


Medical Gases Training Presentation



Nate Elkins, Supervisor,
Idaho Licensing & Certification

Facility Fire Safety & Construction Program

Background

Medical gases have the potential for creating hazardous working environments

When medical gases are not handled and used properly, there is the potential for injuries or accidents to occur

Injuries may result from—

- the displacement of oxygen from a leaking gas cylinder
- fires or injuries caused by flammable gas ignition
- inhalation of a toxic or asphyxiating gas
- flying objects accelerated by an explosion or pressure release

Some examples of medical gases include medical air, USP; oxygen USP; helium USP; nitrogen NF; and mixtures of these gases

USP – United States Pharmacopeia

NF – National Formulary



Lesson Objectives



- **Describe** the hazards associated with medical gases
- **Discuss** safe handling and use guidelines
- **Explain** proper storage procedures

Definitions



Asphyxiant—a gas that has the ability to cause suffocation in an enclosed workspace by displacing breathable air.

Compressed gas—any material that is normally a gas which is placed under pressure or chilled, and contained by a cylinder

Corrosive—a gas that can cause severe burns to skin and other human tissues such as the eye or lung, and can attack clothes and other materials including metal

Cryogenic—liquefied gases that are kept in their liquid state at very low temperatures (below -292°F)

Flammable—a material that will burn or catch on fire easily at normal temperatures below 100°F

Inert—a gas that does not usually react with other things

More Definitions

Gas—a form of matter that does not have a defined shape or volume. Gases can consist of a single element, such as hydrogen gas (H_2), or may be a compound, such as carbon dioxide (CO_2), or a mixture of several gases, such as air. Gases expand to fill the space they are given

Oxidizer—a gas that does not usually burn itself, but will either help the fire by providing more oxygen or they may cause materials that normally do not burn to suddenly catch on fire (spontaneous combustion)

Pyrophoric—a material that ignites instantly upon exposure to oxygen

Reactive—a gas that had the potential to vigorously polymerize, decompose, condense, or become self-reactive under conditions of shock, pressure, temperature, light, or contact with another material

Toxic—Capable of causing injury or death, especially by chemical means; poisonous



Examples

NFPA considers atmospheres to be oxygen deficient when the oxygen content in air falls below 19.5%. Oxygen deficient atmospheres are considered to be immediately dangerous to life and health

Liquid nitrogen (Dermatology) is an asphyxiant and a cryogen.

Common corrosive gases include ammonia, hydrogen chloride, chlorine and methylamine.

Acetylene (used in welding) and hydrogen are flammable gases.

Helium, argon, neon, xenon, krypton, radon (noble gases) are inert gases.

Air, helium, nitrogen, freon, carbon dioxide, water vapor, hydrogen, natural gas, propane, oxygen, ozone, and hydrogen sulfide are some examples of gases.

Oxygen and nitrous oxide are examples of oxidizers.

Phosphine is a pyrophoric gas.

Common dangerously reactive gases are acetylene, 1,3-butadiene, methyl acetylene, vinyl chloride, tetrafluoroethylene and vinyl fluoride. Reactions may be violent, resulting in fire or explosion. Some dangerously reactive gases have other chemicals, called inhibitors, added to prevent these hazardous reactions.

Chlorine is an example of a toxic gas

Content Identification/Product Labeling

Safety begins with the proper identification of the gas cylinder's contents

All cylinders must have a legible label that identifies their contents and gives precautionary warnings to users who are responsible for handling them and for connecting them for use

The color of the cylinder alone may not be used to identify a cylinder's contents

Cylinders that are not properly labeled should be set apart for return to the gas supplier



Physical Hazards

All compressed gases are hazardous because of the high pressures inside the cylinders

Gas can be released deliberately by opening the cylinder valve, or accidentally from a broken or leaking valve or safety device

Even at a relatively low pressure, gas can flow rapidly from an open or leaking cylinder

There have been many cases in which damaged cylinders have become uncontrolled rockets or pinwheels and have caused severe injury and damage. This danger has occurred when unsecured, uncapped cylinders were knocked over causing the cylinder valve to break and high pressure gas to escape rapidly

Most cylinder valves are designed to break at a point with an opening of about 0.75 cm (0.3 inches). This design limits the rate of gas release and reduces cylinder velocity. This limit may prevent larger, heavier cylinders from "rocketing" although smaller or lighter cylinders might take off

Health Hazards

A large, semi-transparent hazard diamond is centered in the background. At the top of the diamond is a black flame symbol. Below the flame, the word "OXIDIZER" is written in large, bold, black capital letters. At the bottom of the diamond, the number "2" is written in large, bold, black capital letters.

Compressed gases may be flammable, corrosive, toxic, reactive, oxidizers, cryogenic, pyrophoric, or cause asphyxiation

Some compressed gases may have a combination of hazards, for example liquid oxygen combines the oxidizer hazard with the cryogenic hazard

Detailed information regarding the physical and chemical properties, specific handling, safety precautions, physiological effects on humans and emergency procedures are covered in the gas suppliers safety data sheets (SDS)

Receipt DO's



Remove any paper wrapping before placing cylinders in service so the label is clearly visible

Inspect cylinders for proper labeling, color-coding, bulges, or damage

Return unused cylinders to the supplier if they are damaged, or improperly color-coded, and if they do not have a label, the label is unreadable, or if the label does not correctly identify the gas contained in the cylinder

Test medical oxygen upon receipt to verify that the cylinders contain medical grade oxygen

Safe Handling DO's



Allow only experienced and trained workers to handle compressed gas cylinders

Read and understand all warning and precautionary information on the cylinders' labels

Identify the gas content by reading the label before use

Attach "in use" cylinders to a stand or to medical equipment designed to hold medical gas equipment

Mark empty cylinders to avoid confusion and delay if a full cylinder is needed quickly

Prevent sparks or flame from coming into contact with cylinders and equipment

Safe Handling DO's



Leave valve protection caps in place (if provided) until cylinders are secured and connected for use (Note: Style E and smaller cylinders are not equipped with valve protection caps and are vulnerable to valve damage if dropped in an inverted position)

Some types of gas cylinders have valve outlet caps and plugs that form a gas-tight seal. Keep the device on the valve outlet except when containers are secured and connected to dispensing equipment

Keep valves closed when the gas is not being used. Closing the valve isolates the cylinder's contents from the surrounding atmosphere and prevents corrosion and contamination of the valve

Close valves before returning empty cylinders to storage and replace the valve protective caps (if provided) before moving cylinders

Handle empty cylinders as carefully as full ones; residual pressure can be dangerous

Still More Safe Handling DO's



Follow instructions for using regulators—

- Open valves slowly
- Slightly open the valve for an instant to clear the opening of possible dust and dirt after removing the valve protection cap
- Stand so that the valve outlet is pointed away from yourself and others in the work area when opening the valve
- Use wrenches or tools provided by the supplier to open the valves
- Make sure that the threads on regulator-to-cylinder-valve connections or the pin-indexing devices on the yoke-to-cylinder-valve connections are properly mated
- Check to make sure connections are tight to prevent leakage
- Open the cylinder valve completely when the cylinder is in use
- Close the cylinder valves and relieve pressure in the regulator before disconnecting the regulator
- Keep valves closed unless gas is being dispensed

- <https://www.youtube.com/watch?v=DcW04sY8S0w>

Safe Handling DONT's



Use cylinders for any purpose other than to supply the contained gas

Use or store ferromagnetic cylinders near the magnetic resonance imager (MRI)

Let oil, grease, or other combustible materials come in contact with containers, valves, regulators, gauges, hoses, and fittings

Lubricate valves, regulators, gauges, or fittings with oil or any other combustible material

Handle cylinders or apparatus with oily hands or gloves

Use an open flame to detect gas leaks

Interchange regulators or other appliances used with one gas with similar equipment used with other gases

More Safe Handling DONT's

Deface or remove any markings used to identify the cylinder's contents

Subject any part of a compressed gas cylinder to temperatures above 125°F

Add adapters to existing connections or modify or replace existing connections

Change, modify, tamper with, or obstruct the discharge ports of pressure relief devices

Place cylinders where they can become part of an electric circuit

Repaint cylinders

Use cylinders as rollers or supports

Safe Moving

DO

Use valve protection caps to protect the valves when moving cylinders

Always secure cylinders to a suitable hand truck when transporting them within the facility

DO NOT

Drop or let cylinders strike against each other

Roll, drag, or slide cylinders

Safe Bulk Storage DO's

Verify that the bulk compressed gas storage location is protected from unauthorized access and does not obstruct egress from the facility

Verify the bulk storage room is constructed of non-combustible or limited combustible materials (concrete or sheet rock respectively for example) and either partially or fully devoted for gas cylinder storage

Post a sign (readable from five feet) identifying it as a gas storage room, including the following warning—CAUTION; OXIDIZING GASES STORED WITHIN; NO SMOKING

Physically separate gases stored within the room by type or hazard class of the gas

Maintain a minimum distance of 20 feet between oxidizing gases and combustible materials (Note: the minimum distance to combustible material may be reduced to 5 feet when the room is protected by an automatic fire sprinkler system)

More Safe Bulk Storage DO's

Physically separate full and empty cylinders and ensure they are marked as such

Rotate cylinders so that they are used in the order that they are received (first in – first out)

Secure cylinders with straps or chains or place them in racks or on shelving cylinders to prevent them from falling

Notify the supplier if a cylinder is noticeably corroded, dented, cut, damaged, or involved in an accident, and follow the supplier's instructions for remedying the situation

Visually inspect stored cylinders on a routine basis, or at least weekly, for any indication of leakage or problems

Emergency Procedures

An emergency is any actual or potential release of a gas that cannot be stopped by closing the cylinder valve

Federal law requires that all facilities using compressed gases develop emergency response plans based on the potential hazards of the gases being stored and used

Practice implementing emergency response plans so that all contingencies are covered

Assign responsibilities and lines of authority for responding to emergencies

Coordinate emergency response with the local fire department and inform them of the gases in use so they can be prepared with the needed expertise and equipment

Develop first aid and medical response procedures for potential injuries

Oxygen



Every oxygen cylinder should have a Warning Tag for Medical Oxygen Equipment, attached to it showing the oxygen purity test results, date tested, tester's initials. (This is good practice)

Store no more than 12 size "E" oxygen cylinders or 1 size H and 2 size E cylinders in a single smoke compartment *(in use and empty cylinders are not included in the count)

The FDA has received reports from hospitals and nursing homes involving 7 deaths and 15 injuries to patients who were thought to be receiving medical grade oxygen, but were receiving a different gas (e.g., nitrogen) that had been mistakenly connected to the oxygen supply system. Texting the oxygen will reduce the chance of error and subsequent harm to patients.

Liquid Nitrogen

Nitrogen has no warning properties—it is colorless and odorless

Liquid nitrogen is a cryogen (boiling point is -320°F at 1 atm)

Store liquid nitrogen containers in a CLEAN, ventilated storage room that is protected with 1-hour fire rated walls and 45-minute fire rated doors. The temperature should stay constant

Store containers away from air intakes, high traffic areas, floor drains, and other underground openings

Do not plug, remove, or tamper with any pressure relief device

Keep all valves closed and outlet caps in place when not in use, and do not leave liquid containers open to the atmosphere for extended periods

- The volume expansion rate of nitrogen is 700 to 1 when warmed to room temperature



More Liquid Nitrogen

Store, handle, and transport cryogenic containers in the upright position

When moving, never tip, slide or roll containers on their side

Use a suitable hand truck for moving containers, and use a nylon strap to secure the container to the hand truck

Move larger containers by pushing, not pulling

Wear appropriate personal protective equipment when transferring liquid nitrogen to smaller containers (safety goggles or glasses with side shields, a face shield, and cryogenic gloves) along with sturdy shoes and long pants without cuffs. Pants should be left outside the work boots or shoes

Use only transfer equipment designed for use with cryogenic liquids



Still More Liquid Nitrogen

Perform transfer operations slowly to minimize boiling and splashing

Discontinue use and contact the supplier if there is any difficulty in operating the container valve or container connections

Contact the supplier if a restriction results from freezing moisture or foreign material present in openings and vents (restrictions and blockages may result in dangerous over-pressurization)

Do not attempt to remove the restriction without proper instructions; if possible, move the container to a remote location

Seek prompt medical assistance as soon as possible following a cold-contact burn



- Medical gas hazards include oxygen displacement, fires, explosions, and toxic gas exposures, as well as the physical hazards associated with high pressure systems
- Personnel who handle medical gases must be well-trained and knowledgeable of the gases' physical and health hazards and safe work practices
- Special storage, use, and handling precautions are necessary to control medical gas hazards
- Employers must evaluate medical gas hazards and have an emergency response plan that defines the procedures and responsibilities to address such emergencies
- All survey agencies will cite facilities for improperly handling medical gas cylinders



NFPA 99-2012, Healthcare Facilities Code

Compressed Gas Association (CGA) P-1, Safe Handling of Compressed Gases in Containers

CGA P-2, Characteristics and Safe Handling of Medical Gases

CGA P-2.7, Guide for the Safe Storage, Handling, and Use of Small Portable Liquid Oxygen Systems in Healthcare Facilities

CGA P-12, Safe Handling of Cryogenic Liquids

CGA P-30, Portable Cryogenic Liquid Containers – Use, Care, and Disposal

Occupational Safety and Health Administration (OSHA), 29 Code of Federal Regulations (CFR) 1910.101, Compressed Gases (General Requirements)



READ MORE

Compressed Gas Checklist



- Location:
- Date of inspection:
- Signature of inspector:
- 1. Are cylinders stored in upright positions and immobilized by chains or other means to prevent them from being knocked over? [CGA 3.4.4 and 29 CFR 1910.101(b)]
- 2. Are cylinders stored away from highly flammable substances such as oil, gasoline, or waste? [CGA 3.3.6]
- 3. Are cylinders stored away from electrical connections, gas flames or other sources of ignition, and substances such as flammable solvents and combustible waste material? [CGA 3.5.1]
- 4. Are flammable gases separated from oxidizing gases in storage areas? [CGA 3.3.3]
- 5. Are oxygen and fuel gas cylinders separated by a minimum of 20 feet when in storage? [CGA 3.5.3]
- Note: A fire-resistant partition between the cylinders can also be used.
- 6. Are storage rooms for cylinders dry, cool, and well-ventilated? [CGA 3.3.5]
- Note: The storage rooms should be fire resistant and the storage should not be in subsurface locations. Cylinders should be stored in secure areas at temperatures below 125°F, away from radiators or other sources of heat.
- 7. Are cylinders stored away from incompatibles, excessive heat, continuous dampness, salt or other corrosive chemicals, and any areas that may subject them to damage? [CGA 3.3.7 and 29 CFR 1910.101(b)]
- Note: Rusting will damage the cylinder and may cause the valve protection cap to stick.
- 8. Is the storage area permanently posted with the names of the gases stored in the cylinders? [CGA 3.3.2 and 29 CFR 1910.101(b)]
- 9. Do all compressed gas cylinders have their contents and precautionary labeling clearly marked on their exteriors? [29 CFR 1910.101(b)]

Compressed Gas Checklist

- 10. Are all compressed gas cylinder valve covers in place when cylinders are not in use? [29 CFR 1910.101(b)]
- 11. Are all compressed gas cylinders stored so they do not interfere with exit paths? [29 CFR 1910.101(b)]
- 12. Are all compressed gas cylinders subjected to periodic hydrostatic testing and interior inspection? [29 CFR 1910.101(a)]
- Note: This is normally done by the supplier.
- 13. Do all compressed gas cylinders have safety pressure relief valves? [29 CFR 1910.101(c)]
- 14. Are cylinders always maintained at temperatures below 125°F? [CGA 3.1.12]
- 15. Are safety relief devices in the valve or on the cylinder free from any indication of tampering? [CGA 3.1.14]
- 16. Is repair or alteration to the cylinder, valve, or safety relief devices prohibited? [CGA 3.1.15]
- Note: All alterations and repairs to the cylinder and valve must be made by the compressed gas vendor. Modification of safety relief devices beyond the tank or regulator should only be made by a competent person appointed by management.
- 17. Is painting cylinders without authorization by the owner prohibited? [CGA 3.1.20]
- Note: Often color codes are used to help designate cylinders. Arbitrary paint is not recommended.
- 18. Are charged or full cylinders labeled and stored away from empty cylinders? [CGA 3.3.4 and 29 CFR 1910.101(b)]
- 19. Is the bottom of the cylinder protected from the ground to prevent rusting? [CGA 3.3.9]



Compressed Gas Checklist

- 20. Are all compressed gas cylinders regularly inspected for corrosion, pitting, cuts, gouges, digs, bulges, neck defects and general distortion? [29 CFR 1910.101(a)]
- 21. Are cylinder valves closed at all times, except when the valve is in use? [CGA 3.1.15]
- Note: Regulator diaphragms have failed, and unwanted gas was delivered to an area or apparatus, causing safety and health problems.
- 22. Are compressed gas cylinders always moved, even short distances, by a suitable hand truck? [CGA 3.2.6]
- Note: They must never be dragged across the floor. Serious accidents have occurred when a cylinder with a regulator in place was improperly moved. The cylinder fell, causing the regulator to shear off, and the cylinder rocketed through several brick walls.
- 23. Is using wrenches or other tools for opening and closing valves prohibited? [CGA 3.4.9]
- Note: Hammering on valve wheels to open them should be strictly prohibited. For valves that are hard to open, contact the supplier for instruction.
- 24. Are suitable pressure regulating devices in use whenever the gas is emitted to systems with pressure-rated limitations lower than the cylinder pressure? [CGA 3.4.5]
- 25. Are all compressed gas cylinder connections such as pressure regulators, manifolds, hoses, gauges, and relief valves checked for integrity and tightness? [29 CFR 1910.101(a)]
- 26. Are all compressed gas cylinders regularly subjected to leak detection using an approved leak detecting liquid? [29 CFR 1910.101(a)]
- Note: Ordinary soap solution may contain oils that are unsafe when used with oxygen cylinders. Leak detection liquids are available from commercial welding supply houses.



Compressed Gas Checklist

- 27. Is an approved leak-detection liquid used to detect flammable gas leaks ? [CGA 3.5.2]
- Note: A flame should never be used.
- 28. Are procedures established for when a compressed gas cylinder leak cannot be remedied by simply tightening the valve? [CGA 3.1.6]
- The procedures should include the following:
 - 1. Attach tag to the cylinder stating it is unserviceable.
 - 2. Remove cylinder to a well ventilated out of doors location.
 - 3. If the gas is flammable or toxic, place an appropriate sign at the cylinder warning of these hazards.
 - 4. Notify the gas supplier and follow his/her instructions as to the return of the cylinder.
- 29. Are employees prohibited from using compressed gases (air) to clean clothing or work surfaces? [29 CFR 1910.101(b)]
- 30. Are compressed gases only handled by experienced and properly trained people? [CGA 3.4.1]





Quiz: Question 1

True or False

The primary physical hazard associated with medical gases is pressure?

Quiz: Question 2

Select the best answer

Cylinders should be returned to the supplier when they are—

- a) damaged
- b) improperly color-coded
- c) the label does not correctly identify the gas contained in the cylinder
- d) All of the above



Quiz: Question 3

True or False

- Employers must evaluate medical gas hazards and have an emergency response plan that defines the procedures and responsibilities to address such emergencies



Quiz: Question 4

Fill in the Blank

No more than _____ size E oxygen cylinders or _____ size H and _____ size E cylinders may be outside of a protected storage room in a single smoke compartment?



Quiz: Question 5

True or False

The best way to identify the contents of a medical gas cylinder is to read the label?-



Quiz: Question 6

True or False

Personnel who handle medical gases must be well-trained and knowledgeable of the gases' physical and health hazards and safe work practices?





Quiz: Question 7

True or False

A minimum distance of 20 feet between oxidizing gases from combustible materials must be maintained except when the cylinders are stored in a room with fire rated construction?

Quiz: Question 8

True or False

Examples of medical gases include medical air, USP; oxygen USP; helium USP; nitrogen NF; and mixtures of these gases?



Quiz: Question 9

Where can you find detailed information regarding the physical and chemical properties, specific handling, safety precautions, physiological effects on humans and emergency procedures-



Quiz: Question 10

True or False

Consistent with good infection control practices, store medical gas cylinders in soiled utility rooms since they are being used for patient care?



Quiz: Question 11

True or False

Ferromagnetic cylinders may be used or stored near the magnetic resonance imager (MRI)?



Quiz: Question 12

Select the best answer

This type of gas that can cause severe burns to skin and other human tissues such as the eye or lung, and can attack clothes and other materials including metal-

- a.) Compressed Gas
- b.) Oxidizer
- c.) Corrosive
- d.) Cryogenic



Quiz: Bonus

Select the best answer

The volume expansion rate of nitrogen is ___ to ___ when warmed to room temperature?

