

Chapter 40: [Chemical Lifecycle Management](#)

# Chemical Storage Asset Requirements

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## 1 Purpose

The purpose of these requirements is to ensure the safe storage of *chemicals* and other *hazardous materials*. They cover storage and inspection of chemicals in *chemical storage assets* and *areas*. They apply to workers (as *chemical users*, *requesters*, and *receivers*), supervisors, line management, *chemical storage asset custodians*, ESH coordinators, the SLAC fire marshal, and the chemical lifecycle management program manager.

## 2 Requirements

### 2.1 General

#### 2.1.1 Custodians

For every chemical storage asset or area, a custodian is designated by line management and given authority and responsibility for safe storage within that asset. Custodians must ensure the following requirements are met:

1. Chemical storage assets have been assigned a property control (PC) identification number (“other cabinets” and gas racks are exempted from this requirement).
2. Contact information for the custodian is posted on the asset or area (for example, on the door to a laboratory, entrance to a warehouse, door of a flammable materials cabinet).
3. The asset meets requirements. This includes performing required testing and inspections.

#### 2.1.2 Inspections

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

For remote areas that are not visited daily, these inspections must be documented (using the [Chemical Lifecycle Management: Storage Area Inspection Form](#)) and the results kept on record for a minimum of one year and made available to the Environment, Safety, and Health (ESH) Division when requested.

*Note* When a storage area contains both hazardous materials and waste, the most restrictive combination of inspection requirements applies. For inspection requirements for hazardous waste storage areas and waste containers, see [Chapter 17, “Hazardous Waste”](#).

### 2.1.3 Secondary Containment

*Sized secondary containment* is required for storage assets when any single container is in excess of 55 gallons of liquid, 550 pounds for solids, or when the aggregate capacity of multiple vessels exceeds 1,000 gallons (10,000 pounds for solids). (See *Hazardous Materials Storage Secondary Containment Guidelines [UN-083]*.) Line management is responsible for ensuring sized secondary containment is in place where needed.

## 2.2 Bulk Storage Tanks

Bulk storage *tanks* are used at SLAC to store many materials including liquid nitrogen, helium, water treatment chemicals (acids, bases, and proprietary treatment chemicals), propane, and fuel. The installation of bulk storage tanks for chemicals requires a design review through the ESH Building Inspection Office before purchase or installation (see [ESH: Project Review Procedure](#)). This review evaluates issues such as siting, material compatibility, safety controls, hazard communication signs, pressure relief, seismic design, security, and fire protection. Appropriate industrial standards will be incorporated into the design of this type of storage asset.

## 2.3 Tube Trailers

Tube trailers contain 20 to 40 long, horizontal, compressed gas cylinders (CGCs) bundled together and connected by manifolds for ease of use, transport, and safety. SLAC uses tube trailers for managing hydrogen and helium.

It is a Department of Transportation (DOT) requirement that tube trailers that are *in commerce* (that is, will be transported over public roads) must be pressure-tested every five years. It is the responsibility of the custodian to arrange for this testing with the assistance of the on-site CMS provider. Hydrostatic tests must be conducted by a qualified testing facility.

## 2.4 Storage Cabinets

All *chemical storage cabinets* must meet the following minimum requirements:

- Doors must be well fitted, equipped with a latch, and self-closing. (Cabinets in continuous use and meeting the fire code at the time of purchase may be used even if not self-closing, but if not in use must be updated or replaced to meet current fire code requirements.)
- Cabinets must be seismically braced to a sound structure to prevent dislodgement during an earthquake. The seismic bracing must not penetrate the cabinet in such a way that it would facilitate release of the chemical from the cabinet. The SLAC fire marshal approves seismic bracing of chemical cabinets to ensure the bracing does not compromise the cabinet listing. Cabinets including contents that weigh 400 pounds or more must have engineered restraints.
- The bottom of the cabinet must be liquid tight to a height of at least two inches (50.8 mm).
- The cabinet, including the door, must be double walled, with 1.5-inch (38.1 mm) airspace between the walls.
- Joints must be riveted or welded and tight-fitting.

- Cabinets must be constructed of metal and must be listed by an accredited listing agency. Unlisted cabinets may be used if approved by the SLAC fire marshal and they
  - Are constructed from steel with a thickness of at least 0.044 inch (1.12 mm) (18 gauge)
  - Meet all the requirements of a listed cabinet
- Approved and rated chemical storage cabinets will not be used for ordinary (non-hazardous) storage.

### 2.4.1 Flammable Container Storage Cabinets

Flammable liquid in quantities greater than 10 gallons per work area<sup>1</sup> must be stored in chemical storage cabinets that meet the design requirements of the *California Fire Code*, chapters 27 through 41 ([24 CCR 2701–4101](#)) and the *Flammable and Combustible Liquids Code* ([NFPA 30](#)). Cabinets used to store flammable liquids must meet the following requirements in addition to those in Section 2.4:

- The combined total of all liquids will not exceed 120 gallons (454 L).
- Cabinets used to store flammable liquids must be provided with a conspicuous label in red letters on contrasting background that reads FLAMMABLE–KEEP FIRE AWAY.
- Combustible material (wood shelves added after purchase, cardboard boxes and paper) should be minimized or eliminated.
- The number of flammable liquid storage cabinets and quantity of flammable materials allowed in a building is regulated and determined by occupancy codes, space between cabinets, and whether the building is equipped with sprinklers. Contact the SLAC fire marshal for details.

### 2.4.2 Corrosive Material Storage Cabinets

Cabinets used to store corrosives must meet the following requirements in addition to those in Section 2.4:

- Incompatible corrosives must not be stored in the same cabinet without containment.
- All corrosive storage cabinets must be conspicuously labeled (letters on contrasting background) with CORROSIVE – ACID or CORROSIVE – BASE.
- Cabinets must be treated or coated on the interior with a material that is non-reactive with the hazardous material stored, and this treatment or coating must cover the entire interior of the cabinet.
- The quantity of corrosive materials allowed in a building is regulated and determined by occupancy codes, space between cabinets, and whether the building is equipped with sprinklers. Contact the SLAC fire marshal for details.

### 2.4.3 Laboratory Hoods with Built-in Storage Cabinets

Built-in flammable liquid and corrosive material storage cabinets in laboratory hoods are subject to the requirements above for storage cabinets.

*Note* For requirements regarding electrical equipment and devices within cabinets used for the storage of flammable chemicals, see the National Electrical Code ([NFPA 70](#)), Section 500.

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<sup>1</sup> A work area is a *use area*, defined as a contiguous area that is controlled and used by one work group in reference to the exemption in 24 CCR Part 9, Section 3404.3.4.4, “Liquids for Maintenance and Operation of Equipment” ([24 CCR 3404.3.4.4](#)).

## 2.4.4 Chemical Refrigerators

Ordinary domestic refrigerators and freezers must not be used for storing flammable liquids due to exposure to electrical components (light bulbs, switches, contacts and motors) that can become potential ignition sources. These ignition sources may initiate a fire or an explosion if flammable vapors are present. Refrigerators and freezers for storing flammable liquids and/or temperature-sensitive chemicals such as peroxides or epoxies must be designed, constructed, and approved for that purpose. Domestic refrigerator/freezers as well as units that have been modified to remove spark sources are not acceptable.

- Refrigerators must be labeled on the exterior: CAUTION – FOR CHEMICAL STORAGE ONLY; DO NOT STORE FOOD OR BEVERAGES IN THIS REFRIGERATOR. Labels may be fabricated by users provided the labels are legible and securely affixed to the refrigerator.
- The custodian must have a means (manual or automated) to document the storage temperature of the temperature-sensitive materials.
- Refrigerators used for food storage in or near work areas (shops and labs) must be labeled with words to the effect of NOTICE – FOOD MAY BE STORED IN THIS REFRIGERATOR. DO NOT STORE CHEMICALS. Refrigerators used for food and beverage storage that are located in lunchrooms and office buildings, where there is no shop or laboratory type chemical use, do not require any postings.

## 2.4.5 Other Storage Cabinets

Storage of small quantities of non-flammable, less hazardous chemicals in other storage cabinets is allowed if present in quantities below the exempt limits for that chemical class as provided by the *California Fire Code* ([24 CCR Part 9](#)), when the following conditions are met:

- The cabinet is clearly identified through exterior labeling as containing chemicals.
- The total quantity of chemicals stored in this fashion per cabinet is less than five gallons.

These cabinets must still be treated as chemical storage assets, that is, mapped and inspected periodically.

## 2.5 Compressed Gas Cylinders

The general requirements below apply to all *compressed gas cylinders (CGCs)* in storage. Additional requirements apply to CGCs stored indoors versus outdoors and also depend on the hazard category of the gas itself (toxic, corrosive, flammable, oxidizing, or asphyxiant). In each case, the most stringent applicable storage requirements apply.

For information on handling, see [Chemical Lifecycle Management: Compressed Gas Cylinder Storage and Handling Requirements](#).

### 2.5.1 Storage Areas

A CGC storage area must be

- 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 hazard categories.

## 2.5.2 Segregation

CGCs in storage must be separated from materials and conditions that present exposure hazards. Cylinders containing corrosive, flammable, or oxidizing gases must be segregated by hazard category (for example, oxidizers only with oxidizers).

*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 half an 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 ventilated gas cabinet.
- The distance requirement is eliminated where both gases are enclosed in ventilated gas cabinets.
- 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 and not less than 18 inches beyond the sides of the containers and has a fire resistance rating of at least half an hour.

## 2.5.3 Indoor Storage

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; they must 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

### 2.5.3.1 Gas Cabinets

*Gas cabinets* are primarily used to mitigate the hazards of *toxic, corrosive, or flammable* gases when used indoors. The installation of gas cabinets requires a design review by the ESH Building Inspection Office before purchase or installation (see [ESH: Project Review Procedure](#) and [Gas Cabinet Guidance](#)).

#### Standard Operating Procedures

Standard operating procedures (SOPs) that detail the safe operation of the gas cabinet must be developed and approved before operation by the ESH coordinator responsible for the area. At a minimum, these procedures must address the following:

- Installation, removal, and securing of gas cylinders inside the cabinet

- Operation of the controller, including the by-pass setting for purge operations and emergency shut-off button
- Purging of the manifold
- Response to alarm activation
- Maintenance requirements, including calibration of gas detection equipment and ventilation checks

SOP training must be provided for all affected workers before operation and tracked for compliance purposes. Should the experiment change in any way, the SOP must be updated and this information communicated to affected workers.

A preventive maintenance program should be implemented to ensure the integrity of connections and piping, adequacy of ventilation, and the functionality of alarms, sensors, valves, controllers, and other hazard mitigations.

### Labeling

The outside of all gas cabinets must be labeled to indicate the gas and gas concentration that is being used inside the cabinet.

#### 2.5.3.2 Gas Hazard Category-specific Requirements

##### Toxic and Corrosive

- Highly toxic gases (and toxic or corrosive ones if there is a concern that an accidental release will cause a health concern) must be stored in gas cabinets or exhausted enclosures.

##### Flammable

- 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.

##### Oxidizing

There are no additional indoor storage requirements for *oxidizers*.

##### Asphyxiant

There are no additional indoor storage requirements for *asphyxiants*.

#### 2.5.4 Outdoor Storage

An outdoor storage area must be

- Located away from gangways or locations where it may be impacted by heavy-moving objects, equipment, or vehicles
- Provided adequate drainage and cover. To prevent rusting, CGCs must be kept away from standing water.
- 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, cylinders should be stored under a protective canopy or cover.
- Provided 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 racks and cages are used for less hazardous gases stored outdoors. Consideration of exposure to the elements needs to be evaluated, as well as safe transport from the storage area to the use area.

#### 2.5.4.1 Gas Hazard Category-specific Requirements

##### Toxic

- 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 must be at least 5 feet (1.5 m) from exposures. The protective structure must not have more than two sides at approximately 90-degree directions, or three sides with connecting angles of approximately 135 degrees.
- When the storage area is located closer than 75 feet (22.9 m) to a building, openings into a building other than piping must 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

- 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 two-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 two-hour fire barrier must be located at least 5 feet (1.5 m) from any exposure.
- The two-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

In addition to the storage requirements listed in indoor storage for 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 <sup>3</sup>	ft <sup>3</sup>	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 two hours and interrupt 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.
- 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

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 <sup>3</sup>	ft <sup>3</sup>	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 two 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.

## 3 Forms

The following forms and systems are required by these requirements:

- [Chemical Lifecycle Management: Storage Area Inspection Form](#) (SLAC-I-730-0A09J-001). Form used to document monthly inspections for remote areas
- [Chemical Management System](#). System used for ordering and tracking chemicals and storing safety data sheets

## 4 Recordkeeping

The following recordkeeping requirements apply for these requirements:

- Results of monthly inspections of remote areas, in the form of a completed inspection form, must be kept on record for a minimum of one year by the chemical storage asset custodian and made available to ESH when requested.

## 5 References

[SLAC Environment, Safety, and Health Manual](#) (SLAC-I-720-0A29Z-001)

- [Chapter 40, “Chemical Lifecycle Management”](#)
  - [Chemical Lifecycle Management: Management and Use Requirements](#) (SLAC-I-730-0A09S-038)
  - [Chemical Lifecycle Management: Compressed Gas Cylinder Storage and Handling Requirements](#) (SLAC-I-730-0A09S-030)
  - [Chemical Management Services \(CMS\)](#)
  - [Chemical Management Services Program Site](#) (SharePoint)
- [Chapter 1, “General Policy and Responsibilities”](#)
  - [ESH: Project Review Procedure](#) (SLAC-I-720-0A24C-001)
- [Chapter 17, “Hazardous Waste”](#)

Other SLAC Documents

- [SLAC CERS \(Chemical Inventory\) GIS](#)
- [Gas Cabinet Guidance](#)

#### Other Documents

- Title 24, *California Code of Regulations*, “California Building Standards Code”, Part 9, “California Fire Code”, Chapter 34, “Flammable and Combustible Liquids” ([24 CCR Part 9, Chapter 34](#))
- National Fire Protection Association (NFPA) 30, *Flammable and Combustible Liquids Code* ([NFPA 30](#))
- National Fire Protection Association (NFPA) 70, *National Electrical Code* ([NFPA 70](#))
- Unidocs. *Hazardous Materials Storage Secondary Containment Guidelines* ([UN-083](#))
- Stanford University, Office of Environmental Health and Safety. [Chemical Safety: Storage Groups](#)