Pressure Vessel Components and Systems and Compressed Gas Cylinders

Scope

Compressed Gas Cylinder Storage

Cylinders of compressed gases shall be stored in areas where they are protected from external heat sources such as flame impingement, intense radiant heat, electric arc, or high-temperature steam lines.

8 CCR 4650(a)

Inside of buildings, cylinders shall be stored in a well-protected, well-ventilated, dry location, and flammable gas cylinders shall be at least 20 feet from highly combustible materials.

8 CCR 4650(b)
CGA P-1 3.7 & 4.2.2

The heating of flammable gas storage areas shall be indirectly heated, such as by air, steam, hot water, etc.

UC Practice

Cylinders are not permitted in unventilated enclosures such as lockers and cupboards.

8 CCR 4650(c)

Adequate space shall be made available for the segregation of gases by hazard class.
Flammable gases shall not be stored with oxidizing agents. Separate storage for full or empty cylinders is preferred. Such enclosures shall serve no other purpose.

Cylinders containing strong oxidizers, such as oxygen, nitrous oxide, etc., shall not be stored near flammable gases or other combustible materials. Oxidizing gases shall be stored at a minimum distance of 20 feet from highly combustible materials, or a noncombustible barrier that is at least 5 feet high and fire-resistant. Valves, pipe fittings, regulators, and other equipment shall be constructed of material and pressure rating that is also compatible with oxygen. Code requires that only noncombustible barriers be used.

8 CCR 4650(d)
CGA P-1 3.7.2
24 CCR 9 (CFC), Section 8001.11.8

Liquefied fuel-gas cylinders shall be stored/transported in an upright position so that the safety relief device is in direct contact with the vapor space in the cylinder at all times.

8 CCR 4650(e)

When toxic or highly toxic flammable gases are stored in rooms outside of gas cabinets or exhausted enclosures, the storage rooms shall be provided with explosion control.

UC Practice
24 CCR 9 (CFC), Section 8003.1.7
Required for H-6 occupancies

When separate gas storage rooms are provided, they shall operate at a negative pressure in relation to the surrounding area, and direct the exhaust ventilation to the fume exhaust system, assuring that incompatible gases are not mixed in the ductwork.

UC Practice
24 CCR 9, Section 8003.3.1.3.4
Required for H-6 occupancies

Storage areas shall be secured against unauthorized entry.

UC Practice
Required for H-6 occupancies

The storage of compressed gas cylinders shall not obstruct exits or routes of egress. Also, compressed gas cylinders shall not be stored near elevators, walkways, platform edges, or in locations where heavy moving objects may strike or fall upon them.

emergency power shall be provided for exhaust ventilation, gas-detection systems, emergency alarm systems, and temperature control systems.

Compressed Gas Cylinder Restraint

Approved storage racks (e.g., Unistrut, pipe racks) shall be provided that adequately secure gas cylinders by chains, metal straps, or other approved materials, to prevent cylinders from falling or being knocked over. Chains are preferable to straps. Straps shall be noncombustible.

Cylinder restraints shall be sufficient to prevent the cylinder from tipping over. In seismically active areas, more than one chain/strap should be used (double chains/straps should be located at one-third and two-thirds the height of the cylinder).

Chain/strap restraints shall be used to restrain a maximum of 3 cylinders per chain/strap or per...
set of chains/straps (if double-chained/strapped).

UC Practice

The purchase and installation of compressed gas cylinder securing systems shall be subject to review and approval of EH&S.

Gas cylinder securing systems should be anchored to a permanent building member or fixture. Connection to a permanent building member or fixture is needed to prevent movement during a seismic event.

UC Practice

Toxic and Corrosive Gas Storage and Distribution

Treatment systems shall be reviewed and approved by EH&S and shall comply with applicable local environmental regulations. Gas storage cabinets and distribution systems should comply with the following standards:

- Semiconductor Equipment and Materials International, Guide for Gaseous Effluent Handling, F5-90

UC Practice

Requirements for Gas Cabinets

Storage and use of toxic and highly toxic compressed gas cylinders shall be within exhaust ventilated gas storage cabinets, laboratory fume hoods, exhausted enclosures, or within separate ventilated gas storage rooms without other occupancy or use. It is acceptable to
mount lecture bottles connected to a manifold in a fume hood.

24 CCR 9, Section 8003.3.1.3.1
Required for H-6 occupancies

Gas cabinets shall be located in a room or area that has non-recirculated exhaust ventilation and operates at negative pressure in relation to the surrounding area, and shall be connected to the fume exhaust system.

Gas cabinets shall have self-closing limited access ports or noncombustible windows to provide access to equipment controls, with an average face velocity of at least 200 fpm, and a minimum of 150 fpm at any part of the access port or window, and design criterion of 200 fpm at the cylinder neck when the average face velocity is >200 fpm.

24 CCR 9, Sections 8003.3.1.3.1, 8003.3.1.3.2, and 8003.3.3.1.8

Gas cabinets shall have self-closing doors, be constructed of at least 0.097-inch (12 gauge) steel, have internal sprinklers, and be seismically anchored.

24 CCR 9, Sections 8003.3.1.3.1, 8003.3.1.3.2, and 8003.3.3.1.8

Gas cabinets must be provided with self-closing limit access ports or noncombustible windows to give access to equipment controls.

Gas cabinet interiors shall be treated, coated or constructed of materials that are compatible with the hazardous materials stored. Such treatment, coating or construction shall be include the entire interior of the cabinet.

Gas cabinets shall be fitted with sensors connected to alarms to notify personnel in the event of a leak or exhaust system failure as appropriate.

The number of cylinders contained in a single gas cabinet shall not exceed three.

UC Practice
24 CCR 9, Sections 8003.3.1.3.1, 8003.3.1.3.2, and 8003.3.3.1.8
Required for H-6 occupancies
Monitoring Toxic and Highly Toxic Gases

Whenever the quantities and composition of the expected toxic gas inventory levels are exceeded, as interpreted by EH&S, then a continuous gas detection system shall be provided to detect the presence of gas. This system shall detect at or below the permissible exposure limit (LEL), ceiling limit, or maximum permissible concentration, except for toxic gases where EH&S has determined that the physiological warning properties for the gas are sufficiently below the permissible exposure limit. The detection system shall initiate a local alarm and transmit a signal to a constantly attended location. Activation of the monitoring system shall automatically close the shutoff valve on toxic, highly toxic, and radioactive gas supply lines to the system being monitored.

24 CCR 9 (CFC), Sections 8003.3.1.6 and 8003.3.1.7

A provision shall be made to allow the air monitoring equipment to function alarms and shut off gas flows as close to the gas sources as possible. Guidance about the gases to be monitored, alarm set points, and where and how the alarms sound shall be provided by the campus EH&S organization.

An approved supervised smoke detection system shall be provided in rooms or areas where highly toxic compressed gases are stored indoors.

24 CCR 9 (CFC), Section 8003.3.1.7

Silane and Other Pyrophoric Gases

Silane is not highly toxic, but it is pyrophoric. The ensuing deflagration can cause severe damage. Silane storage falls into two categories: indoor bunker or outdoor nest.
Silane cylinders shall be stored while secured to steel frames in a silane nest or bunker that is external to buildings that are open on three sides and enclosed by a roof; the cylinders shall be secured by means of an open chain link fence. A canopy provided to protect the stored cylinders from the elements shall be ≥12 ft above grade. The nest shall be ≥9 ft from buildings and the fence. A three-sided fence with the fourth wall constituted by a building wall is acceptable. Bunkers shall be approved by the authority having jurisdiction.

The objective is to provide ample ventilation and minimize potential blast/fire damage in the event of a leak and deflagration.

NFPA 318, Chapters 6-4.1, 4.1.1, 4.1.2, 5.1.1, 5.1.2, 5.3

Cylinders in silane-dispensing stations shall be separated by means of a 1/4-inch steel plate extending 3 inches beyond the footprint of the cylinder and from the top of a purge panel, to 12 inches below the cylinder valve.

These specifications reduce the chance of having a deflagration or fire and minimize damage and injuries should such an incident occur.

NFPA 318 Chapter 6-4.3 (b)

Mechanical or natural ventilation shall provide 1 cfm/ft² of storing or dispensing area. Mechanical ventilation, if used, shall be furnished with emergency backup power.

These specifications reduce the chance of having a deflagration or fire and minimize damage and injuries should such an incident occur.

NFPA 318 Chapter 6-4.3 (c)

Automatic water deluge water spray protection shall be provided in dispensing areas directed at individual cylinders activated by UV/IR detectors. Detection will also activate automatic shutoff valves.

These specifications reduce the chance of having a deflagration or fire and minimize damage and injuries should such an incident occur.

UC Practice
Remote manual shutoff that can be operated from at least 15 feet from the dispensing area shall be provided.

These specifications reduce the chance of having a deflagration or fire and minimize damage and injuries should such an incident occur.

NFPA 318 Chapter 6-4.3 (e)

Silane-dispensing areas shall be separated from buildings and fences.

These specifications reduce the chance of having a deflagration or fire and minimize damage and injuries should such an incident occur.

NFPA 318 Chapter 6-4.3 (a), 5.3 (a)

An automated sequential inert gas evacuation/purge shall be provided for silane dispensing equipment. The inert gas is introduced upstream of the first vent or exhaust connection of a gas delivery header.

These specifications reduce the chance of having a deflagration or fire and minimize damage and injuries should such an incident occur.

NFPA 318 Chapter 6-4.3 (g)

Gas cabinets, if used, shall have only enough room for one cylinder and meet the specifications of SEMI F14-93.

These specifications reduce the chance of having a deflagration or fire and minimize damage and injuries should such an incident occur.

NFPA 318 Chapter 6-5.1.3

An automated sequential inert gas evacuation/purge shall be provided in the gas cabinet with the inert gas introduced upstream of the first vent or exhaust connection of a gas delivery header.

NFPA 318 does not mandate compliance with a SEMI standard, but all other parts are taken
from NFPA 318 and are meant to reduce the chance of having a deflagration or fire, and to minimize damage and injuries should such an incident occur. The SEMI standard is cited to ensure that the equipment meets an adequate, generally recognized standard of quality.

NFPA 318 Chapter 6-7.2

Remote manual shutdown shall be provided from the outside of the gas cabinet.

NFPA 318 does not mandate compliance with a SEMI standard, but all other parts are taken from NFPA 318 and are meant to reduce the chance of having a deflagration or fire, and to minimize damage and injuries should such an incident occur. The SEMI standard is cited to ensure that the equipment meets an adequate, generally recognized standard of quality.

UC Practice

Design of Systems and Apparatus for Cryogenic Fluids

The position of valves and switches for emergency shutdowns shall be accessible and clearly labeled.

UC Practice

Nonsulated pipes or vessels should be positioned and/or identified to prevent inadvertent contact with an unprotected part of the body.

UC Practice

Critical vent areas should be covered, or pointed down (i.e., Dewar necks, and pressure reliefs).

UC Practice

All portions of lines that could contain liquid cryogen shall be protected by pressure relief devices. This means that a pressure relief device shall be installed on any portion of a line that could be isolated by shutoff valves.
Design of Pressure Vessels and Systems

Normal and emergency relief venting and vent piping for pressure vessels should be adequate and in accordance with the design of the vessel.

ASME Boiler and Pressure Vessel Code for Unfired Pressure Vessels
8 CCR Chapter 4, Subchapter 1

Pressure relief valves must be plumbed on any pressure vessel that have unobstructed contact with the pressurized substance.

Pressure relief valves must be set to a maximum of pressure (minus 50 psi for best practice) for relief at the maximum working design pressure of the lowest-pressure-component in any pressurized vessel and piping system.