

Chapter 38

Compressed Gas Cylinders

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1 Overview

Compressed gas cylinders (CGCs) can present a variety of hazards, both because the cylinder may contain gas with hazardous properties and because the gas is under pressure. This chapter describes requirements for the purchase of gas in as well as the safe use, inspection, handling, transport, storage, and removal of CGCs. Requirements for CGCs owned by subcontractors are included.

1.1 Hazards/Impacts

Potential hazards associated with malfunctioning CGCs include explosion, fire, and impact by uncontrolled cylinders. Hazards associated with particular gases and mixtures include fire, asphyxiation, poisoning, and exposure-related illnesses and injuries.

2 Scope

The requirements of this chapter apply to all personnel who handle CGCs, including SLAC employees, users, and visitors, and to all facilities where CGCs are used and stored. All requirements, with the exception of purchasing and certain inspection procedures, also apply to subcontractors.

Because of the potential hazards associated with CGCs and their content, requirements set forth in Chapter 40, "Hazardous Materials", with regard to purchasing, inspection while in storage, handling, transport, and emergency response also apply to CGCs. Accordingly, Chapter 40 requirements are referenced throughout this chapter.¹

CGC types that this chapter applies to include lecture bottles and cylinders belonging to Department of Transportation (DOT) classification series 3A, 3AA, 4BA, 8AL, 3AL, 3E, and SP.² This chapter does not pertain to bulk gas storage systems, tube trailers, tankers, dewars, disposable cylinders, and fire extinguishers.

For requirements concerning cryogenic gases, see Chapter 36, "Cryogenic and Oxygen Deficiency Hazard Safety".³ For requirement concerning other types of pressurized containers, see Chapter 14, "Pressure and Vacuum Vessels".⁴

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- 1 *SLAC Environment, Safety, and Health Manual* (SLAC-I-720-0A29Z-001), Chapter 40, "Hazardous Materials", http://www-group.slac.stanford.edu/esh/hazardous_substances/haz_materials/policies.htm
 - 2 The Department of Transportation (DOT) is the United States government agency responsible for CGC safety regulations, including hazard labeling and hydrostatic testing and transportation requirements.
 - 3 *SLAC Environment, Safety, and Health Manual* (SLAC-I-720-0A29Z-001), Chapter 36, "Cryogenic and Oxygen Deficiency Hazard Safety", http://www-group.slac.stanford.edu/esh/hazardous_substances/cryogenic/policies.htm
 - 4 *SLAC Environment, Safety, and Health Manual* (SLAC-I-720-0A29Z-001), Chapter 14, "Pressure and Vacuum Vessels", http://www-group.slac.stanford.edu/esh/hazardous_activities/pressure/

3 Standards

The CGC program has adopted the following standards:

- Title 29, *Code of Federal Regulations*, “Labor”, Section 1910.101, “Compressed Gases – General Requirements”⁵
 - Section 1910.101(a), “Inspection of Compressed Gas Cylinders” (29 CFR 1910.101a)
 - Section 1910.101(b), “Compressed Gases” (29 CFR 1910.101b)
- Title 29, *Code of Federal Regulations*, “Labor”, Section 1910.253, “Oxygen-fuel Gas Welding and Cutting”⁶
 - Sections 1910.253(b)(2), “Storage of Cylinders – General”, through 1910.253(b)(5)(iii)(L) (29 CFR 1910.253b2–b5iiiL)
- Title 49, *Code of Federal Regulations*, “Transportation”, Chapter 1, “Pipeline and Hazardous Materials Safety Administration, Department of Transportation”⁷
 - Parts 171, “General Information, Regulations, and Definitions”, through 179, “Specifications for Tank Cars” (49 CFR 171–179)
- Title 24, *California Code of Regulations*, Part 9, “California Fire Code”⁸
 - Article 74, “Flammable and Combustible Liquids”
 - Article 80, “Hazardous Materials”
- National Fire Protection Association (NFPA) NFPA 55-2005, “Standard for the Storage, Use, and Handling of Compressed Gases and Cryogenic Fluids in Portable and Stationary Containers, Cylinders, and Tanks”⁹
- The following industry-accepted consensus standards:
 - Compressed Gas Association (CGA) Pamphlet CGA P-1-2000, “Safe Handling of Compressed Gases in Containers”¹⁰
 - CGA Pamphlet C-6-2001, “Standards for Visual Inspection of Steel Compressed Gas Cylinders”¹¹

5 http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9747

6 http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9854

7 “Code of Federal Regulations: Main Page”, <http://www.gpoaccess.gov/cfr/>

8 http://www.bsc.ca.gov/title_24/t24_2001tried.html#part9. Note Title 24, *California Code of Regulations*, is available only through depository libraries and the publishers of its various components. See the SLAC Library, <http://www.slac.stanford.edu/library/>, for available standards. A hard copy of the 1998 “California Fire Code” is available; see <http://www.slac.stanford.edu/spires/find/books/www?key=267759>.

9 See the SLAC Library, <http://www.slac.stanford.edu/library/>, for available standards. NFPA standards are available online from a SLAC login (see <http://www.slac.stanford.edu/library/eresources/slac.htm> for the link and instructions); some hard copies are also available.

10 “Publications”, <http://www.cganet.com/Publication.asp>

- CGA Pamphlet C-8-1997, “Standard for Re-qualification of DOT-3HT Seamless Steel Cylinders”¹²

4 Definitions

Chemical asset custodian. The person designated by an area manager or supervisor as the responsible party for chemical storage assets

Chemical management services (CMS). The software (Haas tcmIS) and material inventory management system through which chemicals are purchased, inspected, delivered, inventoried, paid for and reported

Compressed Gas Association (CGA). An industry- and government-recognized body that sets standards for compressed gases and CGCs

Cylinder, compressed gas (CGC). A pressure vessel designed to hold compressed gas at an absolute pressure greater than 1 atm at 68°F (20°C)

- *Cylinder, abandoned.* Any cylinder that is out of compliance (for example, missing a label, not restrained, shows obvious signs of neglect) for which no owner can be located
- *Cylinder, non-SLAC owned.* Any cylinder that belongs to a contractor or a gas supplier (applies generally to return-to-vendor CGCs, not single-use cylinders)
- *Cylinder, return-to-vendor.* Any refillable CGC that is supplied by the gas supplier
- *Cylinder, SLAC-owned.* Any cylinder that has been purchased by the federal government and made available to SLAC. SLAC-owned cylinders may be labeled as belonging to the Department of Energy (DOE) or a branch of the US Armed Forces. SLAC’s current inventory is managed through the Haas tcmIS system.

Gas. A state of matter in which the matter expands to the confines of its container, such as a CGC. SLAC’s CGC inventory includes gases with properties that require particular use, storage and handling practices. Gas properties (which are listed in the MSDS) and states include

- *Gas, asphyxiant.* A material capable of reducing the level of oxygen in the body to dangerous levels, most commonly by displacing breathable air in an enclosed environment. Displacement reduces the oxygen concentration below the normal level, which is in the 20 percent range. Oxygen deficiency can lead to breathing difficulties, unconsciousness or even death within minutes.¹³
- *Gas, compressed.* A material, or mixture of materials, that is a gas at ambient temperature and pressure but is contained in a CGC or other pressure vessel. Within the vessel, a compressed gas may be in a

11 See the SLAC Library, <http://www.slac.stanford.edu/library/>, for available standards. A hard copy of the CGA C-6-2001 is available; see <http://www.slac.stanford.edu/spires/find/books/www?key=327050>.

12 See the SLAC Library, <http://www.slac.stanford.edu/library/>, for available standards. A hard copy of the CGA C-8-1997 is available; see <http://www.slac.stanford.edu/spires/find/books/www?key=327069>.

13 See *SLAC Environment, Safety, and Health Manual* (SLAC-I-720-0A29Z-001), Chapter 36, “Cryogenic and Oxygen Deficiency Hazard Safety”, http://www-group.slac.stanford.edu/esh/hazardous_substances/cryogenic/policies.htm

gaseous or liquid state, depending on its unique characteristics under particular temperature and pressure conditions.

- *Gas, corrosive.* A gas that exhibits chemical properties that cause visible destruction of, or irreversible alterations in, living tissue and certain metals by chemical action at the site of contact
- *Gas, flammable.* A material that is a gas at room temperature and that is ignitable at ambient temperature and pressure when in a mixture of 13 percent or less by volume with air
- *Gas, inert.* A non-reactive, nonflammable, non-corrosive gas such as argon, helium, krypton, neon, nitrogen, and xenon
- *Gas, oxidizing.* A gas that can support and accelerate combustion of other materials
- *Gas, toxic.* A property of certain materials that causes injury, illness, or death when inhaled, ingested or absorbed through the skin if the material is not handled properly. The CGA defines a toxic gas as any gas that can kill 50 percent of the test subjects (LC₅₀) with a concentration of less than or equal to 5000 parts per million.

Handling. The deliberate movement of material in containers by any means to a point of storage or use

Hydrostatic test. A pressure test done at an off-site facility to verify that a cylinder meets safety specifications

In use. The state of CGC content being withdrawn and used in a non-recoverable manner for application (see also *storage*, below)

Material safety data sheet (MSDS). A document produced by chemical manufacturers and importers to relay chemical, physical, and hazard information about specific substances

Regulator. A device that controls the release of gas from CGCs

Six pack. A gas delivery system that consists of a regulator, tubing, valves, and a metal frame that can hold up to six CGCs. Gas is delivered from one CGC at a time and each is emptied in turn.

Storage. The state of a CGC having been set aside for future use, safe keeping, or inventory of compressed gases or liquefied gases in containers that are not in the process of being used, serviced, loaded or unloaded

Storage area. A designated area, either indoors or outdoors, within which an inventory of CGCs are not in the process of being used, loaded, or unloaded

5 Requirements

5.1 General

General requirements for the purchase, inspection, handling, transport, storage, and removal of CGCs are listed below.

Note All CGCs on the SLAC site must meet all Department of Transportation (DOT) safety requirements and all the requirements of this chapter.

5.1.1 Purchasing and CGC Removal

5.1.1.1 Purchasing

Like all chemicals purchased at SLAC, compressed gases must be ordered through the Haas tcmIS.¹⁴ Only SLAC employees are authorized to initiate a gas purchase, and only employees registered in the Haas tcmIS may place orders. (See Hazardous Materials: Purchasing Procedure.¹⁵)

Gas delivered in CGCs is generally contained in SLAC-owned refillable cylinders. Unlike dewars, cylinders may only be refilled by the gas supplier.

5.1.1.2 Waste Minimization

Only the minimum amount of gas necessary for the immediate purpose should be ordered. This avoids accumulating CGCs that may run out of compliance with inspection requirements if they are stored for long periods.

5.1.1.3 Removal

All CGCs in the SLAC inventory are managed by the Haas tcmIS and the CGC program manager. Once a listed refillable cylinder is empty or of no further use, it must be returned to the vendor. This is initiated by contacting the CGC program manager or the Haas tcmIS representative.

Any disposable, damaged, abandoned, or unidentified CGCs must be reported to the CGC program manager.

Any CGC owned by a subcontractor must be removed by the subcontractor if it is found to be out of compliance with the requirements of this chapter.

5.1.2 Equipment

All cylinders must be managed in accordance with the inspection, handling, storage, and transport requirements outlined below – from the point of delivery until the supplier removes the spent cylinder – as described below.

Note Certain exemptions apply to subcontractor-owned CGCs, as noted below.

5.1.2.1 Chemical Asset Custodian

All CGCs that are not owned by a subcontractor must be assigned a chemical asset custodian if the CGC or its contents are subject to inspections as described below.

14 “Chemical Management Services (CMS)”, <http://www-group.slac.stanford.edu/esh/groups/cgs/cms/>

15 Hazardous Materials: Purchasing Procedure (SLAC-I-730-0A09C-001), <http://www-group.slac.stanford.edu/esh/eshmanual/references/hazmatProcedPurchase.pdf>

5.1.2.2 Inspection

The inspection requirements in Chapter 40, “Hazardous Materials”,¹⁶ apply to CGCs. In particular, the following inspections apply to all CGCs on site:

Inspection of CGCs in Storage

- It is required that the chemical asset custodian inspect CGCs that are in storage once per month.
- Further, a leak test must be conducted for all CGCs containing toxic or flammable gases.
- For documentation requirements, see Hazardous Materials: Storage Inspection Procedure and Form.¹⁷

Note The CGC program manager will periodically inspect various CGC storage sites for compliance.

Inspection at the Point of Delivery

- Required: A leak test must be conducted for all CGCs containing toxic, corrosive, or flammable gases at the point of delivery and this test must be documented using the CGC: Point of Delivery Inspection Form.¹⁸
- Recommended: Inspect CGCs for proper labeling, damage, and unsafe conditions at the point of delivery. If any CGC is found to be improperly labeled, leaking, or damaged at the time of delivery, delivery must be refused.

Note Subcontractors are responsible for ensuring that CGCs they bring on site meet the equivalent safety precaution achieved by a point of delivery inspection.

Inspection of CGCs in Use

It is recommended that CGCs be visually inspected prior to each use.

5.1.2.3 Labeling

All CGCs must be properly, completely, and legibly labeled at all times to indicate

- Cylinder contents
- Type of hazard the content poses (toxic, flammable, oxidizing, corrosive, or asphyxiant)
- Hydrostatic test date

All labeling must be original and originate with the gas vendor. If any information is missing, the CGC program manager must be contacted.

16 SLAC Environment, Safety, and Health Manual (SLAC-I-720-0A29Z-001), Chapter 40, “Hazardous Materials”, http://www-group.slac.stanford.edu/esh/hazardous_substances/haz_materials/policies.htm

17 Hazardous Materials: Storage Inspection Procedure and Form (SLAC-I-730-0A09J-001), <http://www-group.slac.stanford.edu/esh/forms/>

18 CGC: Point of Delivery Inspection Form (SLAC-I-730-0A09J-005), <http://www-group.slac.stanford.edu/esh/forms/>

Note CGCs delivered by the Haas gas supplier carry a yellow cylinder status label with perforated tabs. These are removed as the cylinder status changes from full, to in service, to empty.¹⁹

5.1.2.4 Hydrostatic Test Date

Hydrostatic tests must be conducted by a qualified testing facility. The test date is stamped onto the cylinder each time the cylinder is tested. An acceptable test date depends on the status of the cylinder:

- Newly ordered cylinders must show a test date that is less than five years from the delivery date unless the testing interval for that specific cylinder type is longer.

Note Most SLAC CGCs require testing every five years.

- Empty cylinders exceeding the test date limit must be tested by a qualified testing facility prior to refilling.

Note SLAC does not refill any CGCs.

- Cylinders in use are allowed to exceed the five year limit.

5.1.2.5 Handling and Use

The safe handling and use of CGCs depend on the implementation of the requirements as described in CGC: Safety Requirements²⁰ and CGC: Handling and Use Requirements.²¹ Specified requirements include

- Observing hazard class-specific safety requirements
- Observing precautions prior to hook up and use
- Taking measures to properly secure CGCs
- Protecting CGC valves and ensuring proper regulator use
- Observing ANSI standards for piping labeling and marking
- Properly managing empty CGCs

Note For additional information, see Chapter 40, “Hazardous Materials”.²²

5.1.2.6 Storage

Comprehensive storage requirements for hazardous materials are described in Chapter 40, “Hazardous Materials”,²³ and in CGC: Storage Area Requirements.²⁴ All safety requirements and precautions

19 CGC: Yellow Tag Use Requirements (SLAC-I-730-0A09S-029), <http://www-group.slac.stanford.edu/esh/eshmanual/references/cgcReqTagUse.pdf>

20 CGC: Safety Requirements (SLAC-I-730-0A09S-027), <http://www-group.slac.stanford.edu/esh/eshmanual/references/cgcReqSafety.pdf>

21 CGC: Handling and Use Requirements (SLAC-I-730-0A09S-030), <http://www-group.slac.stanford.edu/esh/eshmanual/references/cgcReqHandling.pdf>

22 *SLAC Environment, Safety, and Health Manual* (SLAC-I-720-0A29Z-001), Chapter 40, “Hazardous Materials”, http://www-group.slac.stanford.edu/esh/hazardous_substances/haz_materials/policies.htm

pertaining to the class of hazard the gas belongs to must be observed. Additional storage requirements pertain to the combination of gases used in welding.

Welding in Conjunction with Construction

Acetylene and oxygen can only be stored together for more than 24-hours if they are in a welding cart with a patented engineered steel fire barrier. Acetylene and oxygen CGCs in a regular welding cart must be placed in appropriate storage if these gases will not be used again within a 24-hour period

Welding Conducted for General Industry Purposes

CGCs containing acetylene and oxygen may remain in a cart indefinitely as long as the cylinders remain in an upright position and the regulator remains in place.

5.1.2.7 Transport

The transport requirements in Chapter 40, "Hazardous Materials",²⁵ apply to CGCs. In particular, SLAC-owned CGCs are required to be transported to SLAC by a Haas CMS vendor. No exceptions are allowed.

Once delivered to the user, cylinders may only be transported within the immediate work area and only in a cart or vehicle fitted with the proper restraining equipment. Before transport, a protective cap must be placed over the valve.

Cylinders owned by subcontractors must be transported in accordance with all DOT regulations.

5.1.3 Personnel

5.1.3.1 Personal Protective Equipment

The minimum recommended personal protective equipment (PPE) for persons working with CGCs is steel-toed boots or shoes. Additional recommended PPE includes protecting workers from gas-specific hazards as indicated on the MSDS for the contents of the CGC.

5.1.4 Roles and Responsibilities

5.1.4.1 CGC Program Manager

The CGC program manager will

- Develop and enforce CGC program requirements
- Spot inspect certain CGC storage areas throughout the year

23 *SLAC Environment, Safety, and Health Manual* (SLAC-I-720-0A29Z-001), Chapter 40, "Hazardous Materials", http://www-group.slac.stanford.edu/esh/hazardous_substances/haz_materials/policies.htm

24 CGC: Storage Area Requirements (SLAC-I-730-0A09S-026), <http://www-group.slac.stanford.edu/esh/eshmanual/references/cgcReqStorage.pdf>

25 *SLAC Environment, Safety, and Health Manual* (SLAC-I-720-0A29Z-001), Chapter 40, "Hazardous Materials", http://www-group.slac.stanford.edu/esh/hazardous_substances/haz_materials/policies.htm

- Arrange for the removal of cylinders that have no further use, including but not limited to damaged or abandoned cylinders.

5.1.4.2 Haas tcmIS Representative

The on-site Haas tcmIS representative will

- Be available to train users in placing an order using the Haas tcmIS
- Arrange for the removal of SLAC-owned CGCs that are of no further use

5.1.4.3 Managers and Supervisors

Managers and supervisors will

- Ensure users are properly trained in the use, handling, and storage of CGCs
- Ensure users are equipped with the proper PPE for working with CGCs and their contents
- Ensure all CGCs are properly stored, handled and used in accordance with the requirements of this chapter
- Designate a person responsible for required inspections
- Ensure all compressed gases are ordered through the Haas tcmIS
- Ensure that equipment is maintained in good operating condition

5.1.4.4 Chemical Asset Custodians

The chemical asset custodian will

- Be designated by management or the area manager
- Conduct monthly inspections of CGC storage areas as required in Chapter 40, “Hazardous Materials”²⁶
- Conduct the initial inspection at the point of delivery, if applicable

5.1.4.5 Compressed Gas Cylinder Users

Users will

- Use cylinders in a manner consistent with the requirements of this chapter
- Report any CGC or equipment malfunctions to their supervisor

5.2 Procedures and Specific Requirements

All SLAC-owned CGCs must be inspected, stored, used, handled, and transported according to the following specific requirements. For a list of all implementing documents, see Section 6, “Exhibits”.

Note Subcontractor-owned CGCs are subject to the same requirements except for the purchase of gas and the point of delivery inspection.

²⁶ SLAC Environment, Safety, and Health Manual (SLAC-I-720-0A29Z-001), Chapter 40, “Hazardous Materials”, http://www-group.slac.stanford.edu/esh/hazardous_substances/haz_materials/policies.htm

5.2.1 Purchasing

Steps to follow to purchase compressed gas (Hazardous Materials: Purchasing Procedure²⁷)

5.2.2 Inspection

Required monthly inspection (Hazardous Materials: Storage Inspection Procedure and Form²⁸)

Required point of delivery inspection (CGC: Point of Delivery Inspection Form²⁹)

CGC-specific inspection requirements and additional information (CGC: Inspection Requirements,³⁰ CGC: Leak Detection Requirements,³¹)

5.2.3 Handling and Use

Handling and use requirements (CGC: Safety Requirements³², CGC: Handling and Use Requirements³³, and CGC: Portable Oxygen-fuel for Welding and Cutting Requirements³⁴)

5.2.4 Storage

Storage and segregation requirements (CGC: Storage Area Requirements³⁵)

5.2.5 Transport

Restrictions and requirements for on-site transport (CGC: Transport Requirements³⁶)

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- 27 Hazardous Materials: Purchasing Procedure (SLAC-I-730-0A09C-001), <http://www-group.slac.stanford.edu/esh/eshmanual/references/hazmatProcedPurchase.pdf>
 - 28 Hazardous Materials: Storage Inspection Procedure and Form (SLAC-I-730-0A09J-001), <http://www-group.slac.stanford.edu/esh/forms/>
 - 29 CGC: Point of Delivery Inspection Form (SLAC-I-730-0A09J-005), <http://www-group.slac.stanford.edu/esh/forms/>
 - 30 CGC: Inspection Requirements (SLAC-I-730-0A09S-028), <http://www-group.slac.stanford.edu/esh/eshmanual/references/cgcReqInspect.pdf>
 - 31 CGC: Leak Detection Requirements (SLAC-I-730-0A09S-025), <http://www-group.slac.stanford.edu/esh/eshmanual/references/cgcReqLeak.pdf>
 - 32 CGC: Safety Requirements (SLAC-I-730-0A09S-027), <http://www-group.slac.stanford.edu/esh/eshmanual/references/cgcReqSafety.pdf>
 - 33 CGC: Handling and Use Requirements (SLAC-I-730-0A09S-030), <http://www-group.slac.stanford.edu/esh/eshmanual/references/cgcReqHandling.pdf>
 - 34 CGC: Portable Oxygen-fuel for Welding and Cutting Requirements (SLAC-I-730-0A09S-024), <http://www-group.slac.stanford.edu/esh/eshmanual/references/cgcReqOxygen.pdf>
 - 35 CGC: Storage Area Requirements (SLAC-I-730-0A09S-026), <http://www-group.slac.stanford.edu/esh/eshmanual/references/cgcReqStorage.pdf>

5.3 Training

There are no specific training requirements beyond on-the-job training with an experienced user of CGC-related equipment and understanding the procedures set forth in this chapter.

6 Exhibits

- “Chemical Management Services (CMS)”³⁷
- Hazardous Materials: Purchasing Procedure (SLAC-I-730-0A09C-001)³⁸
- Hazardous Materials: Storage Inspection Procedure and Form (SLAC-I-730-0A09J-001)³⁹
- CGC: Implementation Plan (SLAC-I-730-0A09M-006)⁴⁰
- CGC: Handling and Use Requirements (SLAC-I-730-0A09S-030)⁴¹
- CGC: Yellow Tag Use Requirements (SLAC-I-730-0A09S-029)⁴²
- CGC: Inspection Requirements (SLAC-I-730-0A09S-028)⁴³
- CGC: Safety Requirements (SLAC-I-730-0A09S-027)⁴⁴
- CGC: Storage Area Requirements (SLAC-I-730-0A09S-026)⁴⁵
- CGC: Point of Delivery Inspection Form (SLAC-I-730-0A09J-005)⁴⁶
- CGC: Leak Detection Requirements (SLAC-I-730-0A09S-025)⁴⁷
- CGC: Portable Oxygen-fuel for Welding and Cutting Requirements (SLAC-I-730-0A09S-024)⁴⁸
- CGC: Transport Requirements (SLAC-I-730-0A09S-031)⁴⁹

36 CGC: Transport Requirements (SLAC-I-730-0A09S-031), <http://www-group.slac.stanford.edu/esh/eshmanual/references/cgcReqTransport.pdf>

37 <http://www-group.slac.stanford.edu/esh/groups/cgs/cms/>

38 <http://www-group.slac.stanford.edu/esh/eshmanual/references/hazmatProcedPurchase.pdf>

39 <http://www-group.slac.stanford.edu/esh/forms/>

40 <http://www-group.slac.stanford.edu/esh/eshmanual/references/cgcPlanImplement.pdf>

41 <http://www-group.slac.stanford.edu/esh/eshmanual/references/cgcReqHandling.pdf>

42 <http://www-group.slac.stanford.edu/esh/eshmanual/references/cgcReqTagUse.pdf>

43 <http://www-group.slac.stanford.edu/esh/eshmanual/references/cgcReqInspect.pdf>

44 <http://www-group.slac.stanford.edu/esh/eshmanual/references/cgcReqSafety.pdf>

45 <http://www-group.slac.stanford.edu/esh/eshmanual/references/cgcReqStorage.pdf>

46 <http://www-group.slac.stanford.edu/esh/forms/>

47 <http://www-group.slac.stanford.edu/esh/eshmanual/references/cgcReqLeak.pdf>

48 <http://www-group.slac.stanford.edu/esh/eshmanual/references/cgcReqOxygen.pdf>

7 References

*SLAC Environment, Safety, and Health Manual (SLAC-I-720-0A29Z-001)*⁵⁰

- Chapter 6, “Confined Space”⁵¹
- Chapter 12, “Fire and Life Safety”⁵²
- Chapter 14, “Pressure and Vacuum Vessels”⁵³
- Chapter 19, “Personal Protective Equipment”⁵⁴
- Chapter 36, “Cryogenic and Oxygen Deficiency Hazard Safety”⁵⁵
- Chapter 40, “Hazardous Materials”⁵⁶

Other

- *Handbook of Compressed Gases*, Compressed Gas Association, Inc, Fourth Edition, Kluwer Academic Publishers, 1999⁵⁷
 - Chapter 2, “Regulations Pertaining to Compressed Gases”
 - Chapter 4, “Compressed Gas Containers and Appurtenances”
 - Chapter 5, “Safety Guidelines for Compressed Gases and Cryogenic Liquids
 - Chapter 9, “Compressed Gas Cylinders: Marking, Labeling, Inspection, Testing, Filling, Disposition”
- *Hazardous Materials Management Desk Reference*
 - Chapter 7, “Safety Overview”
 - Chapter 9, “Personal Protective Equipment”
- *Prudent Practices in the Laboratory Handling and Disposal of Chemicals*⁵⁸
 - Chapter 4, “Management of Chemicals”
 - Chapter 5, “Working with Chemicals”
 - Chapter 6, “Working with Laboratory Equipment”

49 <http://www-group.slac.stanford.edu/esh/eshmanual/references/cgcReqTransport.pdf>

50 <http://www-group.slac.stanford.edu/esh/eshmanual/>

51 http://www-group.slac.stanford.edu/esh/hazardous_activities/confinedspace/policies.htm

52 http://www-group.slac.stanford.edu/esh/general/fire_safety/policies.htm

53 http://www-group.slac.stanford.edu/esh/hazardous_activities/pressure/

54 <http://www-group.slac.stanford.edu/esh/general/ppe/policies.htm>

55 http://www-group.slac.stanford.edu/esh/hazardous_substances/cryogenic/policies.htm

56 http://www-group.slac.stanford.edu/esh/hazardous_substances/haz_materials/policies.htm

57 <http://www.springer.com/west/home?SGWID=4-102-22-33291946-0&changeHeader=true>

58 <http://newton.nap.edu/html/prudent/contents.html>

8 Implementation

The requirements of this chapter will become effective following the schedule in CGC: Implementation Plan.⁵⁹

9 Ownership

Department: Chemical and General Safety

Program: Compressed Gas Cylinders

Owner: Program Manager, Stafford McCaskill

⁵⁹ CGC: Implementation Plan (SLAC-I-730-0A09M-006), <http://www-group.slac.stanford.edu/esh/eshmanual/references/cgcPlanImplement.pdf>

Hazardous Materials: Purchasing Procedure

Department: Chemical and General Safety

Program: Hazardous Materials

Owner: Judy Fulton

Authority: ES&H Manual, Chapter 40, Hazardous Materials

All chemical purchasing transactions must be managed through the chemical management system (CMS) using the Haas tcmIS.¹ This procedure details how to order chemicals through this system and what to do if the chemical you would like to order is not currently in the catalog.

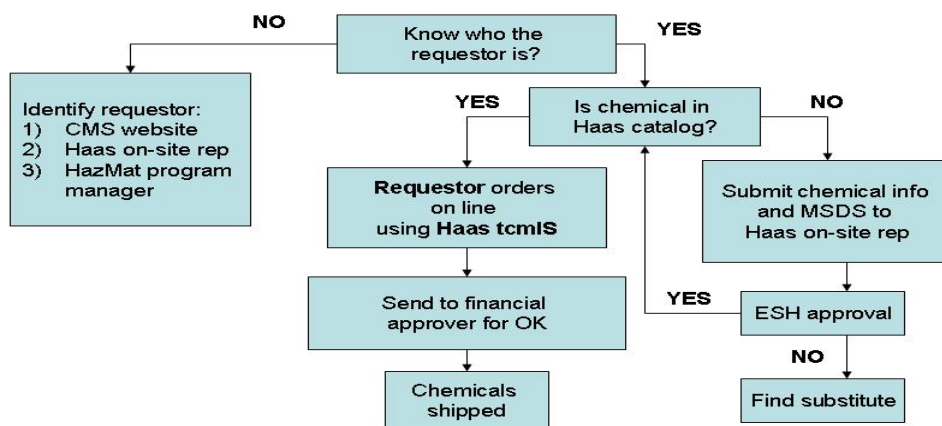
Overview

To access the Haas tcmIS system, you must be a SLAC employee and registered with Haas. To initiate registration, contact the on-site Haas representative. Ordering is accomplished by a process that involves two levels of system registrants for most purchases:

- Requester: places orders contingent on approval by financial approver
- Financial approver: authorizes purchases

Note The Haas on-site representative is available to assist in registering and placing orders.

This diagram illustrates all potential steps that may be required to order chemicals.



1 "Chemical Management Services", <http://www-group.slac.stanford.edu/esh/groups/cgs/cms/>

Procedure

Step	Person	Action
1.	SLAC employee	Identifies the requester for work area Checks the list of authorized CMS users ² or contacts the on-site Haas representative to initiate registration or identify the requestor. ³ Alternatively, contacts the hazardous materials program manager for more information.
2.	SLAC employee/ Requester	Determines if the chemical is in the catalog Identifies the exact name, manufacturer, and container type and size of the material and checks if is listed. If listed, goes to step 3. If the chemical is not listed, submits a full description and MSDS to the onsite Haas representative. Instructions for submitting a new item request are available on the CMS web site. The purchase request will go through the ES&H approval procedure (depicted in green) in the chemical purchasing process flow diagram. ⁴ If approved, the item will be added to the catalog.
3.	Requester	Fills out the purchase request The request includes identifying the financial approver, and the requesting process results in an email notification being sent to the financial approver
4.	Financial approver	Approves the order if it is within the approved financial limits. Approval triggers an order to ship chemicals to the site according to requestor instructions in tcmIS.

Note Appropriate program managers in ES&H (air, water, industrial hygiene, hazardous materials, and pollution prevention) are notified of all new chemical material requests that are processed using tcmIS. In the event of special hazards associated with the material (for example, highly toxic, carcinogenic, highly flammable, reactive, radioactive), the program managers may contact the requester to require a further review of the material and/or operation associated with the use of the proposed material. This review will verify the intended use of the material includes the necessary considerations and controls to ensure it can be stored, used, and disposed of safely and in accordance with any applicable regulations. If the safety and/or environmental issues cannot be resolved, the program managers reserve the right to deny the acquisition of this material.

2 “CMS Authorized Users”, https://www-internal.slac.stanford.edu/esh/departments_groups/cms/users.htm

3 “Haas TCM, Inc. Contact Information”, <http://www-group.slac.stanford.edu/esh/groups/cgs/cms/contacts.htm>

4 Hazardous Materials: Purchasing Flow Chart (SLAC-I-730-0A09S-014), <http://www-group.slac.stanford.edu/esh/eshmanual/references/hazmatFlowPurchasing.pdf>

Hazardous Materials: Storage Inspection Procedure and Form

Department: Chemical and General Safety

Program: Hazardous Materials

Owner: Program Manager, Judy Fulton

Authority: ES&H Manual, Chapter 40, Hazardous Materials

Monthly documented inspections must be carried out by the chemical asset custodian or designated person for all chemical storage areas and all chemical container types.

Inspection results must be kept on record for a minimum of one year, and must be made available to ES&H when requested. The following forms can be adapted to meet the specifications of your storage area, but all basic inspection elements must be included.

Note For inspection requirements for hazardous waste storage areas and waste containers, see Chapter 17, "Hazardous Waste".¹

Documenting Inspection Results

1. Enter the inspection location on the inspection form and verify that this location is accurately mapped on the CMS chemical use map.² If the location is new, or information is missing or out of date, contact the hazardous materials program manager or the ESH coordinator to relay any updates.
2. Each month, enter the date, your initials, and place a "check" in every square that applies to this location if the condition meets all safety requirements. The form accommodates 12 inspections, or one full year.

Note If the item does not apply, cross the section out. For example, if there are no compressed gas cylinders (CGCs), mark one large line or "X" through the section. Alternatively, modify the form to more closely meet the conditions of the storage area.

3. If an inspection item requires corrective action, record your observations and comments on the "Observations and Corrective Actions Log" below. Also record the date that the corrective action was completed.

1 SLAC Environment, Safety, and Health Manual (SLAC-I-720-0A29Z-001), Chapter 17, "Hazardous Waste", http://www-group.slac.stanford.edu/esh/environment/hazardous_waste/policies.htm

2 "Chemical Management Services (CMS)", <http://www-group.slac.stanford.edu/esh/groups/cgs/cms/>. The link of interest is found under the heading "System Links", "Chemical Use Maps".

CGC: Implementation Plan

Department: Chemical and General Safety

Program: Compressed Gas Cylinders

Owner: Stafford McCaskill

Authority: ES&H Manual, Chapter 38, Compressed Gas Cylinders

The requirements of Chapter 38, “Compressed Gas Cylinders”, will be phased in according to the following schedule.

Section Number	Section Title	Requirement Note	Status	Effective Date	Schedule Note
5	Requirements				
5.1	General				
5.1.1	Purchasing and CGC Removal		New	Immediate	
5.1.2.1	Chemical Asset Custodian		New	Immediate	The chemical asset custodian will be responsible for required inspections, which will be phased in as indicated below.
5.1.2.2	Inspection (Monthly, storage)	Inspection form required	New	6/30/2007	
5.1.2.2	Inspection (Point of Delivery)	Inspection form required for toxic, corrosive, and flammable gases	New	3/31/2007	
5.1.2.3	Labeling		New	Immediate	
5.1.2.4	Hydrostatic Test Date		New	Immediate	
5.1.2.5	Handling and Use (engineering controls on existing operations)		New	9/30/2007	
5.1.2.5	Handling and Use (new operations)		New	Immediate	
5.1.2.6	Storage: Storage Area Requirements	A storage area assessment will determine if an implementation plan is required.	New	2/25/2009	
5.1.2.6	Storage: Storage Area Requirements	Evaluation of outdoor storage areas for elevated temperatures (>125° F)	New	9/30/2007	
5.1.2.6	Storage: Welding Gases	Welding cart with steel fire barrier may be required.	New	Immediate	
5.1.2.7	Transport		New	Immediate	
5.1.3	Personnel		New	Immediate	

CGC: Implementation Plan

Section Number	Section Title	Requirement Note	Status	Effective Date	Schedule Note
5.1.3.1	Personal Protective Equipment		New	Immediate	
5.1.4	Roles and Responsibilities		New	Immediate	
5.2	Procedures and Specific Requirements	All requirements are described in Section 5.1 above.			
5.3	Training		New	Immediate	

CGC: Handling and Use Requirements

Department: Chemical and General Safety

Program: Compressed Gas Cylinders

Owner: Stafford McCaskill

Authority: ES&H Manual, Chapter 38, Compressed Gas Cylinders

The following are the handling and use requirements for compressed gas cylinders (CGCs) from hook up to CGC return.

Note In addition to the following requirements, adhere to the equipment manufacturer's operating instructions and make certain that you have completed all applicable training with an experienced equipment user.

For information on the safe use of gas according to hazard class, also see CGC: Safety Requirements.¹

Before the First Use

Before a CGC is used the first time, take the following precautions:

- Make sure the CGC is equipped with the correct regulator.
- Inspect the regulator and CGC valve and remove any grease, oil, dirt, and solvent. Never use grease or oil to lubricate regulators or valves - compressed gas and volatile lubricants can cause an explosion.
- Never force connections that do not fit because an improper fit may indicate that the regulator or connector is not suitable. Verify which type of regulator or connector is required.
- Place the CGC so that the valve handle is easily accessible
- Only use wrenches or tools provided by the CGC supplier to open or close a valve; never use pliers.
- A CGC must be placed so that it is easily accessible, does not become part of an electric circuit, and does not become entangled in experimental apparatus.

Securing CGCs

Each CGC (separate or in a six-unit stand) must be secured at all times as described below.

Individual CGCs

- Use appropriate material, such as chain, plastic coated wire cable, or commercially available straps
- Use two restraints to secure cylinders that are four or more feet in length. Place one restraint around the cylinder body above the cylinder's center of gravity; place the second restraint around the cylinder body below the cylinder's center of gravity. (A good rule of thumb is to place the restraints at 1/3 and 2/3 the length of the cylinder).

1 CGC: Safety Requirements (SLAC-I-730-0A09S-027), <http://www-group.slac.stanford.edu/esh/eshmanual/references/cgcReqSafety.pdf>

CGCs in Six-unit Stands

- When storing six-unit stands (six-packs), individually secure each gas cylinder to the stand using a single restraint.
- Restrain the stand itself in a cage, or secure it to a wall or to the ground.

Piping Systems

Pipes and tubes that carry hazardous materials must be used in accordance with Chapter 40, "Hazardous Materials",² and must be labeled in accordance with American National Standards Institute (ANSI) A13.1 requirements, which requires that markings

- Consist of the content's name and include a direction of flow arrow
- Are provided at each valve; at wall, floor or ceiling penetrations; at each change of direction; and at a minimum of every 20 ft throughout the piping run

General Use Requirements

- Keep valve protection caps in place until gas will be withdrawn or the CGC will be connected to a manifold.
- Never leave the valve open when equipment is not in use, even when the cylinder is empty; an open valve can admit air and moisture, which can cause contamination and internal corrosion.
- Before opening the cylinder valve, back the regulator pressure adjusting screw off to release any spring force.
- CGC discharge lines should be equipped with approved check valves. This prevents inadvertent contamination of cylinders connected to a closed system.
- Use the cylinder valve, not the regulator, for turning gas off.
- Close the cylinder valve and release all pressure before removing the regulator.
- CGCs—even when partially empty—must never be heated by any device that could raise the surface temperature of the cylinder to above 125° F.
- Keep the cylinder clear of all electrical circuits, flame, and sparks.

Upright and Inverted Use

- CGCs containing flammable liquefied gas must be used valve end up, except those designed for use in a horizontal position and those CGCs containing non-liquefied gases.
- An upright position must include a position in which the cylinder axis is inclined as much as 45 degrees from the vertical and in which the relief device is always in direct communication with the gas phase.
- The CGC must be secured and the dispensing apparatus must be specifically designed for inverted use.

2 *SLAC Environment, Safety, and Health Manual* (SLAC-I-720-0A29Z-001), Chapter 40, "Hazardous Materials", http://www-group.slac.stanford.edu/esh/hazardous_substances/haz_materials/policies.htm

Empty CGCs

Handling

- Handle empty CGCs with the same care accorded to full CGCs.
- Do not completely empty a cylinder; always leave some residual pressure.
- Once a CGC is nearly empty, replace the cap and store it in the CGC storage area, segregated from filled CGCs.
- Label all empty cylinders with tags or write “Empty” or “MT” along with the date it was emptied using chalk or durable marker. If the CGC has a yellow tag, be sure to tear off the “In Service” section to identify the cylinder for removal.³
- Mark any unidentifiable cylinder “contents unknown”.
- Do not refill a cylinder.

Return to Vendor

Once any SLAC-owned or return-to-vendor cylinder is empty, or once the gas in such a cylinder is of no further use, the CGC must be returned to the vendor using the Haas tcmIS. Contact the Haas representative to initiate removal.⁴

Note The vendor will automatically remove CGCs labeled “Empty” with the vendor-supplied yellow tag.

Damaged, Unidentifiable, or Abandoned CGCs

Damaged, unidentifiable, or abandoned CGCs are handled by the CGC program manager, who initiates proper disposal through the Waste Management (WM) Group. Contact the CGC program manager to initiate removal.

3 For more information about the yellow label provided by Haas, see CGC: Yellow Tag Use Requirements (SLAC-I-730-0A09S-029), <http://www-group.slac.stanford.edu/esh/eshmanual/references/cgcReqTagUse.pdf>

4 “Haas TCM, Inc. Contact Information”, <http://www-group.slac.stanford.edu/esh/groups/cgs/cms/contacts.htm>

CGC: Yellow Tag Use Requirements

Department: Chemical and General Safety

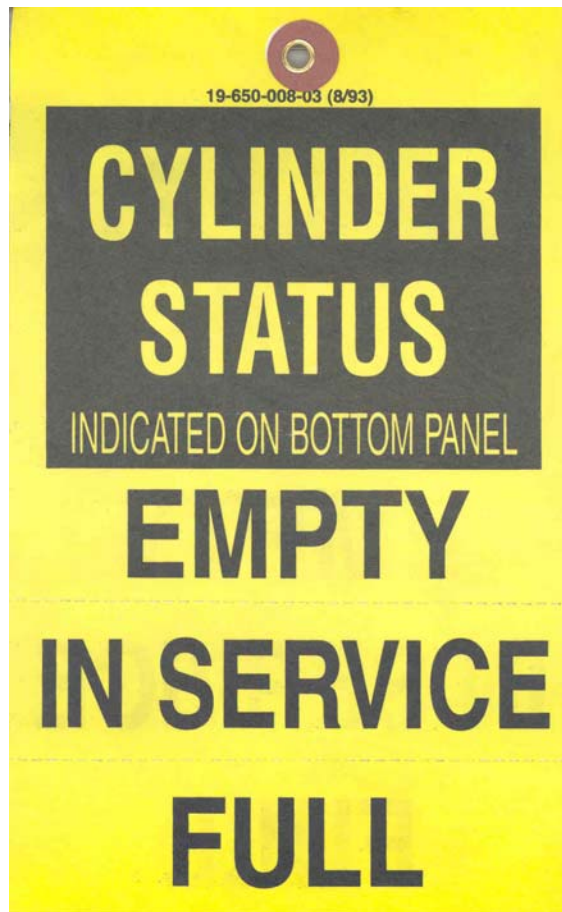
Program: Compressed Gas Cylinders

Owner: Stafford McCaskill

Authority: ES&H Manual, Chapter 38, Compressed Gas Cylinders

Compressed gas cylinders (CGCs) delivered by the Haas vendor carry the yellow tag depicted below. The tag indicates the cylinder status and should be used as follows:

- **FULL**
The original tag, which includes all status options, indicates that no gas has been discharged. If you discharge any gas, be sure to tear off the FULL tab.
- **IN SERVICE**
IN SERVICE indicates that gas has been discharged. The CGC is ready to be returned to the vendor when a small amount of pressure remains. (Do not discharge completely.) Tear off the IN SERVICE portion of the tag when the pressure is low.
- **EMPTY**
The cylinder is ready for removal by the gas vendor.



CGC: Inspection Requirements

Department: Chemical and General Safety

Program: Compressed Gas Cylinders

Owner: Stafford McCaskill

Authority: ES&H Manual, Chapter 38, Compressed Gas Cylinders

All SLAC-owned compressed gas cylinders (CGCs) must undergo inspections as required in both this chapter and Chapter 40, "Hazardous Materials".¹ These requirements and additional recommended practices are described below.

Required Inspections

Point of Delivery

A documented inspection at the point of delivery must be conducted by the chemical asset custodian or other designated person at the identified drop-off area for any gas in the following hazard classes: toxic, corrosive, and flammable.

Note – Inspections for CGCs containing gases whose primary hazard class is asphyxiant or oxidizer are not required, but are highly recommended.

The inspector must

- Visually inspect all CGCs for proper labeling and check for any signs of damage as listed in CGC: Point of Delivery Inspection Form²
- Conduct a leak test for CGCs containing toxic, corrosive, or flammable gas as described in CGC: Leak Detection Requirements.³ Keep a signed inspection form on file for a minimum of one year
- Return to the vendor any CGC that does not meet requirements listed on the form

CGCs in Storage

A monthly documented inspection of CGCs in storage must be carried out by a chemical asset custodian using the Hazardous Materials: Storage Inspection Procedure and Form.⁴

The custodian must

- Check all inspection items on the form. The form is divided into three categories (storage area, all containers, and additional inspection items for CGCs) and all three apply to CGCs.
- Test any CGCs containing toxic, corrosive, or flammable gas for leaks
- Keep documentation on file for one year

1 *SLAC Environment, Safety, and Health Manual* (SLAC-I-720-0A29Z-001), Chapter 40, "Hazardous Materials", http://www-group.slac.stanford.edu/esh/hazardous_substances/haz_materials/policies.htm

2 CGC: Point of Delivery Inspection Form (SLAC-I-730-0A09J-005), <http://www-group.slac.stanford.edu/esh/forms/>

3 CGC: Leak Detection Requirements (SLAC-I-730-0A09S-025), <http://www-group.slac.stanford.edu/esh/eshmanual/references/cgcReqLeak.pdf>

4 Hazardous Materials: Storage Inspection Procedure and Form (SLAC-I-730-0A09J-001), <http://www-group.slac.stanford.edu/esh/forms/>

CGC: Inspection Requirements

- Immediately report any indication of damage or potentially hazardous conditions to the CGC program manager or the Haas representative

Recommended Inspections

Daily Inspection of CGCs in Use

It is always good practice to inspect any CGC in use as well as all apparatus connected to it daily for leaks and damage.

CGC Program Assessment Inspection

The CGC program manager will visually inspect a representative number of CGCs each calendar year in one or more locations. Inspections will be announced in advance, and will identify such hazards as any CGC that is

- Unlabeled
- Unrestrained
- Improperly segregated
- Inaccessible
- Used infrequently and should be moved into storage
- Blocking traffic or exits
- Under storage conditions that promote weathering of the cylinder or label

Any unsafe conditions will be logged, reported, and resolved by advising the CGC owner of mitigating steps.

CGC: Safety Requirements

Department: Chemical and General Safety

Program: Compressed Gas Cylinders

Owner: Stafford McCaskill

Authority: ES&H Manual, Chapter 38, Compressed Gas Cylinders

The general hazard labeling and information section applies to all compressed gas cylinders (CGCs) and their contents. Additional requirements apply to the hazard classes toxic, corrosive, flammable, oxidizing, and asphyxiant, as described below.

Note Gases with multiple hazard categories must meet all applicable safety requirements of each hazard category.

General Hazard Labeling and Information

- **CGCs.** The gas supplier must clearly label each CGC to identify content and the associated hazard(s). These labels must remain intact and not be damaged.
- Consult the material safety data sheet (MSDS) available from the supplier or SLAC MSDS resources for additional hazard information.¹
- **Personal protective equipment (PPE).** Consult the MSDS for PPE recommendations for gases in specific hazard categories. The minimum recommended PPE for working with CGCs is steel-toed boots or shoes.
- **Hazardous material pipes and tubes.** Any pipe or tube connected to a CGC containing hazardous material must be labeled in accordance with American National Standards Institute (ANSI) A13.1 requirements.²

Category-specific Gas Hazards³

Toxic Gas

The Compressed Gas Association (CGA) defines a toxic gas as any gas that can kill 50 percent of the test subjects (LC₅₀) with a concentration of less than or equal to 5000 parts per million. Currently, carbon monoxide is the only toxic gas used at SLAC. Other commonly encountered toxic gases include: chlorine, hydrogen cyanide, fluorine, and hydrogen chloride. Safety considerations require that persons working with toxic gases

- Contact the CGC program manager to determine the specific safety and health regulations associated with the storage, installation, and use of the toxic gas intended to be used..
- Keep inventory at the minimum amount practicable
- Read all of the information on the MSDS associated with the product before use
- Keep appropriate PPE available (gas mask-cartridge-type absorbent or a self contained breathing apparatus).

1 "MSDS Viewer", <http://www.tcmis.com/tcmis/doe/msds>

2 For details, see CGC: Handling and Use Requirements (SLAC-I-730-0A09S-030), <http://www-group.slac.stanford.edu/esh/eshmanual/references/cgcReqHandling.pdf>

3 The requirements specified in all gas hazard category-specific sections are pursuant to the National Fire Protection Association (NFPA) 55, Chapter 7, "Compressed Gases".

CGC: Safety Requirements

- Inform all personnel in the immediate area about the hazard of the gas, appropriate methods of protection against harmful exposure, and first aid treatment in case of exposure
- Use a chemical fume hood or wear appropriate PPE to control exposure while performing manipulations of materials that pose an inhalation or exposure hazard

Corrosive Gas

Common corrosive gases include ammonia, chlorine, hydrogen chloride, and methylamine. Handling these gases requires precaution because they can burn and destroy body tissues on contact. Highly soluble gases (for example, ammonia and hydrogen chloride) cause severe nose and throat irritation, while substances of lower solubility (for example, nitrogen dioxide, phosgene, and sulfur dioxide) can penetrate deep into the lungs. Corrosive gases also attack and corrode metals. The precautions listed above for toxic gas also apply to corrosive gases. In addition

- An emergency eyewash and shower should be located no more than 10 seconds from where the gas is used, and access to the eyewash must not be obstructed (by, for example, a wall).
- Do not rely on properties such as odor or eye, nose, or respiratory tract irritation as a warning of overexposure.
- Protect all exposed skin surfaces from contact with corrosive or irritating gases and vapors.
- Close regulators and valves when the CGC is not in use. Flush with dry air or nitrogen after use.
- To prevent dangerous reverse flow, use a trap, check valve, or vacuum break device when corrosive gases are to be discharged into a liquid.

Flammable Gas

Note Many gases with a primary hazard of flammability also carry a secondary hazard of asphyxiant.

Flammable gases used at SLAC include acetylene, ethylene, hydrogen, and isobutene. For these gases the following requirements apply:

- Open no more than $\frac{1}{2}$ turn of the spindle, and preferably no more than $\frac{3}{4}$ of a turn of the valve on CGCs containing acetylene or other flammable gases. This reduces the risk of explosion and allows for the valve to be closed quickly.
- Ground static-producing equipment located in flammable gas areas.
- Do not smoke within 25 feet of a flammable gas.
- Do not use a flame to detect leaks.
- **Acetylene.** Keep operating pressures for acetylene below 15 psig, and never use copper fitting or tubing because copper can become brittle and with time may present an explosion hazard.

*Note For additional information, see CGC: Portable Oxygen-fuel for Welding and Cutting Requirements.*⁴

Oxidizing Gas

This category covers those gases that, in the presence of an ignition and a fuel source, will support and may vigorously accelerate combustion. Oxidizers include such gases as oxygen and nitrogen dioxide. When oxidizing gases are released in certain concentrations, an explosion could result.

Oxidizers such as oxygen must generally be separated from flammable gas containers or combustible materials, especially oil or grease. Safety precautions for oxygen include

- Opening oxygen cylinder valves all of the way during use
- Not smoking when oxygen or flue gases are present
- Not smoking on or within 15 feet of any vehicle while loading or unloading
- Never substitute oxygen for compressed air for such purposes as: to run pneumatic tools, to start internal combustion engines, to blow out pipelines, to create pressure for ventilation, or to use in oil heating burners.

*Note For additional information, see CGC: Portable Oxygen-fuel for Welding and Cutting Requirements.*⁵

Asphyxiants

The most common types of gas at SLAC fall into this hazard category: asphyxiants include all inert gases such as the Noble gases as well as carbon dioxide and nitrogen.

- Asphyxiants pose an extreme hazard in confined spaces, and special monitoring and precautions must be in place, as outlined in Chapter 6, “Confined Space”.⁶

4 CGC: Portable Oxygen-fuel for Welding and Cutting Requirements (SLAC-I-730-0A09S-024), <http://www-group.slac.stanford.edu/esh/eshmanual/references/cgcReqOxygen.pdf>

5 CGC: Portable Oxygen-fuel for Welding and Cutting Requirements (SLAC-I-730-0A09S-024), <http://www-group.slac.stanford.edu/esh/eshmanual/references/cgcReqOxygen.pdf>

6 *SLAC Environment, Safety, and Health Manual* (SLAC-I-720-0A29Z-001), Chapter 6, “Confined Space”, http://www-group.slac.stanford.edu/esh/hazardous_activities/confinedspace/policies.htm

CGC: Storage Area Requirements

Department: Chemical and General Safety

Program: Compressed Gas Cylinders

Owner: Stafford McCaskill

Authority: ES&H Manual, Chapter 38, Compressed Gas Cylinders

Each of the following section is prefaced with general requirements that apply to all compressed gas cylinders (CGCs) in storage. Additional requirements and considerations apply to CGCs stored indoors vs. outdoors and also depend on the hazard class(es) the CGC content belongs to. In each case, the most stringent applicable storage requirements apply.

Note For more information on toxic, corrosive, flammable, oxidizing, or asphyxiant hazard classes, see CGC: Safety Requirements.¹

General

A CGC storage area must be

- Labeled to identify the area and contact information for the chemical asset custodian
- Equipped with personnel protective equipment (PPE) and emergency equipment as required by the hazard category
- Sited out of pedestrian and vehicle traffic
- Designed to meet segregation requirements for empty CGCs and specific gas hazard categories

Separation Requirements

Applicable fire codes specify that CGCs in storage must be separated from materials and conditions that present exposure hazards. Cylinders containing flammable, oxidizing, toxic, or corrosive gases must be segregated by hazard category.

Note Gases not in these hazard categories, including inert gases such as nitrogen and helium, have no specific separation requirements.

The segregation requirement can be met using distance or a barrier such as a fire wall or gas cabinet, as follows:

- A minimum of 20 feet (6.1 m) must separate CGCs containing gases belonging to these hazard categories, or
- The 20 feet (6.1 m) distance can be eliminated when hazard categories are separated by a barrier of noncombustible materials at least 5 feet (1.5 m) high that has a fire resistance rating of at least 0.5 hour, or
- The 20 feet (6.1 m) distance is allowed to be reduced to 5 feet (1.5 m) where one of the gases is enclosed in a gas cabinet.
- The distance requirement is eliminated where both gases are enclosed in gas cabinets.

¹ CGC: Safety Requirements (SLAC-I-730-0A09S-027), <http://www-group.slac.stanford.edu/esh/eshmanual/references/cgcReqSafety.pdf>

CGC: Storage Area Requirements

- Where separation is not possible, isolate flammable gas containers by constructing a noncombustible barrier that extends not less than 18 inches above the tallest container but not less than 18 inches beyond the sides of the containers and has a fire resistance rating of at least 0.5 hour

Indoor Storage

General Indoor Storage Requirements

An indoor storage area must be

- Well-ventilated, cool, dry, and free of corrosive materials that may damage metal CGCs
- Away from public hallways or other unprotected areas; do not block any exits or doorways
- Away from elevators and unprotected platform ledges
- Away from any area where CGCs could fall for distances exceeding one-half the height of the cylinder
- Away from objects that may fall and damage the cylinders

Gas Hazard Category-specific Requirements

Toxic Gases

For both toxic and corrosive gases, SLAC is subject to Article 80 of the California Uniform Fire Code as well as to the local toxic gas ordinances for San Mateo County. These codes specify the following:

- Toxic gases must be stored in gas cabinets or exhausted enclosures and these must be served by internal fire suppression systems.
- **Gas cabinets** must comply with all of the following:
 - Operate at negative pressure in relation to the surrounding area
 - Be provided with self-closing limited access ports or noncombustible windows to give access to equipment controls. The average velocity at the face of access ports or windows shall not be less than 200 feet per minute (1.02 m/s) with a minimum of 150 feet per minute (0.76 m/s) at any point of the access port or window
 - Be connected to an exhaust system
 - Be provided with self-closing doors
 - Be constructed of not less than 0.097-inch (2.46 mm) (12 gage) steel
- **Exhausted enclosures** must be designed to
 - Operate at a negative pressure in relation to the surrounding area
 - Provide an average velocity at the face of the enclosure of not less than 200 feet per minute (1.02 m/s) with a minimum of 150 feet per minute (0.76 m/s) at any point.

Corrosive Gas

- See requirements for toxic gases, above.

Flammable Gas

- Signs must be posted within 25 feet (7.6 m) of the storage area perimeter that prohibit smoking or the use of open flame, or both.
- Stored CGCs without pressure-relief devices must be separated from flammable gases with pressure-relief devices.
- Flammable gases must be stored in well ventilated areas away from oxidizers, open flames, sparks, and other sources of heat or ignition.
- Portable fire extinguishers (of carbon dioxide or dry chemical types) or other fire protection or suppression systems or devices must be available for fire emergencies.

Oxidizers

There are no additional indoor storage requirements for oxidizers.

Asphyxiants

There are no additional indoor storage requirements for asphyxiants.

Outdoor Storage

General Outdoor Storage Requirements

An outdoor storage area must

- Be located away from gangways or locations where they may be impacted by heavy-moving objects, equipment or vehicles
- Provide adequate drainage and cover. To prevent rusting, keep CGCs away from standing water.
- Be located away from sources of heat and ignition including direct sunlight; CGCs, whether full or partially full, must not be exposed to temperatures exceeding 125° F (52° C). If possible, store cylinders under a protective canopy or cover.
- Provide clear access for safe and unobstructed delivery of CGCs and six-packs. This may require infrastructure improvements such as the installation of ramps, paving unimproved roads, or pouring concrete pads. This may also require maintenance such as sweeping up loose gravel or administrative controls such as enforcing parking restrictions to allow safe access for delivery trucks.

Gas Hazard Category-specific Requirements

Toxic Gas

- Outdoor storage of highly toxic or toxic compressed gases must not be within 75 feet (22.9 m) of a building, property line, street, alley, public way or means of egress to a public way unless the storage is shielded by a structure having a minimum fire-resistive rating of two hours and which interrupts the line of sight between the storage and the exposure. The protective structure shall be at least 5 feet (1.5 m) from exposures. The protective structure shall not have more than two sides at approximately 90-degree directions, or three sides with connecting angles of approximately 135 degrees.

CGC: Storage Area Requirements

- When the storage area is located closer than 75 feet (22.9 m) to a building, openings into a building other than piping shall not be above the height of the top of the shielding structure or within 50 feet (15.2 m) horizontally from the storage area whether or not shielded by a protective structure.
- The storage area must not be within 75 feet (22.9 m) of air intakes
- CGCs stored outside of buildings must be stored under a canopy of noncombustible construction. (Such storage is not considered indoor storage.)
- An automatic fire-sprinkler system must be provided for canopies used for storage of highly toxic or toxic compressed gases.

Corrosive Gas

- The outdoor storage (or use) of corrosive compressed gas must be 20 feet (6.1 m) from buildings, property lines, streets, public ways, or means of egress.
- A 2-hour fire barrier wall without openings or penetrations, and extending not less than 30 inches (0.8 m) above and to the sides of the storage area, is allowed in lieu of the 20 feet (6.1 m) distance.
- The fire barrier wall must be either an independent structure or the exterior wall of the building adjacent to the storage area.
- The 2-hour fire barrier must be located at least 5 feet (1.5 m) from any exposure.
- The 2-hour fire barrier must not have more than two sides at approximately 1.57 rad (90 degree) directions, or not more than three sides with connecting angles of approximately 2.36 rad (135 degrees).

Flammable Gas

In addition to the storage requirements listed in indoor storage for compressed flammable gas, outdoor storage must be in accordance with the following requirements.

Table 1 Flammable Gas Outdoor Storage: Distance to Exposure by Quantity Stored

Aggregate Quantity per Storage Area		Minimum Distance to Buildings, Streets, Public Ways, or Property Lines		Minimum Distance between Storage Areas	
m ³	ft ³	m	ft	m	ft
<120	<4,225	1.5	5	1.5	5
120.1–598	4,226–21,125	3	10	3	10
598.1–1435	21,126–50,700	4.6	15	3	10
1435.1–2393	50,701–84,500	6	20	3	10
≥2393.1	≥84,501	7.5	25	6	20

- The minimum required distances are allowed to be reduced to 5 feet (1.5 m) where protective structures having a minimum fire resistance rating of 2 hours and which interrupts the line of sight between the storage and the exposure.
- The protective structure must be at least 5 feet (1.5 m) from the storage or use area perimeter.

CGC: Storage Area Requirements

- The configuration of the protective structure must be designed to allow natural ventilation to prevent the accumulation of hazardous gas concentrations.
- Storage must be located at least 50 feet (15.2 m) from air intakes.

Oxidizing Gas

In order to prevent safety hazards such as the accumulation of hazardous gas concentrations, oxidizing gases must be stored in accordance with the following.

Table 2 Oxidizing Gas Outdoor Storage: Distance to Exposure by Quantity Stored

Quantity of Gas Stored (at normal temperature and pressure)		Distance to a Building or to a Public Way or Property Line		Minimum Distance between Storage Areas	
m ³	ft ³	m	ft	m	ft
0–1416	0–50,000	1.5	5	1.5	5
1417–2832	50,001–100,000	3.0	10	3.0	10
≥2833	≥100,001	4.6	15	4.6	15

- The distances do not apply where protective structures having a minimum fire resistance of 2 hours and interrupt the line of sight between the container and the exposure.
- The protective structure must be at least 5 feet (1.5 m) from the storage area perimeter.
- The configuration of the protective structure must allow natural ventilation to prevent the accumulation of hazardous gas concentrations.

CGC: Point of Delivery Inspection Form

Department: Chemical and General Safety

Program: Compressed Gas Cylinders

Owner: Stafford McCaskill

Authority: ES&H Manual, Chapter 38, Compressed Gas Cylinders

A point of delivery inspection by a chemical asset custodian or other designated person is required for compressed gas cylinders (CGCs) that contain toxic, corrosive, or flammable gases. A point of delivery inspection is not required for gases whose primary hazard class is asphyxiant or oxidizer, but an inspection is nevertheless highly recommended because this is a good opportunity to return non-compliant CGCs to the vendor. Inspection items are tabulated in the checklist below.

Note A signed copy of this checklist meets the inspection requirement; keep on file for a minimum of one year.

Meets Requirements		What to Look For
Yes	No	Complete Label Information
<input type="checkbox"/>	<input type="checkbox"/>	▪ Legible
<input type="checkbox"/>	<input type="checkbox"/>	▪ Identifies the type of gas
<input type="checkbox"/>	<input type="checkbox"/>	▪ Indicates any hazards
<input type="checkbox"/>	<input type="checkbox"/>	Leaks
		▪ Asphyxiants: Visual check suffices
		▪ Toxic, corrosive, and flammable gases: A leak test is required (see CGC: Leak Detection Requirements ¹ for additional information)
		Gas name and type (from label or MSDS) _____
		Leak detection method _____
<input type="checkbox"/>	<input type="checkbox"/>	CGC Condition
		▪ No dents, bulging, cuts, digs, and gouges or other visible signs of damage
<input type="checkbox"/>	<input type="checkbox"/>	▪ No corrosion
<input type="checkbox"/>	<input type="checkbox"/>	Valid Hydrostatic Test Date
		▪ Test date is reasonably close to within five years of the CGC delivery date (see below for additional information and exceptions to the five-year testing interval)
Required inspections only: complete this section		
Inspection Date _____		
Inspected by _____		
Signature _____		

1 CGC: Leak Detection Requirements (SLAC-I-730-0A09S-025), <http://www-group.slac.stanford.edu/esh/eshmanual/references/cgcReqLeak.pdf>

Determining the Hydrostatic Test Date

A hydrostatic test is conducted at predetermined intervals prior to refilling – usually every five years for most SLAC-owned CGCs. Testing is arranged by the vendor, and the test date is stamped on the cylinder, usually near the shoulder or into the valve guard ring welded to the CGC.

Test date markings follow this pattern: month – inspector’s initials – year. For example, 1 – AB – 03 indicates that the last cylinder test date was January 2003 (and the inspector’s initials are “AB”). For most CGC types, the cylinder would begin to be due for another test in January 2008.

Note Exceptions to the five-year test expiration apply to particular types of CGCs that are made of more resistant materials and require testing only once every 10 years. If the test date is nearing the five-year mark, check to see if the CGC is this type.

CGC: Leak Detection Requirements

Department: Chemical and General Safety

Program: Compressed Gas Cylinders

Owner: Stafford McCaskill

Authority: ES&H Manual, Chapter 38, Compressed Gas Cylinders

Following a leak detection procedure is an integral part of conducting inspections, and it is required for compressed gas cylinder (CGCs) containing toxic, corrosive, or flammable gases on these occasions:

Upon CGC delivery

A minimum of once per month while such CGCs are in storage

Leak detection may also be indicated when CGCs are in use if a gauge shows an unexplained drop in pressure or any time there is an unaccounted for odor.

Leak Detection Methods

Leak Detector

The most reliable – and preferred – method for detecting a gas leak is using a direct reading instrument with a sensor. Follow the manufacturer's instructions for correct use.

Note One reliable instrument has been the Matheson Leak Hunter Plus, Model 8066.

Soapy Solution

A common and simple way to check for leaks is to wet all connections and areas where a leak may occur (see below) with soapy water and check for bubble formation.

Note Never use a flame to find a leak!

Common Leak Locations

Areas where leaks are likely to occur, in order of most to least likely, are

- **The valve.** The valve is a part of the cylinder and should only be repaired by the supplier.
- **The valve outlet connection.** Potential remedies include checking for dirt in the connection, replacing damaged connectors, or adding washers.
- **The valve stem.** Leakage from valves fitted with an adjustable gland can be handled by gently tightening the gland nut while the valve is partially open. All gland nuts have right-hand threads, and a quarter turn is normally sufficient maximum torque: 50 ft-lbs.

Note Some gland nuts are backed with a lock-nut, which must be loosened before any gland nut adjustment. The lock-nut must be tightened after the gland nut adjustment.

CGC: Leak Detection Requirements

- The joint between the cylinder valve and the cylinder. Although rare, if a leak occurs in this location, notify the supplier immediately. No attempt should be made to tighten a valve, especially if the CGC is full.

If You Find a Leak

The appropriate response to a leak depends on when it found, the type of gas, and the probable cause. In all cases, if the leak cannot be stopped within regular use and handling parameters, the CGC must be returned to the supplier: never try to service or modify a CGC.

Non-emergencies

- If a leak is detected at the point of delivery, return the CGC to the vendor.
- If a leak is detected while the CGC is in use and the leak poses no hazard because of the type of gas or the CGC location, tag the CGC or put a vendor-supplied collar on it. Then contact the Haas representative to arrange for removal.¹

Emergencies

- If you suspect a CGC containing a toxic gas is leaking and the leak cannot be stopped in a safe manner, evacuate and follow the facility emergency plan (FEP) for your area.²
- For more information on what to do in the event of a chemical emergency, see the *SLAC Consolidated Chemical Contingency Plan (CCCP)*.³
- For procedural and reporting information, see the emergency procedures outlined in Chapter 16, “Spills”.⁴

1 “Haas TCM, Inc. Contact Information”, <http://www-group.slac.stanford.edu/esh/groups/cgs/cms/contacts.htm>

2 “Facility Emergency Plans”, <https://www-internal.slac.stanford.edu/esh/emergency/fep/>

3 *Consolidated Chemical Contingency Plan* (SLAC-I-730-3A86H-008), <http://www-group.slac.stanford.edu/esh/documents/CCCP.pdf>

4 *SLAC Environment, Safety, and Health Manual* (SLAC-I-720-0A29Z-001), Chapter 16, “Spills”, <http://www-group.slac.stanford.edu/esh/environment/spills/policies.htm>

CGC: Portable Oxygen-fuel for Welding and Cutting Requirements

Department: Chemical and General Safety

Program: Compressed Gas Cylinders

Owner: Stafford McCaskill

Authority: ES&H Manual, Chapter 38, Compressed Gas Cylinders

Because of their volatility, extra safety precautions must be observed when using the combination of gases required for welding or cutting operations. These basic safety requirements apply to all SLAC employees and subcontractors and to all compressed gas cylinders (CGCs) used for welding and cutting.

Handling

- Do not handle CGCs roughly because the contents are under pressure.
- Fasten CGCs securely; chain in an upright position to a wall or cart.
- Remove regulators and replace protective caps before moving or transporting CGCs.

Use

- Keep fire-extinguishing equipment readily accessible near welding or cutting operations if combustible materials are present.
- Locate CGCs away from areas where they may be struck or subjected to physical damage. They must be a safe distance from arc welding, cutting operations, or any other source of heat, sparks, or flame.
- Periodically check connections for leaks to prevent fires or explosions. Use a direct-reading instrument, or apply soapy water to connections and check for bubbles. Repair leaks immediately.
- Use acetylene tanks only while in an upright position.
- Open cylinder valves as required by the type of gas.
 - Acetylene: Open the valve no more than three-fourths of a turn so it can be closed quickly in case of emergency.
 - Oxygen: Open the valve fully. While welding or cutting, leave the valve wrench in position.
- Set the appropriate operating pressure. Never set acetylene pressure over 15 psi. Follow the manufacturer's recommendations for the operating pressures appropriate to the metal being welded and for the tip size being used.
- Ensure reverse flow-check valves and flash arrestors are installed on the oxygen and acetylene lines to control flashbacks and backfires. The back flow prevention valve may be on the tank or on the wand.
- Never allow the electrode, electrode holder, or any other electrically "hot" parts to touch a CGC.
- Ensure that gas delivery hoses are a different color for each gas.
- Purge fuel and oxygen hoses individually before lighting up a torch tip.
- Be sure the CGC valves are closed and pressure is relieved from the hoses before leaving the work area.

CGC: Portable Oxygen-fuel for Welding and Cutting Requirements

- If a CGC is not going to be in use within the next 24 hours, see below for storage requirements.

Confined Space

- A confined entry permit must be applied for and received prior to using any gas in a confined space. (See Chapter 6, “Confined Space”.¹)
- When using shielding gases indoors or in a confined space, always use enough ventilation to ensure adequate oxygen levels.

Outdoor Use

- If working outdoors, a hot work permit may be required. (See Chapter 12, “Fire and Life Safety”.²)

Storage

Requirements for when acetylene and oxygen CGCs must be placed in storage depend on the job description or classification:

For welding done in conjunction with construction, acetylene and oxygen can only be stored together for more than 24-hours if they are in a welding cart with a patented engineered steel fire barrier.³ Acetylene and oxygen CGCs in a regular welding cart must be placed in appropriate storage if these gases will not be used again within a 24-hour period.⁴

For welding conducted for general industry purposes (outside of construction areas): CGCs containing acetylene and oxygen may remain in a cart indefinitely as long as the cylinders remain in an upright position and the regulator remains in place on the CGCs.

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- 1 *SLAC Environment, Safety, and Health Manual* (SLAC-I-720-0A29Z-001), Chapter 6, “Confined Space”, http://www-group.slac.stanford.edu/esh/hazardous_activities/confinedspace/policies.htm
 - 2 *SLAC Environment, Safety, and Health Manual* (SLAC-I-720-0A29Z-001), Chapter 12, “Fire and Life Safety”, http://www-group.slac.stanford.edu/esh/general/fire_safety/policies.htm
 - 3 The cart must comply with 29 CFR 1926.350(a)(10). See OSHA Standard Interpretation: http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=INTERPRETATIONS&p_id=24741
 - 4 CGC: Storage Area Requirements (SLAC-I-730-0A09S-026), <http://www-group.slac.stanford.edu/esh/eshmanual/references/cgcReqStorage.pdf>

CGC: Transport Requirements

Department: Chemical and General Safety

Program: Compressed Gas Cylinders

Owner: Stafford McCaskill

Authority: ES&H Manual, Chapter 38, Compressed Gas Cylinders

In order to ensure that compressed gas cylinders (CGCs) are transported safely, the following requirements apply to SLAC and subcontractor owned cylinders.

SLAC-owned CGCs

SLAC-owned CGCs can only be transported to and from SLAC property by Haas CMS vendor subcontractors. To transport a CGC on-site, such as to the area where it will be used or to the storage area, personnel must

- Wear any required personnel protective equipment (PPE) that is appropriate to the gas hazard class
- Remove the regulator before transport
- Always install a suitable protective valve cover
- Use an appropriate cylinder cart basket and follow all manufacturer instructions for securing CGCs
- If using a forklift or other vehicle, properly secure the cylinder(s)
- Lift the CGC by the body (not the valve cover) in order to avoid dropping the cylinder; if the cylinder is dropped on a hard surface or strikes against other cylinders, an explosion could result
- Never drag, slide, or roll a CGC

Subcontractor-owned CGCs

Subcontractor-owned cylinders must be transported in accordance with Department of Transportation (DOT) regulations. These include

- Ensuring that the cylinders are properly labeled
- Removing the regulator before transport
- Displaying all applicable hazard placards on the transport vehicle
- Properly restraining cylinders to the vehicle