**FLAMMABLE AND COMBUSTIBLE LIQUIDS**

**STANDARD OPERATING PROCEDURE (SOP)**

**Type of SOP:** ☐ Process ☐ Hazardous Chemical ☒ Hazardous Class

**All personnel subject to these SOP requirements must review a completed SOP and sign the associated training record. Completed SOPs must be kept with the UC Davis Laboratory Safety Manual or be otherwise readily accessible to laboratory personnel. Electronic access is acceptable. SOPs must be reviewed, and revised where needed, as described in the** [**UC Davis Laboratory Safety Manual**](http://safetyservices.ucdavis.edu/article/laboratory-safety-manual)**. Note that not all hazardous chemicals are appropriately addressed in a control-banded SOP, and some chemicals are subject to several control-banded SOPs. The unique properties of each chemical must be considered before including it into a control band. If you need assistance completing this SOP template or with hazard assessment for your chemical use please contact** **chem-safety@ucdavis.edu****.**

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| Date SOP Written:  | **1/25/22** |  | Approval Date: | **1/25/22** |
| SOP Prepared by: | **Dietmar Kueltz** |
| **CLSC SOP Task Force** |
| SOP Reviewed and Approved by (name/signature): | **Dietmar Kueltz** |
| Department:  | **Animal Science** |
| Principal Investigator/Laboratory Supervisor:  | **Dietmar Kueltz** | Phone:  | **530-752-2991** |
| Lab Manager/ Safety Coordinator:  | **Bryce Parker** | Phone:  | 530 312-7233 |
| Emergency Contact(s):  | **Leslie Oberholtzer** | Phone:  | 530-219-6664 |
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| Location(s) covered by SOP: | Building: | **Meyer Hall, Cole B** | Lab Phone: | **530-752-7322** |
| Room #(s):  | **1323 – 1333, 120, 133** |

1. **HAZARD OVERVIEW**

Flammable and combustible liquids are those which can ignite when exposed to an ignition source at the flash point of the liquid. For a fire to occur three elements are required (fuel, ignition source, and oxygen), flammable and combustible liquids serve as fuel for a fire.

1. **HAZARDOUS CHEMICAL(S)/CLASS OF HAZARDOUS CHEMICAL(S)**

Flammable liquids are defined by their flash point (*i.e.*, the minimum temperature at which vapors are formed on the surface of a substance in sufficient quantity to ignite when exposed to an ignition source). OSHA and GHS (hazard codes H224, H225, H226) define flammable liquids as those with a flash point less than 37.8 °C (100 °F), while combustible liquids (hazard code H227) have a flash point greater than 37.8 °C (100 °F). The California Fire Code further classifies flammable liquids by their flash and boiling points. A summary table is provided below:



A few examples of common flammable or combustible liquids in use on the UC Davis campus are:

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| **Chemical name** | **Boiling point** | **Flash point** | **Classification** | **GHS Code** |
| Acetone | 56 °C (133 °F) | -17 °C (1 °F) | IB | H225 |
| 1-Butanol | 117 °C (243 °F) | 29 °C (84 °F) | IB | H226 |
| Diesel fuel | 149 - 371°C (300 - 700 °F) | >65 C (149 F) | II | H226 |
| Diethyl ether | 36.6 °C (94.3 °F) | -45 °C (-49°F) | IA | H224 |
| Ethanol | 78.4 °C (173.1 °F) | 12.8 °C (55.0 °F) | IB | H225 |
| 1-Propanol | 97.2 °C (207 °F) | 23.3 °C (74 °F) | IC | H225 |
| Vacuum pump oil | 476 °C (889 °F) | 288 °C ( 550°F) | IIIA | H227 |

The classification of flammable liquids impacts the Maximum Allowable Quantity (MAQ) for the laboratory. Please contact Fire Prevention to assess the materials and space to determine the applicable MAQs. Additional information is available in a [SafetyNet on Flammable Liquid Storage](http://safetyservices.ucdavis.edu/safetynet/flammable-liquid-storage).

**Nitronaphthalene, 2,2,2-trifluorethanol, 2-mercaptoethanol, 2-mehtylbutane (Chromasolv), 2-propanol, optima (LCMS grade), Acetic acid, Glacial acetic acid, Acetic anhydride, Acetone, Acetonitrile, Ammonia 2.0 M solution in ethyl acetate, Ammonium formate, Ammonium hydroxide solution (28%, and 29%), Chloroform, Dimethyl sulfoxide, Ethanol (200 proof), Ethyl acetate, LCMS grade, Ethyl alcohol (200 proof), Formaldehyde, Formic Acid, Iso-Amyl alcohol, Isobutanol, Methane sulfonic acid solution, Methanol, N,N-dimethylformamide, Petroleum ether, Phenolphthalein 2% solution, Proteoextract protein precipitation kit, Trifluoracetic acid, Xylenes**

1. **ENGINEERING/VENTILATION CONTROLS**

**Chemical Fume Hood**

Flammable liquids should be used in a certified chemical fume hood. Flammable liquids should not be used in reverse-flow laminar flow benches (*e.g.*, clean bench), recirculating biosafety cabinets, poorly-ventilated rooms, or near ignition sources.

**Flammable Liquid Storage Cabinets**

Flammable liquid storage cabinets must meet NFPA 30 specifications, Flammable and Combustible Liquids Code, and the California Fire Code. Cabinets must also be Underwriter Laboratories (U.L.) 1275 listed. Self-closing doors with a latching mechanism are required. Cabinets should be placed so that they do not block or impede egress. Flammable liquid storage cabinets are not required to be vented. Any ventilation of a flammable liquid storage cabinet must be approved by UC Davis Fire Prevention (see UC Davis SafetyNet, “[Venting Flammable Storage Cabinets](http://safetyservices.ucdavis.edu/safetynet/venting-flammable-storage-cabinets)”). Grounding is not required unless Class IA flammable liquids are being dispensed from the cabinet. If grounding is desired, the flammable liquid storage cabinet must be grounded to a static grounding terminal and not to the ground of an electrical receptacle. Any metal receiving container must be bonded to the grounded dispensing container.

**Refrigerator/Freezers**

If flammable liquids must be stored at reduced temperature, a U.L. Listed Flammable Material Storage Refrigerator/Freezer must be used. These refrigerator/freezers are designed to prevent ignition of flammable vapors inside the storage compartment. Explosion-proof refrigerators have very limited use and require special hazardous-location wiring rather than the simple plug-in type power cord. Consult with the UC Davis Fire Prevention Office before purchasing an Explosion proof Refrigerator.

**Flammable storage cabinets are used to store these chemicals except for the volumes permitted to be kept outside of such cabinets; Chemical hood is used to prevent inhalation of toxic fumes.**  **Flammables are not to be used near any open flame or ignition source. Room temperature is kept adequate to prevent autoignition of flammables.**

1. **ADMINISTRATIVE CONTROLS**

The following elements are required:

1. Complete the [UC Laboratory Safety Fundamentals](http://safetyservices.ucdavis.edu/training/uc-laboratory-safety-fundamentals) (or approved equivalent) training prior to working in the laboratory;
2. Complete laboratory-specific safety orientation and training on laboratory-specific safety equipment, procedures, and techniques to be used, including any applicable laboratory-specific Laboratory Safety Plan(s), prior to receiving unescorted access to the laboratory;
3. Demonstrate competency to perform the procedures to the Principal Investigator (PI), Laboratory Supervisor, laboratory-specific Safety Officer, or trainer;
4. Be familiar with the location and content of any applicable Safety Data Sheets (SDSs) for the chemicals to be used ([SDS can be accessed online](https://safetyservices.ucdavis.edu/units/ehs/research/safety-data-sheets));
5. Implement good laboratory practices, including good workspace hygiene;
6. Inspect all equipment and experimental setups prior to use;
7. Follow best practices for the movement, handling, and storage of hazardous chemicals (see Chapters 5 and 6 of [Prudent Practices in the Laboratory](http://ucanr.edu/sites/ucehs/files/133892.pdf) for more detail). An appropriate spill cleanup kit must be located in the laboratory. Chemical and hazardous waste storage must follow an appropriate segregation scheme and include appropriate labeling. Hazardous chemical waste must be properly labelled, stored in closed containers, in secondary containment, and in a designated location;
8. Do not deviate from the instructions described in this SOP without prior discussion and approval from the PI or Laboratory Supervisor;
9. Notify the PI or Laboratory Supervisor of any accidents, incidents, near-misses, or upset condition (*e.g.,* unexpected rise or drop in temperature, color or phase change, evolution of gas) involving the Flammable Liquids described in this SOP; and
10. Abide by the laboratory-specific working alone SOP, if applicable.

For Flammable Liquids, the following are also required:

1. Areas where Flammable Liquids are used or stored must have access to a safety shower/eye wash station within ten seconds of travel, and a Class A/B/C fire extinguisher. Dry sand, Met-L-X, soda ash or dry lime extinguishing agents may be needed. All safety showers, eyewashes, and fire extinguishers in these areas must be fully functioning and inspected monthly.
2. No more than 10 gallons of flammable liquids, including hazardous waste, may be stored outside of an approved Flammable Liquid storage cabinet, at any time in any room;
3. Each Flammable Liquid storage cabinet must have self-closing doors with a latching mechanism;
4. Flammable Liquids must be separated from incompatible materials (*e.g.*, oxidizers, alkali metals, pyrophorics, and water-reactive materials); and
5. If stored outside of a Flammable Liquid storage cabinet, Flammable Liquids shall not be stored near ignition sources.

**Handling of large volumes (>1 L) of these chemicals is only permissible by trained graduate students, lab assistants (except undergraduate students) and postdocs. Working alone with large volumes (>1 L) is not permissible.**

**Flammables must be stored in a flammable cabinet, and/or away from ignition sources and incompatible materials. When handling flammables, proper PPE must be worn including, but not limited to gloves, and flame retardant lab coat; Storage of these chemicals is in special cabinets for flammable chemicals.**

1. **PERSONAL PROTECTIVE EQUIPMENT (PPE)**

At a minimum, long pants (covered legs) and closed toe/closed heel shoes (covered feet) are required to enter a laboratory or technical area where hazardous chemicals are used or stored.

In addition to the minimum attire required upon entering a laboratory, the following PPE is required for all work with Flammable Liquids:

1. Eye Protection:
	1. At a minimum ANSI Z87.1-compliant safety glasses are necessary.
	2. Splash goggles may be substituted for safety glasses, and are required for processes where splashes are foreseeable or when generating aerosols.
	3. Ordinary prescription glasses will NOT provide adequate protection unless they also meet the Z87.1 standard and have compliant side shields.
2. Body Protection: At a minimum a chemically-compatible laboratory coat that fully extends to the wrist is necessary.
	1. Clothing worn under PPE should not be constructed from synthetic materials
	2. A flame-resistant laboratory coat that is NFPA 2112-compliant that fully extends to the wrist is required if using large quantities (>1 liter) or when using flammable liquids near an open flame or ignition source. The only exception to this requirement is for conducting Flame Sterilization following the [campus approved SOP](http://safetyservices.ucdavis.edu/sites/default/files/documents/FlameSterilization_SOP_template.pdf). Some FR fabrics (*e.g.*, Nomex®, Rhovyl®, Kevlar®, etc.) are highly permeable and do not provide good chemical resistance; and
	3. For chemicals that are corrosive and/or toxic by skin contact/absorption additional protective clothing (*e.g.,* face shield, chemically-resistant layer, disposable sleeves, etc.) are required where splashes or skin contact is foreseeable.
3. Hand Protection: When hand protection is needed for the activities described in this SOP define the type of glove to be used based on: A) the chemical(s) being used, B) the anticipated chemical contact (*e.g.,* incidental, immersion, etc.), C) the manufacturers’ permeation/compatibility data, and D) whether a combination of different gloves is needed for any specific procedural step or task.
	1. Flame-resistant gloves should be considered if using large quantities (>1 liter) or using Flammable Liquids near an open flame or ignition source.

**Use fire-retardant lab coat (blue), appropriate gloves, and eye protection (googles or face shield), use closed-toed shoes and long pants. When working with flammables, PPE that must be worn are gloves, flame retardant lab coat, long pants, and close toed shoes. Donning: lab coat first then gloves. When doffining: remove gloves carefully, one at a time, then lab coat. Wash hands after doffing, and be sure to check any clothing that may have had a flammable come into contact with it.**

1. **SPILL AND EMERGENCY PROCEDURES**

Follow the guidance for chemical spill cleanup from [SafetyNet #13](http://safetyservices.ucdavis.edu/safetynet/guidelines-chemical-spill-control) and/or the [UC Davis Laboratory Safety Manual](http://safetyservices.ucdavis.edu/article/laboratory-safety-manual), unless specialized cleanup procedures are described below. Emergency procedure instructions for the UC Davis campus and UCD Medical Center are contained in the [UC Davis Laboratory Safety Manual](http://safetyservices.ucdavis.edu/article/laboratory-safety-manual), [campus Emergency Response Guide (ERG)](http://safetyservices.ucdavis.edu/sites/default/files/documents/Emergency_Response_Guide.pdf), and [UCD Health System ERG](http://www.ucdmc.ucdavis.edu/medresearch/downloads/labsafety/2.6-UCDHS-Emergency-Response-Guide.pdf). The applicable ERG must be posted in the laboratory. All other locations must describe detailed emergency procedure instructions below.

**Follow standard safety SOP for spill cleanup. Use Lab sill kit for cleaning smaller spills (<1 L) and call the fire department or EHS to clean up larger spills. For Acetic acid, glacial acetic acid, methane sulfonic acid, and formic acid follow spill cleanup procedures according to corrosives SOP. For Chloroform, and Formaldehyde, follow spill cleanup procedure listed in Carcinogens SOP. Call 911 in case of fire. For small fires use fire extinguisher.**

1. **WASTE MANAGEMENT AND DECONTAMINATION**

Hazardous waste must be managed according to [Safety Net #8](http://safetyservices.ucdavis.edu/safetynet/guidelines-disposal-chemical-waste), and must be [properly labeled](http://safetyservices.ucdavis.edu/article/hazardous-waste-storage-and-labeling). In general, hazardous waste must be removed from your laboratory within 9 months of the accumulation start date; refer to the [accumulation time for waste disposal](http://safetyservices.ucdavis.edu/article/hazardous-waste-storage-and-labeling). Hazardous waste pick up requests must be completed using [WASTe](https://ehs.ucop.edu/waste/#/).

**Note:** See the [WASTe Factsheet](http://safetyservices.ucdavis.edu/sites/default/files/documents/WASTe_Factsheet.pdf) for instructions on how to complete a label.

**Fill out waste tag and store waste in waste storage area; arrange waste pick up with EHS before the required date or when waste container us full. Clean contaminated equipment and areas by using spill kit and / or disposable towels. For Acetic acid, glacial acetic acid, methane sulfonic acid, and formic acid follow waste decontamination and disposal procedures according to corrosives SOP. For Chloroform, and Formaldehyde, follow waste procedure listed in Carcinogens SOP.**

Upon completion of work with hazardous chemicals and/or decontamination of equipment, remove gloves and/or PPE to wash hands and arms with soap and water. Additionally, upon leaving a designated hazardous chemical work area remove all PPE worn and wash hands, forearms, face and neck as needed. Contaminated clothing or PPE should not be worn outside the lab. Soiled lab coats should be sent for professional laundering. Grossly contaminated clothing/PPE and disposable gloves must not be reused.

1. **DESIGNATED AREA**

**Designated areas for Flammables include Meyer 1323,1327,1329, and 1333. Designated flammable storage cabinets under benches; chemical fume hood in main lab room; small volumes on lab benches, shelves, and in refrigerator, freezers as permitted by UCD EHS guidelines.**

1. **DETAILED PROTOCOL**

**Do not use these chemicals unless properly trained in the relevant SOPs for their use; When working in the lab with hazardous chemicals, supplies, or equipmemt, a laboratory worker must:**

**1. Not work alone (if you are alone in the laboratory, leave),**

**2. Be cognizant of all of the SDS and safety information presented in this document.**

**3. Wear the proper and required PPE including but not limited to flame retardant lab coat, gloves, safety glasses/googles, respiratory protection, close toed shoes, and long pants.**

**4. Work with flammables inside the certified chemical fume hood as much as possible.**

**5. Keep all flammables away from any source of ignition.**

**\*For Acetic acid, glacial acetic acid, methane sulfonic acid, and formic acid follow detail protocol according to corrosives SOP.**

**\*For Chloroform, and Formaldehyde, follow detailed protocol listed in Carcinogens SOP.**

**TEMPLATE REVISION HISTORY**

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| **Version** | **Date Approved** | **Author** | **Revision Notes:** |
| **1.0** | **10/26/2015** | **CLSC Task Force** | **New template** |
| **1.1** | **3/10/2016** | **Chris Jakober** | **Updated URLs following website redesign, added URL to UCDHS ERG** |
| **1.2** | **11/30/2016** | **Lindy Gervin** | **Unlocked editable fields** |
| **1.3** | **3/13/2017** | **Lindy Gervin** | **Updated links in section 7 to WASTe system** |
| **1.4** | **5/10/2017** | **Lindy Gervin** | **Added email address to introduction** |
| **1.5** | **12/2/2020** | **Phillip Painter** | **Updated SDS hyperlink in section 4** |

**LAB-SPECIFIC REVISION HISTORY**

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| --- | --- | --- | --- |
| **Version** | **Date Approved** | **Author** | **Revision Notes:** |
| **1.1** | 4/4/18 | **Leah Rechlin** |       |
| **1.2** | 1/25/22 | **Dietmar Kueltz** | New Template implemented; updated other info |
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**Documentation of Standard Operating Procedure Training**

*(Signature of all users is required)*

* Prior to using **Flammable Liquids**, laboratory personnel must be trained on the hazards involved in working with this SOP, how to protect themselves from the hazards, and emergency procedures.
* Ready access to this SOP and to a Safety Data Sheet for each hazardous material described in the SOP must be made available.
* The Principal Investigator (PI), or the Laboratory Supervisor if the activity does not involve a PI, must ensure that their laboratory personnel have attended appropriate laboratory safety training or refresher training within the last three years.
* Training must be repeated following **any** revision to the content of this SOP. Training must be documented. This training sheet is provided as one option; other forms of training documentation (including electronic) are acceptable but records must be accessible and immediately available upon request.

**Designated Trainer:** *(signature is required)* Dietmar Kueltz

 **Signatures for this SOP are included in the Initial and Annual Lab refresher training documents**

I have read and acknowledge the contents, requirements, and responsibilities outlined in this SOP:

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| **Name** | **Signature** | **Trainer Initials** | **Date** |
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