typical customer installation (see Fig. 4) includes a tank, vaporizer, and pressure control manifold. Tanks may be spherical or cylindrical in shape. They are mounted in fixed locations as stationary vessels or on railroad car or truck chassis for easy transportation. Sizes range from 500 gallons to 420,000 gallons. All tanks are powder- and vacuum-insulated in the annular space. Tanks are equipped with various circuits to control product fill, pressure build-up, pressure relief, product withdrawal, and tank vacuum. Tanks are designed to ASME specifications for the pressures and temperatures involved.

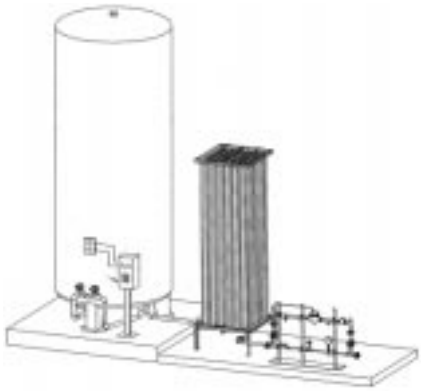

Fig. 4 A typical customer station with a cryogenic storage tank.

Emergency Response System

- Call: **+1 (800) 523-9374** (Continental U.S. and Puerto Rico)
- Call: **+1 (610) 481-7711** (Other locations)
- 24 hours a day, 7 days a week
- For assistance involving Air Products and Chemicals, Inc. gases and equipment.

Product Safety Information

- For MSDS and Safetygrams: **www.airproducts.com/productstewardship**
- Fax-on-Demand: Call: **+1 (800) 245-2746**
- Enter MSDS Index No. 1000 for a complete list of available safety literature.
- 24 hours a day, 7 days a week

Technical Information Center

- Call: **+1 (800) 752-1597** (U.S.)
- Call: **+1 (610) 481-8565** (Other locations)
- Fax: **+1 (610) 481-8690**
- E-mail: **gasinfo@apci.com**
- Monday–Friday, 8:00 a.m.–5:00 p.m. EST

Information Sources

- Compressed Gas Association
  1725 Jefferson Davis Highway, Suite 1004
  Arlington, VA 22202-4102
  Phone: +1 (703) 412-0900
- National Fire Protection Association
  1 Batterymarch Park, P.O. Box 9101
  Quincy, MA 02269-9101
  Phone: +1 (800) 344-3555

Air Products and Chemicals, Inc., 7201 Hamilton Boulevard, Allentown, PA 18195-1501
Phone: +1 (800) 654-4567, +1 (610) 481-4911. Fax: +1 (800) 880-5204. www.airproducts.com

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Safetygram-15

Cylinder Pressure-Relief Devices

General

Pressure-relief devices are installed on most cylinders to prevent the rupture of a normally pressurized cylinder when it is inadvertently exposed to fire or high temperatures. There are many types of pressure-relief devices; each has a designated use. Types of pressure-relief device designs include fusible plugs, rupture disks, rupture disks with fusible metal backing, and spring-loaded relief valves.

This Safetygram identifies the pressure-relief devices used to provide cylinder protection for various compressed gases. The specific pressure-relief device designated for a compressed gas cylinder depends on many factors, including the type of gas, the Department of Transportation (DOT) rated service, test pressures of the cylinder, and the cylinder size.

The Compressed Gas Association (CGA) lists the pressure-relief devices to be used on specific products in their Pamphlet S-1.1 "Pressure-Relief Device Standards Part 1: Cylinders for Compressed Gases." DOT regulations require compliance with this document for the selection and use of pressure-relief devices to be used on compressed gas cylinders.

CAUTION: Pressure-relief devices do not permit the user to exercise any less care in following proper handling, use, and storage procedures for cylinders.

Types of Cylinder Pressure-Relief Devices

The CGA has identified several types of pressure-relief devices:

Type CG-1: The Rupture Disk Device

A rupture disk device is a nonreclosing pressure-relief device actuated by static pressure and designed to function by the bursting of a pressure-containing disk. The disk is the operating part of the device. It is a flat disk, typically made of metal, designed to a specification that will allow it to burst at a predetermined pressure to permit the release of gas. Rupture disks relieve overpressure in cylinders that may result from an external fire or from overfilling. The burst pressure of rupture disks may not exceed the minimum DOT-required test pressure of the cylinder, which is generally 5/3 of the cylinder service pressure. Some exceptions to this rule are:

- The burst pressure must not exceed 4500 psig for DOT-3E or CTC-3E specification cylinders.
- The burst pressure must not be less than 105% of the cylinder test pressure or greater than 80% of the minimum burst pressure for DOT-39 cylinders.

The pressure rating of the disk is typically stamped onto the face of the device.

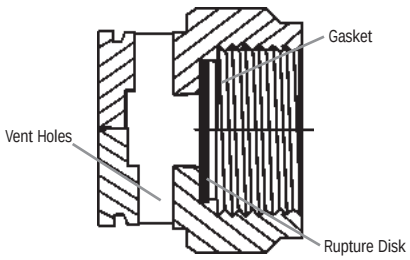

Fig. 1 Type CG-1 Pressure-Relief Device

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Type CG-2: Fusible Plug Device Rated at 165°F

The fusible plug device is a nonreclosing pressure relief device designed to function by the yielding or melting of a plug of fusible metal. The type CG-2 plugs use an alloy that yields at a temperature not exceeding 170°F, nor less than 157°F (165°F nominal). These devices are not suitable for service pressures exceeding 500 psig. Pressures above 500 psig may cause the fusible alloy to extrude and eventually release the product.

Failures from excess pressure are time- and pressure-dependent. These devices cannot be relied upon to protect from overpressurization at temperatures below their melting point.

They are designed to protect the cylinder from overpressurization caused by exposure to excessive heat only. In the event a cylinder is exposed to fire or other sources of excess heat, the fusible plug is designed to melt and release the cylinder contents. This prevents product within the cylinder from creating excessively high pressures, caused by high external temperatures, and rupturing the cylinder. The plugs may use one of several designs to hold the fusible alloy in place. (See Fig. 2.) The temperature rating of the fusible metal is stamped into the face of the device.

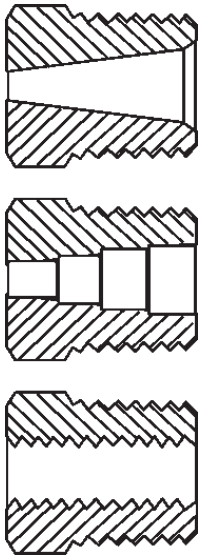

Fig. 2 Type CG-2, 3 Pressure-Relief Device

Type CG-3: Fusible Plug Device Rated at 212°F

This device is similar to the CG-2 pressure-relief device except that it uses a fusible metal with a higher melting temperature. The CG-3 device uses a fusible alloy with a melting point not exceeding 220°F, nor less than 208°F (212°F nominal). This device is most commonly found on acetylene cylinders.

Type CG-4: Combination Rupture Disk/ Fusible Alloy Rated at 165°F

The CG-4 consists of a rupture disk backed by a fusible plug on the atmospheric side of the disk. The burst pressure of the disk must not exceed the minimum DOT required test pressure of the cylinder (except as noted under Type CG-1); the fusible metal must yield between 157-170°F (165°F nominal).

The combination pressure-relief device provides protection against cylinder rupture caused by fire or high temperatures. If a fire occurs, the fusible metal yields or melts and cylinder overpressure caused by the heated gas is relieved by the bursting of the rupture disk. Both the pressure and temperature requirements of the device must be satisfied before the device can function.

This device will not protect a cylinder from overpressurization if the fusible alloy is not heated to its yield temperature. The fusible alloy will prevent the disk from rupture if it remains in place. The fusible metal prevents premature rupture disk failure from momentary overpressurization and also protects the disk from external corrosion which could cause premature failure of the rupture disk.

The face of these devices is marked with the burst pressure rating of the disk and the yield temperature of the fusible alloy.

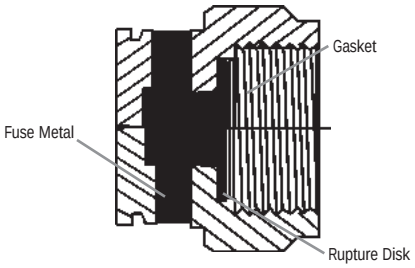

Fig. 3 Type CG-4, 5 Pressure-Relief Device

Type CG-5 Combination Rupture Disk/ Fusible Alloy Rated at 212°F

This device is the same as the CG-4 pressure-relief device except that it uses a fusible metal with a higher melting temperature. The CG-5 device uses a fusible alloy with a melting point not exceeding 220°F, nor less than 208°F (212°F nominal).

Type CG-7: Pressure-Relief Valve

Pressure-relief valves are spring-loaded valves that are normally closed. When the cylinder pressure exceeds the pressure setting of the spring in the relief valve, the valve opens and begins discharging the cylinder contents. Once the cylinder pressure decreases to the relief valve's pressure setting, the valve will normally reseat—without leakage—after venting sufficient gas to control the internal cylinder pressure. The pressure setting of the pressure-relief valve must not be less than 75%, nor more than 100% of the minimum test pressure of the cylinder. The reseating pressure must not be less than the pressure in a normally charged cylinder at 130°F.

An exception is the relief valve on DOT-39 cylinders. With these, the set pressure must not exceed 80% of the minimum burst pressure of the cylinder and must not be less than 105% of the cylinder test pressure.

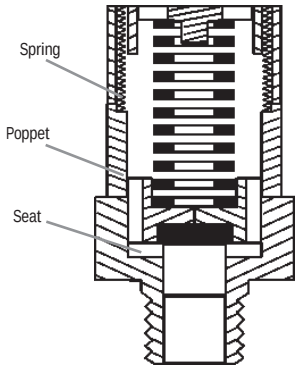

Fig. 4 Type CG-7 Pressure-Relief Device

Cylinder Pressure-Relief Devices for Several Gases

Cylinder pressure-relief devices for several common industrial gases are described below. For information about relief devices on other gas cylinders, consult your supplier.

Air, Argon, Helium, Nitrogen, Oxygen

These gases are nonflammable and stored in cylinders as high-pressure gases. The pressure-relief device used on these gas cylinders is normally Type CG-1.

Carbon Dioxide, Nitrous Oxide

These products are nonflammable and are stored in cylinders as liquefied compressed gases. Cylinders are normally protected by Type CG-1 pressure-relief devices. Small medical cylinders with post-type valves may be protected by Type CG-1 rupture disks or by Type CG-4 combination rupture disk/fusible plug relief devices.

Hydrogen

Hydrogen is flammable and stored in cylinders as a high-pressure gas. Cylinders under 65” long must be equipped with rupture disk/fusible alloy Type CG-4 or Type CG-5 devices. Cylinders greater than 65” in length and 9 5/8” in diameter must be equipped with Type CG-4, Type CG-5, or Type CG-1 rupture-disk devices. Cylinders over 65” in length and 22” in diameter must use Type CG-1 rupture disk devices.

Propane, APACHI™ Gas

Propane and Air Products’ APACHI gas are flammable. They are stored in cylinders as liquefied compressed gases. Cylinders containing these products are usually protected by Type CG-7 spring-loaded, pressure-relief valves. A Type CG-3 212°F fusible metal plug may be used, but only when in combination with the Type CG-7 pressure-relief valve.

Acetylene

Acetylene is a flammable gas stored in cylinders as a dissolved gas. The cylinders are filled with a porous material saturated with a solvent, usually acetone. The acetylene dissolves into the solvent as it is placed into the cylinder. These cylinders are protected by Type CG-3 fusible metal plugs with a nominal yield temperature of 212°F. The devices are usually an integral part of the cylinder rather than being installed in the cylinder valve. Some small acetylene cylinders, Type B or MC size cylinders, are equipped with fusible plugs in the valve body.

Medical Gas Cylinders with Post-Type Valves

Post-type valves on small medical cylinders are generally equipped with Type CG-4 rupture disks with 165°F fusible metal backing. Carbon dioxide and nitrous oxide cylinders may be equipped with the CG-4 or the CG-1 devices.

Safety Considerations

Cylinder pressure-relief devices must be maintained in proper operating condition to function correctly.

- **NEVER** tamper with pressure-relief devices in valves or cylinders.
- Only qualified gas supplier personnel should service pressure-relief devices.
- Care should be taken when handling and storing cylinders to prevent damage to the pressure-relief devices.
- Do not obstruct any pressure-relief device. Dirt, paint, corrosion, or other materials prevent pressure-relief devices from functioning properly.
- If any obstruction, deformation, or extrusion of fusible metal is observed in a pressure-relief device, notify the supplier. The cylinder should be removed from service immediately and appropriate action arranged through the supplier.
- Any problem with pressure-relief devices should be immediately reported to your supplier.

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RECORD ID D94-11-008

STANDARD NUMBER 29 CFR 1910.253

INFORMATION DATE 941116

ABSTRACT

This interpretation addresses questions about storage of oxygen and acetylene cylinders. Specifically, are cylinders considered to be in storage when the gauges are off? Also, can oxygen and acetylene cylinders be transported on the same trailer?

Cylinders are not considered to be in storage when they are connected for use or on specially designed trucks as described in ANSI Z49.1, "Safe Practices for Users of Gas Burning and Welding Equipment." Oxygen and acetylene cylinders may be transported simultaneously on specially designed trucks.

INTERPRETATION 29 CFR 1910.253

This interpretation addresses questions about storage of oxygen and acetylene cylinders. Specifically, are cylinders considered to be in storage when the gauges are off? Also, can oxygen and acetylene cylinders be transported on the same trailer?

Occupational Safety and Health Administration (OSHA) standard 29 CFR 1910.253(b)(2), "Storage of Cylinders," states, "Cylinders should be stored in definitely assigned places away from elevators, stairs, or gangways. Assigned storage spaces shall be located where cylinders will not be knocked over or damaged by passing or falling objects, or subject to tampering by unauthorized persons." The standard also states that valve protection caps shall always be in place except when cylinders are in use or connected for use.

In addition, OSHA Interpretation 19930909 explains that "Compressed gas cylinders with the regulators installed are considered by OSHA to be 'connected for use'." The interpretation also states, "The critical factor that distinguishes cylinders in storage [where valve protection caps are required] from those not in storage is those not in storage must be in use or connected for use, with provisions made to protect the

regulator and the valve. Also, in accordance with the requirement of 1910.253(b)(5)(ii)(G), cylinder valves must be closed when work is finished."

29 CFR 1910.253(b)(5)(ii)(D) and OSHA Interpretation 19930909 also address transportation of compressed gas cylinders. 29 CFR 1910.253(b)(5)(ii)(D) states that, "Unless cylinders are secured on a special truck, regulators shall be removed and valve-protection caps, when provided for, shall be put in place before cylinders are moved." The interpretation defines the "special truck" as a vehicle or cart used for the specific purpose of transporting compressed gas cylinders "connected for use" in the workplace and specifies that the cylinders must be held in an erect or nearly erect position and protection of the cylinder valves and regulators must be provided.

Leaving one oxygen cylinder and one acetylene cylinder on a specially designed truck as described in ANSI Z49.1 would not create an unacceptable hazard. Moving the cylinders could create a greater hazard than leaving them on the specially designed trucks. In addition, there is a greater hazard in disconnecting the gauges each time work is stopped than in leaving the gauges attached and the pressure cut off.

The Response Line spoke with Dale Kavanaugh of OSHA's Office of Construction and Maritime Compliance Assistance (202)-219-8136 regarding this inquiry. Dale relayed to us that OSHA is preparing to issue a memo of interpretive guidance on this particular issue. OSHA's new guidance (which is not yet final or we would attach a copy - 1/4/95) states that oxygen and acetylene tanks may be left on a welder's cart while work is ongoing, i.e. during lunch breaks, overnight and even over a weekend. The OSHA policy guidance states that if the tanks are not to be used for periods exceeding two days then they must be stored. This guidance memo is expected to be published by OSHA within a month.

In conclusion, cylinders with the guages attached but in the off position are considered "in use", while cylinders with the guages off, as in not attached to the cylinders are considered to be in storage. Cylinders are not considered to be in storage when they are connected for use, and if the cylinders will not be used for more than two days (with the exception of weekends), they should be placed into storage. Oxygen and acetylene tanks can be transported simultaneously on specially designed trucks.

RECORD ID D98-08-004 Precedented

STANDARD NUMBER D94-11-008

INFORMATION DATE 09-25-1998

SUBJECT Storage Of Oxy-acetylene Cylinders

QUESTION

OSHA has released a June 22, 1998 letter of interpretation on the storage of oxy-acetylene cylinders on welding carts that is more restrictive than DOE interpretations on this issue. What is DOE's current interpretation of the storage requirements for these cylinders. The OSHA letter contains the following questions and answers: Ql: Assuming that the contents of the tanks will not be used up during a single shift, must the oxygen and acetylene tanks on the dolly be removed from the cart each day and separated in accordance with 1910.253(b)(4)(iii)? Al: Yes. According to 1910.253(b)(4)(i), oxygen cylinders shall not be stored near highly combustible material or near reserve stocks of carbide and acetylene or other fuel-gas cylinders. Oxygen cylinders in storage shall be separated from fuel-gas cylinders or combustible materials by a minimum distance of 20 feet or by a noncombustible barrier at least 5 feet high having a fire-resistance rating of at least one-half hour. Q2: Will the employer be in compliance with the standard if the tanks remain tethered to the cart, without regulators but with valve protection caps, ready for use the next shift? A2: No. A careful review of the Compressed Gas Association Pamphlet (P-1, 1965) reveals that for safe handling, cylinders that are not in use should be placed in storage and securely attached to a fixed object to prevent the movement of the cylinders. (Also referenced in 1910.101 - Compressed Gases standard.) Valve protection caps should always be in place, hand-tight, except for when cylinders are in use or connected for use (1910.253(b)(2)(iv)).

REGULATORY REVIEW

DOE review of OSHA´s Q1 and A1: DOE believes that according to 1910.253(b)(2), oxygen and acetylene cylinders that are in frequent use but not used for a shift (e.g., overnight or over a weekend) are in everyday use rather than in storage. Cylinders that are being used frequently and remain together and tethered to a cart are therefore not required to be removed to separate storage. DOE review of OSHA´s Q2 and A2: Once again, DOE believes that oxygen and acetylene cylinders that are in frequent use but not used for a shift (e.g., overnight or over a weekend) are not required to be removed to separate storage. Furthermore, DOE views the practice of leaving oxygen and acetylene tanks that are in everyday use and tethered to a cart at the end of a shift, without regulators but with valve protection caps installed, to be safer that removing the cylinders to separate storage. Removing the cylinders to separate storage

incurs greater risk of worker muscoloskeletal and traumatic (e.g., contusion, abrasion, or bone fracture) injury from increased handling of the cylinders and greater risk of excessive wear or crossthreading leading to gas leaks and subsequent fires or explosions. It is common practice within the Department and industry to allow cylinders to remain together and tethered to a cart that is being used frequently. Cylinders that are not in frequent use should, however, be separated and protected in accordance with the provisions of 1910.253(b)(4). There is no significant body of fire or accident data that would support the notion that the tethered configuration, as described above, represents a significant risk to workers or the facility. DOE has written to OSHA requesting that OSHA review their June 22, 1998, letter of interpretation. The DOE letter (attached) includes DOE Response D94-11-008 (also attached) on this subject.

Safetygram-14

Don't Turn a Cylinder Into a Rocket

General

A standard industrial gas cylinder containing 330 cubic feet of gas at a pressure of 2640 psig can, after a cylinder valve is broken off, become a rocket attaining a speed of several miles per hour in a fraction of a second after the gas begins venting from the broken cylinder connection.

Important Precautions

The following precautions should be taken to prevent accidents with cylinders.

1. When storing cylinders, secure them to a wall or vertical support by means of restraining straps or chains.
2. When moving cylinders, use a cylinder cart with a chain restraint in place. Do not drag cylinders.
3. When transporting cylinders, use an open vehicle and secure them.
4. Valve protection caps should be installed on cylinders at all times when not in use.
5. Cylinders should never be dropped, rolled, or carried in a horizontal position as the cylinder valve may be broken off.
6. Cylinders should never be used as rollers for moving equipment.
7. If a cylinder or cylinder valve is leaking, call the Air Products 24-hour Emergency Response number: +1 (800) 523-9374 in the U.S., Canada, and Puerto Rico, or +1 (610) 481-7711 for other locations.

   If the leak is in the user's system, close the cylinder valve, vent the pressure, and purge with an inert gas before attempting repairs.
8. Segregate cylinders in storage as to type of gas and whether empty or full, and maintain a distance of 20 feet between cylinders containing oxidizers and cylinders containing flammables.
9. Smoking is prohibited in the vicinity of cylinders containing flammable gases or oxidizers.
10. **NEVER** stick anything into the cylinder cap holes in an attempt to loosen the cap. Use an adjustable strap wrench to remove stuck caps. If the cap is still difficult to remove, attach a tag or label to the cylinder identifying the problem and return the cylinder to the supplier.
11. Wrenches should not be used on valves equipped with a handwheel. If the valve is difficult to operate or faulty, contact your supplier to arrange return of the cylinder.

NOTE: Item 1 does not apply to cylinder charging facilities.

The back of this document can be used as a poster for your cylinder storage area.

Further Information

- Product Safety: **+1 (800) 245-2746**
- Emergency Response:
  +1 (800) 523-9374 (Continental U.S. and Puerto Rico)
  +1 (610) 481-7711 (Other locations)
- Technical Information: **+1 (800) 752-1597** (Continental U.S. and Puerto Rico)
  +1 (610) 481-8565 (Other locations)

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