Standard Operating Procedure January 2023
FLAMMABLE AND COMBUSTIBLE LIQUIDS

This standard operating procedure (SOP) is intended to provide general guidance on how to safely work with flammable liquids. This SOP is generic in nature and only addresses safety issues specific to flammable and combustible liquids. In some instances, several general use SOPs may be applicable for a specific chemical.

Definitions

The National Fire Protection Agency (NFPA) considers any chemical flammable if it has a flashpoint below 37.8ºC (100ºF).

There are three classes of flammable liquids per the NFPA:

- Class IA. Liquids having a flash point below 73F (23°C) and having a boiling point below 100F (38°C). *Examples*: acetaldehyde, butyne, chloropropylene, dimethyl sulfide, ethyl chloride, and ethyl ether.
- Class IB. Liquids having a flash point below 73F (23°C) and having a boiling point above 100F (38°C). *Examples*: acetone, benzene, carbon disulfide, ethyl alcohol, ethyl acetate, gasoline, hexane, isopropanol, methanol, and toluene.
- Class IC. Liquids having a flash point at or above 73F (23°C) and below 100F (38°C) *Examples*: amyl alcohol, butyl alcohol, isobutyl alcohol, methyl isobutyl ketone, styrene, turpentine, and xylene.

OSHA defines a flammable liquid as any liquid having a flashpoint at or below 199.4 °F (93 °C).

OSHA Flammable liquids are divided into four categories as follows:

- Category 1 shall include liquids having flashpoints below 73.4 °F (23 °C) and having a boiling point at or below 95 °F (35 °C).
- Category 2 shall include liquids having flashpoints below 73.4 °F (23 °C) and having a boiling point above 95 °F (35 °C).
- Category 3 shall include liquids having flashpoints at or above 73.4 °F (23 °C) and at or below 140 °F (60 °C). When a Category 3 liquid with a flashpoint at or above 100 °F (37.8 °C) is heated for use to within 30 °F (16.7 °C) of its flashpoint, it shall be handled in accordance with the requirements for a Category 3 liquid with a flashpoint below 100 °F (37.8 °C).
- Category 4 shall include liquids having flashpoints above 140 °F (60 °C) and at or below 199.4 °F (93 °C). When a Category 4 flammable liquid is heated for use to within 30 °F (16.7 °C) of its flashpoint, it shall be handled in accordance with the requirements for a Category 3 liquid with a flashpoint at or above 100 °F (37.8 °C).

Combustible Liquid: A liquid having a flash point above 100°F. Combustible liquids are subdivided as follows:

- Class II: Liquids with a flash point at or above 100°F and below 140°F (60°C). *Examples*: No. 1, 2 and 3 fuel oils, kerosene, and hexyl alcohol.

- Class IIIA: Liquids with a flash point at or above 140°F and below 200°F (93°C). *Examples*: aniline, benzaldehyde, butyl cellosolve, nitrobenzene and pine oil.
- Class IIIB: Liquids with a flash point at or above 200°F. *Examples*: animal oils; ethylene glycol; glycerin; lubricating, quenching, and transformer oils; triethanolamine; benzyl alcohol; hydraulic fluids and vegetable oils.

Boiling Point: The temperature at which a liquid's vapor pressure is equal to the atmospheric pressure. Liquids with low boiling points are very volatile.

Flash Point: The minimum temperature of a liquid at which sufficient vapor is liberated to form a vapor-air mixture that will ignite and propagate a flame away from the ignition source (flash fire not continuous combustion).

Flammable (Explosive) Limits/Flammable (Explosive) Range: The terms flammable and explosive are used interchangeably since unconfined vapors mixed in air will burn while confined vapors will produce an explosion. The minimum vapor concentration in air that, when ignited, will propagate a flame is the lower flammable limit (LFL or LEL). The maximum vapor concentration in air that when ignited will propagate a flame is the upper flammable or explosive limit (UFL or UEL).

Vapor Pressure: A measure of the pressure created by a liquid's vapor at a specific temperature. Flammable or combustible liquids with a high vapor pressure at room temperature are more hazardous than liquids with lower vapor pressures because they will produce more flammable vapor without heating.

Vapor Density: The weight of a volume of pure vapor or gas (with no air present) compared to the weight of an equal volume of dry air at the same temperature and pressure. A vapor density figure less than one indicates the vapor is lighter than air. A figure greater than one indicates the vapor is heavier than air.

Fire Area: An area of a building separated from the remainder of the building by construction having a fire resistance at least 1 hour (i.e. a single laboratory area).

Flammable Material Storage Cabinet: A storage cabinet constructed and arranged in accordance with NFPA and International Fire Code standards. Note: Cabinets that are typically located underneath bench tops and fume hoods are not considered approved cabinets unless they are provided with appropriate UL/FM labeling.

Flammable Liquid Storage Room: A room used for the storage of large quantities of flammable and combustible liquids which meets the construction, arrangement and protection requirements of the City of Baton Rouge, NFPA and International Building and Fire Code standards.

Safety Can: A metal container of not more than 5-gallon capacity which is UL/FM Approved and is provided with a flame arrestor, a spring-closing lid and spout cover

designed to relieve internal pressure when subjected to fire exposure.

Approved Plastic Container: A plastic container meeting the requirements of and containing products authorized by the U. S. Department of Transportation (DOT) Hazardous Materials Regulations, 49 CFR or by Part 6 of the United Nations Recommendations on the Transport of Dangerous Goods (i.e. UN 1H1 – non-removable head type plastic containers or as authorized by DOT exemption). The 5 gallon "red" container commonly used for gasoline is an example of a container meeting these guidelines.

Potential Hazards/Toxicity

Physical Hazards

Flammable liquids usually have high vapor pressures at room temperature and their vapors, mixed with air at the appropriate ratio, can ignite and burn. As with all solvents, their vapor pressure increases with temperature and therefore as temperatures increase, they become more hazardous. Combustible liquids require heating for ignition and are easier to extinguish

The concentrated vapors of flammable liquids may be heavier than air and can cause vapor trails which can travel to reach an ignition source, resulting in a flashback fire. Fire can also result from reactions between flammables or combustibles and oxidizers.

Health Hazards

In addition to the fire hazard, many flammable and combustible liquids pose health hazards as well. Effects from acute inhalation exposures range from irritation to CNS depression, nausea and dizziness. In extreme situations, coma can result. Chronic exposures may lead to live or kidney damage. Skin absorption can lead to similar long-term effects as inhalation exposures. Skin contact with solvents may result in defatting and drying of the skin. Some flammable liquids also have additional health hazards, i.e., benzene is also a known human carcinogen.

As the hazards may vary by compound, users must familiarize themselves with the specific hazards of the compounds they are working with, which can be found on the chemical's Safety Data Sheet (SDS). SDSs are available through the internet using a simple name search.

Personal Protective Equipment (PPE)

The University's Personal Protective Equipment Policy can be found on the Standard Operating Procedure section of the EHS website.

Eye Protection

Safety glasses must be worn whenever handling flammable liquids. When there is the potential for splashes, goggles and/or a face shield must be worn.

Hand Protection

Gloves must be worn when handling flammable liquids. Exam style nitrile gloves (minimum 4mil thickness) are generally adequate for handling these compounds in laboratory settings when skin contact is unlikely. However, if skin contact is likely or larger amounts are being used, then a utility grade glove should be worn over the exam style nitrile. To ensure that the appropriate utility grade glove is selected, refer to the manufacturer's glove selection information on the chemical's SDS, or contact EHS.

Skin and Body Protection

Long pants or clothing that covers the body to the ankles and closed-toe solid top shoes must be worn when handling flammable liquids. Lab coats must be worn. When working with large amounts of flammable liquids, a 100% cotton or flame-resistant lab coat is preferred. For flammable liquids that pose health hazards through dermal absorption, additional protective clothing (i.e., apron, oversleeves) may be appropriate where chemical contact with the skin is likely.

Engineering Controls

Fume Hood

Fume hoods, or other locally exhausted ventilation, should be used whenever handling flammable liquids. Local exhaust ventilation is particularly important when using larger quantities (>500ml) or when flammables are heated or at increased pressure.

Storage/Handling

- Minimize the storage of flammable liquids outside flammable rated storage cabinets. The volume stored outside of rated cabinets and safety cans should be <10 gallons per laboratory.
- 5-gallon cans of flammable liquids should be stored inside flammable rated cabinets.
- Refrigerators used for the storage of flammable liquids should be designed/rated for this purpose.
- Keep flammables segregated from incompatible materials, including oxidizers.
- Store at/below eye level (~5 feet).
- Flammable cabinets should be unvented. If venting is required or requested, EH&S must be contacted for a specific evaluation and guidelines.
- Metal surfaces or containers through which flammable liquids flow must be properly grounded, to discharge static electricity.
- Large quantities (≥5 gallons) of flammable liquids should be handled using spark-free tools in areas free of ignition sources, including spark emitting motors and equipment.
- Never heat flammable liquids by using an open flame. Use steam baths, water baths, oils baths, heating mantles or hot air baths.
- If flammable liquids must be heated in an oven, make sure the oven is appropriately designed for flammable liquids (no internal ignition sources and/or vented mechanically).

- When heating flammable liquids, ensure that the autoignition temperature of the solvent is above the oven temperature or its internal elements.
- Do not distill flammable liquids under reduced pressure.

Waste Disposal

Flammable liquids must be collected as hazardous waste including dilute aqueous solutions. Water from the LSU sewers goes to the Baton Rouge sewer system. As such, it is EHS policy that nothing can be disposed by pouring it down the drain. EHS will pick up these solutions for disposal. Researchers are not charged for waste collection at LSU. In addition, all items contaminated with a flammable liquid which is also acutely toxic (P-Listed) must be collected as hazardous waste, ex: carbon disulfide. This includes reagent bottles, weigh boats, pipette tips, kimwipes, and other similar items that have come into contact with these compounds.

Emergency Procedures

Fire Extinguishers

Both ABC dry powder and carbon dioxide extinguishers are appropriate for most fires involving acutely toxic compounds. Fire extinguishers should be located within a 50 ft. travel distance.

Eyewash/Safety Showers

An ANSI approved eyewash station that can provide quick drenching or flushing of the eyes should be immediately available within 10 seconds travel time for emergency use. An ANSI approved safety drench shower should also be available within 10 seconds travel time from where these compounds are used. Ensure the locations of the eyewashes and safety showers, and how to activate them, are known prior to an emergency.

First Aid Procedures

If inhaled

Remove to fresh air. The employee should notify their supervisor and then call the Employee Injury Call Center at 877-764-3574 to speak to a registered nurse. The Call Center is available 24 hours every day. The nurse will discuss the incident/injury with the employee and determine the employee's immediate medical needs.

In case of skin contact

Go to the nearest emergency shower if contaminated. Yell for assistance and rinse for 15 minutes, removing all articles of clothing to ensure contaminate is completely removed. The employee should notify their supervisor. Follow up with a call the Employee Injury Call Center at 877-764-3574 to speak to a registered nurse.

In case of eye contact

Go to the nearest emergency eyewash. Yell for assistance and rinse for 15 minutes. . The employee should notify their supervisor and follow up with a call the Employee Injury Call Center at 877-764-3574 to speak to a registered nurse.

Spills

Small Spill

If a small spill of a low toxicity flammable liquid occurs, lab personnel should be able to safely clean it up by following standard spill clean-up procedures:

- Alert people in immediate area of spill
- Increase ventilation in area of spill (open fume hood sashes)
- Wear personal protective equipment, including utility grade gloves
- Confine/adsorb spill with spill clean-up pads or absorbent
- Collect residue, place in container, label container, and dispose of as hazardous waste
- Clean spill area with soap and water Larger Spill/Any spill outside a fume hood
- If necessary, call EHS for emergency assistance (225-578-5640).

Larger Spill/Any spill outside a fume hood

- Call LSU Police for emergency assistance at 225-578-3231
- Notify EHS (225-578-5640).
- Evacuate the spill area
- Post someone or mark-off the hazardous area with tape and warning signs to keep other people from entering
- Stay nearby until emergency personnel arrive and provide them with information on the chemicals involved