UCI Environmental Health & Safety

Storage of Flammable and Combustible Materials

REFERENCE GUIDE

Revised: March 2023

Buying chemicals in bulk may seem more efficient. However, there are limits to the number of flammable materials (i.e., chemicals, solvents, oxidizers, etc.) stored in research labs, shops, and storage areas. Maximum Allowable Quantities (MAQ) are limits on flammable material storage established by applicable fire codes and clarify the amount of flammable and combustible materials allowed in a defined area within a building. Numerous storage requirements are outlined within the fire code; if you have questions or need support managing your lab/unit's chemical storage, please contact EHS at safety@uci.edu.

Definitions

Chemical Hygiene Plan (CHP): A written program developed and implemented by the employer which sets forth procedures, equipment, personal protective equipment, and work practices that are capable of protecting employees from the health and physical hazards presented by hazardous materials used in that particular workplace and meets the requirements of Cal OSHA subsection 5191(e). The CHP outlines the chemical inventory requirements and online chemical inventory systems for the campus. Each UCI laboratory storing hazardous materials must have a current laboratory-specific CHP.

Chemical Inventory: A documented list of hazardous chemicals and quantities of chemicals stored in a specific location. Chemical inventories shall be reconciled annually and updated every time a chemical container is brought into the space or removed from the inventory. All locations that use or store hazardous materials must have a current chemical inventory and follow applicable storage and handling Standard Operating Procedures and storage/handling compliance requirements.

Chemical storage: The storage of controlled substances or hazardous materials (including hazardous waste) in chemical stores, chemical storage cabinets, or similar devices.

Combustible Liquid: A liquid having a closed-cup flash point at or above 100°F (37.8°C). Combustible liquids are further subdivided as follows:

- Class II. Liquids with a flash point at or above 100°F (37.8°C) and below 140°F (60°C)
- Class IIIA. Liquids with a flash point at or above 140°F (60°C) and below 200°F (93.4°C)
- Class IIIB. Liquids with a flash point at or above 200°F (93.4°C)

Control Area: A control area is a space within a building where hazardous materials are stored, dispensed, used, or handled. Control areas are constructed with features like fire-rated walls that prevent the spread of fire to and from other areas in the building, allowing for safe emergency egress and fire department response. The number of control areas on a floor varies greatly across UCI buildings.

Corrosive: A chemical that causes visible destruction of, or irreversible alterations in, living tissue by chemical action at the point of contact. A chemical shall be considered corrosive if, when tested on the intact skin of albino rabbits by the method described in DOTn 49 CFR 173.137, such chemical destroys or changes irreversibly the structure of the tissue at the point of contact following an exposure period of 4 hours. This term does not refer to action on inanimate surfaces.

Flammable Gas: A material which is a gas at 68°F (20°C) or less at 14.7 pounds per square inch atmosphere (psia) (101 kPa) of pressure [a material that has a boiling point of 68°F (20°C) or less at 14.7 psia (101 kPa)] which:

- is ignitable at 14.7 psia (101 kPa) when in a mixture of 13 percent or less by volume with air; or
- has a flammable range at 14.7 psia (101 kPa) with air of not less than 12 percent, regardless of the lower limit.
- The limits specified shall be determined at 14.7 psi (101 kPa) of pressure and a temperature of 68°F (20°C) in accordance with ASTM E 681.

Flammable Liquid: A liquid having a closed cup flash point below 100°F (38°C). Flammable liquids are further categorized into a group known as Class I liquids. The Class I category is subdivided as follows:

- Class IA. Liquids having a flash point below 73°F (23°C) and having a boiling point below 100°F (38°C).
- Class IB. Liquids having a flash point below 73°F (23°C) and having a boiling point at or above 100°F (38°C). Class IC. Liquids having a flash point at or above 73°F (23°C) and below 100°F (38°C). The category of flammable liquids does not include compressed gases or cryogenic fluids.

Flammable Solid**:** A solid, other than a blasting agent or explosive, that is capable of causing fire through friction, absorption of moisture, spontaneous chemical change or retained heat from manufacturing or processing, or which has an ignition temperature below 212°F (100°C) or which burns so vigorously and persistently when ignited as to create a serious hazard. A chemical shall be considered a flammable solid as determined in accordance with the test method of CPSC 16 CFR Part 1500.44, if it ignites and burns with a self-sustained flame at a rate greater than 0.0866 inch (2.2 mm) per second along its major axis.

Flammable Liquefied Gas**:** A liquefied compressed gas which, under a charged pressure, is partially liquid at a temperature of 68°F (20°C) and which is flammable.

Flammable Material: A material capable of being readily ignited from common sources of heat or at a temperature of 600°F or less.

Flash Point: The minimum temperature of a liquid or solid at which it gives off vapor sufficient to form an ignitable mixture with a gaseous oxidant (i.e., oxygen) near the surface of the liquid or solid under specified environmental conditions.

Hazardous Material: Those chemicals or substances which are physical hazards or health hazards as defined by the California Fire Code (CFC), whether the material is in usable or waste conditions. Hazardous materials are categorized as either physical hazards or health hazards (e.g., some examples of physical hazards – flammable, oxidizer, or water-reactive. Health hazards – highly toxic, or corrosive).

Highly Toxic**:** A material which produces a lethal dose or lethal concentration which falls within any of the following categories:

1. A chemical that has a median lethal dose (LD50) of 50 milligrams or less per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each.
2. A chemical that has a median lethal dose (LD50) of 200 milligrams or less per kilogram of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between 2 and 3 kilograms each.
3. A chemical that has a median lethal concentration (LC50) in air of 200 parts per million by volume or less of gas or vapor, or 2 milligrams per liter or less of mist, fume or dust, when administered

by continuous inhalation for one hour (or less if death occurs within 1 hour) to albino rats weighing between 200 and 300 grams each.

Mixtures of these materials with ordinary materials, such as water, might not warrant classification as highly toxic. While this system is basically simple in application, any hazard evaluation that is required for the precise categorization of this type of material shall be performed by experienced, technically competent persons.

Maximum Allowable Quantity (MAQ): An MAQ is the maximum amount of hazardous materials allowed to be stored or used within a control area in a building. These limits are established by the CFC and are broken down by hazard class. The maximum allowable quantity per control area is based on the material state (solid, liquid, or gas) and the material storage or use conditions. The MAQ within a building must be separated by control areas. The MAQ is intended to ensure the quantities of hazardous materials in a building are within the safe operating levels for the fire and life safety elements to which the building is designed and operated. Please refer to: https://www.ehs.uci.edu/maq/index.php
for more information related to Campus MAQ requirements.

Organic Peroxide: An organic compound that contains the bivalent -O-O- structure and which may be considered to be a structural derivative of hydrogen peroxide where one or both of the hydrogen atoms have been replaced by an organic radical. Organic peroxides can present an explosion hazard (detonation or deflagration) or they can be shock sensitive. They can also decompose into various unstable compounds over an extended period of time.

Class I. Describes those formulations that are capable of deflagration but not detonation.
Class II. Describes those formulations that burn very rapidly and that pose a moderate reactivity hazard.
Class III. Describes those formulations that burn rapidly and that pose a moderate reactivity hazard.
Class IV. Describes those formulations that burn in the same manner as ordinary combustibles and that pose a minimal reactivity hazard.
Class V. Describes those formulations that burn with less intensity than ordinary combustibles or do not sustain combustion and that pose no reactivity hazard.
Unclassified detonable (UD). Organic peroxides that are capable of detonation. These peroxides pose an extremely high-explosion hazard through rapid explosive decomposition.

Oxidizer: A material that readily yields oxygen or other oxidizing gas, or that readily reacts to promote or initiate combustion of combustible materials and, if heated or contaminated, can result in vigorous self-sustained decomposition.

Class 4. An oxidizer that can undergo an explosive reaction due to contamination or exposure to thermal or physical shock and that causes a severe increase in the burning rate of combustible materials with which it comes into contact. Additionally, the oxidizer causes a severe increase in the burning rate and can cause spontaneous ignition of combustibles.
Class 3. An oxidizer that causes a severe increase in the burning rate of combustible materials with which it comes in contact.
Class 2. An oxidizer that will cause a moderate increase in the burning rate of combustible materials with which it comes in contact.
Class 1. An oxidizer that does not moderately increase the burning rate of combustible materials.

Oxidizing Gas: A gas that can support and accelerate combustion of other materials more than air does.

Pyrophoric: A chemical with an autoignition temperature in air, at or below a temperature of 130°F (54°C).

Toxic: A chemical falling within any of the following categories:

1. A chemical that has a median lethal dose (LD_{50}) of more than 50 milligrams per kilogram, but not more than 500 milligrams per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each.
2. A chemical that has a median lethal dose (LD_{50}) of more than 200 milligrams per kilogram but not more than 1,000 milligrams per kilogram of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between 2 and 3 kilograms each.

A chemical that has a median lethal concentration (LC_{50}) in air of more than 200 parts per million but not more than 2,000 parts per million by volume of gas or vapor, or more than 2 milligrams per liter but not more than 20 milligrams per liter of mist, fume or dust, when administered by continuous inhalation for 1 hour (or less if death occurs within 1 hour) to albino rats weighing between 200 and 300 grams each

Unstable (Reactive) Material: A material, other than an explosive, which in the pure state or as commercially produced, will vigorously polymerize, decompose, condense or become self-reactive and undergo other violent chemical changes, including explosion, when exposed to heat, friction or shock, or in the absence of an inhibitor, or in the presence of contaminants, or in contact with incompatible materials. Unstable (reactive) materials are subdivided as follows:

Class 4. Materials that in themselves are readily capable of detonation or explosive decomposition or explosive reaction at normal temperatures and pressures. This class includes materials that are sensitive to mechanical or localized thermal shock at normal temperatures and pressures.
Class 3. Materials that in themselves are capable of detonation or of explosive decomposition or explosive reaction but which require a strong initiating source or which must be heated under confinement before initiation. This class includes materials that are sensitive to thermal or mechanical shock at elevated temperatures and pressures.
Class 2. Materials that in themselves are normally unstable and readily undergo violent chemical change but do not detonate. This class includes materials that can undergo chemical change with rapid release of energy at normal temperatures and pressures, and that can undergo violent chemical change at elevated temperatures and pressures.
Class 1. Materials that in themselves are normally stable but which can become unstable at elevated temperatures and pressure.

Water-Reactive Material: A material that explodes; violently reacts; produces flammable, toxic or other hazardous gases; or evolves enough heat to cause autoignition or ignition of combustibles upon exposure to water or moisture. Water-reactive materials are subdivided as follows:

Class 3. Materials that react explosively with water without requiring heat or confinement.
Class 2. Materials that react violently with water or have the ability to boil water. Materials that produce flammable, toxic or other hazardous gases, or evolve enough heat to cause autoignition or ignition of combustibles upon exposure to water or moisture.
Class 1. Materials that react with water with some release of energy, but not violently.

Used (Material): Placing a material into action, including solids, liquids, and gases.

Chemical Inventory Requirements

Pursuant to the CHP, each laboratory group and location that stores hazardous materials is required to maintain a current chemical inventory that lists all of the chemicals and compressed gases stored in the

lab/area, and the quantity of these chemicals. Chemical inventories are used to comply with storage limits/fire regulations and are used in the case of an emergency.

Principal Investigator /Laboratory Supervisor Responsibilities:

- Maintain a current chemical inventory that includes the location and quantity of all chemicals and compressed gases.
- Reconcile chemical inventory at least annually to verify that the electronic inventory and physical inventory are the same.
- Contact hazardous waste management to dispose of unwanted or expired hazardous materials, and containers that are unlabeled or in poor condition.

Responsibilities of Personnel Who Handle Potentially Hazardous Chemicals:

- Review existing chemical inventory before ordering a new chemical.
- Purchase the minimum amount of chemicals necessary for the research.
- Add new chemical containers to the online inventory the same day they are added to the laboratory.
- Discard unwanted, expired, and degraded chemical containers as chemical waste.
- Remove discarded containers from the online inventory the same day they are removed from the laboratory.

General Requirements

An area's MAQ requirements can vary significantly depending on the quantity of hazardous materials stored, material hazard class, quantity impact on the lab/areas designated control areas, floor level (amounts allowed decrease the higher the floor), and design/operation of the building fire protection system (i.e., sprinklers, etc.). It is important to note that floor/building control areas are calculated based on chemicals stored within the entire control area where the lab/area is located. The calculations for allowable quantities may be affected by the contiguous lab areas (either next door, the floor above, or the floor below, depending on how the control area is calculated). In addition, the MAQ is also calculated based on all flammable material used (including chemicals stored, used in research processes, and hazardous waste within the space).
It is the responsibility of the Principal Investigator (laboratory spaces) or unit managers (non-laboratory areas) to manage their chemical inventory and ensure that the Fire Code MAQ is adhered to when managing lab/area flammable storage and usage requirements. For questions about the control area where the lab/area is located, please contact EHS. Staff can review the building/floor/area and clarify the lab/area (Control area) specific allowable quantities of flammable materials.

Flammable and Combustible Liquids Container Size and Quantity Limits

California fire codes strictly limit the total quantity of flammable and combustible liquids and container size stored outside of flammable liquids storage cabinets or approved storage rooms in a laboratory.
The hazard classification of a liquid determines the type and size of a storage container.

- Container and portable tank sizes must comply with Chart 1 below. Containers in-which material arrives from a supplier are deemed acceptable per 8 CCR 5532(a), given that they comply with DOT requirements.

Container Size

Chart 1 describes the type and maximum size of shipping/storage containers, or safety cans, a lab is allowed to use based on the liquid's hazard classification.

Chart 1: Maximum container size by hazard class					
Type	**Class I-A**	**Class I-B**	**Class I-C**	**Class II**	**Class III-A-B**
Glass[1] or approved plastic containers (see exceptions)	1 pint (0.47L)	1 quart (0.94L)	1 gallon (3.79L)	1 gallon (3.79L)	1 gallon (3.79L)
Metal containers	1 gallon (3.79L)	5 gallon (18.95L)	5 gallon (18.95L)	5 gallon (18.95L)	5 gallon (18.95L)
OSHA compliant safety cans[2]	2 gallon (7.58L)	5 gallon (18.95L)	5 gallon (18.95L)	5 gallon (18.95L)	5 gallon (18.95L)
Metal drums	For storage requirements: • Research employees, contact your EHS School coordinator. • Non-research employees, contact EHS at safety@uci.edu.			60 gallon (227.4L)	60 gallon (227.4L)

1. Exceptions: Glass or approved plastic containers up to 1 gallon may be used for flammable liquids when;
   a. The liquid may become unfit for use when it contacts metal or corrodes metal containers.
   b. When the user's process requires a specific amount of liquid, up to 1 gallon, storage in a metal container would affect the analytical standard of the liquid. *[See References (below) Code of Regulations (CCR), Title 8, §5532, for details of these exceptions.]*
2. Safety cans come in various styles that make them suitable for pouring or dispensing materials. Containers that are OSHA compliant are considered appropriate for meeting the definitions of safety can, as long as they are in functioning condition.

Spray/squirt bottles used to store and release flammable materials shall be limited to 16 ounces in capacity. They must clearly convey what product is in the bottle and the hazards associated with that product.

Quantity Limits

Chart 2 describes the allowable total quantity of flammable or combustible liquid stored in a facility.

Chart 2: **Maximum quantities (California Fire Code)**				
	Category 1	**Category 2**	**Category 3**	**Category 4**
Description	Flash point < 23 °C (73.4 °F) and initial boiling point ≤ 35 °C (95 °F)	Flash point < 23 °C (73.4 °F) and initial boiling point > 35 °C (95 °F)	Flash point ≥ 23 °C (73.4 °F) and ≤ 60 °C (140 °F)	Flash point >60 °C (140 °F) and ≤ 93 °C (199.4 °F)

<table>
<tr><td>Pictogram</td><td>  </td><td>  </td><td>  </td><td>(No symbol)</td></tr>
<tr><td>Hazard Statement</td><td>Extremely flammable liquid and vapor</td><td>Highly flammable liquid and vapor</td><td>Flammable liquid and vapor</td><td>Combustible liquid</td></tr>
<tr><td rowspan="3">Storage Quantities</td><td colspan="3">Flammable Liquids: No more than 10 gallons outside of flammable liquid storage cabinets for Category 1-3.</td><td>Combustible Liquids: No more than 25 gallons outside of flammable liquid storage cabinets.</td></tr>
<tr><td colspan="4">Combined Flammable and Combustible Liquid: No more than 25 gallons of flammable and combustible liquids combined outside of flammable liquid storage cabinets. No more than 10 gallons may be flammable liquids.</td></tr>
<tr><td colspan="4">Storage of Flammable and Combustible Liquids in Labs: Laboratories with more than 10 gallons of flammable and combustible liquids must have a flammable liquid storage cabinet. No more than 60 gallons of flammable and combustible liquids may be stored in a flammable liquids storage cabinet. All flammable and combustible liquids stored and used in Laboratories must be in approved containers or safety cans.</td></tr>
</table>

A user cannot add more flammable storage cabinets to the lab/area as the Fire Code limits the MAQ for labs/areas based on the volume and type of flammable material being stored.

Items to consider when using a flammable cabinet:

- Please only order the quantity of flammable solvents that can safely be stored in the research lab.
- According to the Fire Code, no more than 10 gallons of flammable solvents may be stored outside of flammable storage cabinets, and most labs/areas have limited cabinet space.
- The typical 65” high flammable storage cabinet is rated for 45 gallons but cannot hold 5-gallon drums.
- The large size flammable storage cabinet (pictured) below can hold 5-gallon drums but is only rated for 60 gallons.

References

- Flammable Liquids, Gases, and Vapors - Design, Construction, and Capacity of Containers– Code of Regulations (CCR), Title 8, §5532
- Flammable Liquids, Gases, and Vapors - Office, Educational and Institutional Occupancies– Code of Regulations (CCR), Title 8, §5538

Contact EHS at (949) 824-6200 or safety@uci.edu for more information and questions regarding MAQs.