




QUARTERLY SPECIAL REPORT

YOUR GUIDE TO
**SAFE STORAGE OF
FLAMMABLE LIQUIDS**
IN THE WORKPLACE



**SAFETY
& HEALTH**



Flammable liquids are used in almost every type of workplace. They are used as fuel in vehicles, as lubricants in industrial machinery, as manufacturing materials, as cleaners and solvents, in paints and disinfectants, and the list goes on. This means many employees are exposed to the hazards of flammable liquids and must be trained to keep themselves and their coworkers safe.

CODES AND STANDARDS

OSHA's flammable liquids standard at 29 CFR 1910.106 requires safe handling and storage of flammable liquids to reduce the likelihood of explosions and fires. The standard for flammable liquids applies differently depending on the type of business storing the liquids. For instance, you are allowed to store large amounts of flammable liquids in a protected warehouse, but you may not store flammable liquids in office areas except what is needed for maintaining and operating equipment.

In addition, the National Fire Protection Association NFPA 30, Flammable and Combustible Liquids Code applies to indoor and outdoor storage, handling, and use of flammable liquids.

If you store, handle, or use flammable liquids in your workplace, you must also be familiar with and follow your local fire codes. Call your local fire department, search your municipal website, or contact your state fire marshal for more information on your local codes.





TRAINING

It is important for employers to train employees on the hazards of flammable liquids, including:



How to identify flammable liquids,



Fire prevention and control, and



Safe handling methods

HOW TO IDENTIFY FLAMMABLE LIQUIDS

One common misconception is that you can tell that a liquid is flammable by looking at its container. But flammable liquids come in many different types of containers, from aerosol cans to drums, totes, portable tanks, and even tanker trucks and rail cars. To know if a container holds a flammable liquid, you need to read the container label and the chemical's safety data sheet.



SAFETY DATA SHEETS (SDSs)

Safety data sheets (SDSs) are required under OSHA's Hazard Communication Standard (29 CFR 1910.1200) as part of employees' "right to know" the hazards of the chemicals in their work areas. The SDS provides complete information about a chemical, including its physical makeup, how to store it, what to do if it spills, how to dispose of it, and what precautions are needed to work with it.

There are 16 sections on the SDS, beginning with information of greatest concern to workers, followed by more technical information. The sections that address flammable liquids are Section 2, which identifies the hazards of a substance, and Section 9, which identifies physical and chemical properties associated with the substance or mixture. This is where flash point, upper and lower flammability or explosive ranges, and boiling points will be listed.

SDSs are sent with the initial shipment of a chemical and with the first shipment after an SDS is updated so workers have the information they need to properly handle and store the liquids.



CONTAINER LABELS

OSHA also has specific requirements for the labels on containers of hazardous chemicals, including flammable liquids. Six label elements must appear on every label:

1. Product identifier
2. Signal word
3. Hazard statement(s)
4. Pictogram(s)
5. Precautionary statement(s)
6. Contact information (name, address, and phone number) of the chemical manufacturer or importer

Employees need training on reading and understanding labels under OSHA's Hazard Communication Standard. But for flammable liquid safety, employees should be able to tell if the container holds a flammable liquid just by looking at the label. Three elements should stand out to employees. These are the pictogram, signal word, and hazard statement(s). For example, if the chemical is a Category 1 flammable liquid, the label would include the flame pictogram, the signal word "Danger," and the hazard statement "Extremely flammable liquid and vapor."



OSHA uses three pictograms to indicate flammable liquids. These are the pictograms for oxidizers, flammables, and explosives.

The two signal words are “Danger” for the more severe hazards and “Warning” for less severe hazards. Only one signal word should be on the label. If more than one hazard exists, you use the signal word for the more severe hazard.



FLAME OVER CIRCLE

- ▶ Oxidizers



FLAME

- ▶ Flammables
- ▶ Self-reactives
- ▶ Pyrophorics
- ▶ Self-heating
- ▶ Emits flammable gas
- ▶ Organic Peroxides



EXPLODING BOMB

- ▶ Explosives
- ▶ Self-reactives
- ▶ Organic Peroxides

Hazard statements are standardized phrases which are assigned to a class and category that describe the nature of the hazards of a product. They provide immediate precautionary information about the material.

Example: **Flammable Liquids**

- ▶ Category 1: Extremely flammable liquid and vapor
- ▶ Category 2: Highly flammable liquid and vapor
- ▶ Category 3: Flammable liquid and vapor
- ▶ Category 4: Combustible liquid

Together, the pictogram, signal word, and hazard statement warn against the dangers of the material, including whether the material is an extremely flammable aerosol, highly flammable liquid, has a combustible vapor, and so on.



HAZARDS OF FLAMMABLE LIQUIDS

Flammable liquids vaporize and mix with the air when left in open or leaking containers and when they are heated. To control these hazards, the liquid's flash point and boiling point must be understood, along with issues such as compatibility, explosive range, and auto ignition temperatures.



DEFINITION OF A FLAMMABLE LIQUID

OSHA defines “flammable liquid” as any liquid having a flashpoint at or below 199°F (93°C). Flammable liquids are divided into four categories:

- ▶ **Category 1** includes liquids having flashpoints below 73.4°F (23°C) and having a boiling point at or below 95°F (35°C).
- ▶ **Category 2** includes liquids having flashpoints below 73.4°F (23°C) and having a boiling point above 95°F (35°C).
- ▶ **Category 3** includes 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 is heated for use to within 30°F of its flashpoint, it is handled requirements for a Category 3 liquid with a flashpoint below 100°F].
- ▶ **Category 4** includes 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 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.

Note that when a liquid with a flashpoint greater than 199.4°F (93°C) is heated for use to within 30°F (16.7°C) of its flashpoint, it is handled per the requirements for a Category 4 flammable liquid.



FLASH POINT

The most important definition to understand with flammable liquids is the flash point. The flash point is the minimum temperature at which a liquid gives off vapor in sufficient concentration to form an ignitable mixture with air near the surface of the liquid. Generally, the lower the flash point, the more hazardous the flammable liquid.

Understanding the liquid's flash point is critical. It's not the liquid that burns, but the vapor the liquid gives off. The vapor can form an ignitable mixture, and if there is an ignition source nearby, it can catch fire or explode.

A SOLVENT WITH
A FLASHPOINT OF
65°F SPILLS
INDOORS WHERE THE
AMBIENT TEMPERATURE
IS **70°F**. THIS
MEANS THAT IF ENOUGH
VAPOR FROM THE
SPILL IS PRESENT, IT
COULD IGNITE.





BOILING POINT

A liquid's boiling point is the point at which the liquid will begin to turn into a gas by evaporating into the atmosphere at a pressure of 14.7 pounds per square inch (normal air pressure at sea level). The lower the boiling point is, the easier it is for the liquid to evaporate and the greater the fire risk. Boiling point is greatly affected by air pressure, meaning that at higher elevations, liquids boil faster at lower temperatures.

At higher altitudes, the liquid's boiling point is lower. That's why it takes longer to boil an egg in Denver, CO, than in Saginaw, MI.

VAPOR PRESSURE

It's important to understand vapor pressure for storing flammable liquids. Vapor pressure means the pressure generated by the vapor a liquid produces in a closed container. The higher the vapor pressure, the more likely the liquid is to evaporate and give off vapors. Vapor pressure rises as temperature rises. Note that liquids with high vapor density tend to pool near the floor or gather in low areas such as sumps, manholes, and trenches.



IF YOU CLEAN UP A SPILL OF FLAMMABLE LIQUID WITH SHOP RAGS AND PLACE THEM IN AN UNVENTED CONTAINER NEAR AN INCINERATOR, THE BUILDUP OF VAPOR PRESSURE MAY CAUSE THE CONTAINER TO BULGE AND POSSIBLY EXPLODE.



INCOMPATIBILITY

Workers should know if the chemicals they are using will react with each other. Reactions can result in explosions, fires, and deadly gases. Care should be taken to store incompatible materials away from each other and ensure that any spills of the chemicals cannot mix.

UPPER AND LOWER EXPLOSIVE RANGE

A mixture of flammable vapor and air can explode when exposed to an ignition source. The concentration at which the liquid's vapor in air is capable of burning is its flammability or "explosive" range.

This range is different for every chemical. It falls between a lower and upper explosive limit (LEL and UEL) and indicates the range between the highest and lowest concentrations of vapor in air that will ignite or explode. The wider the combustion range, the more likely the vapor is to ignite or explode.



AUTO-IGNITION TEMPERATURES

The auto-ignition temperature is the lowest temperature needed to ignite a gas or vapor in the air without a source of ignition being present.

AUTO IGNITION TEMPERATURES OF COMMONLY USED FLAMMABLE LIQUIDS

Acetaldehyde	365°F
Acetic acid	347°F
Acetone, propanone	869°F
Butane	761°F
Ethyl acetate	799°F
Gasoline	475-536°F
Isopropyl alcohol	750°F
Trichloroethylene	770-788°F



SAFE USE AND HANDLING OF FLAMMABLE LIQUIDS

All flammable liquids, whether in incidental storage or in protected storage, must be handled safely. This means storing flammable liquids in closed containers when not in use, promptly cleaning up any spills or leaks, and controlling sources of ignition in areas where flammable liquids are in use. You must also post warning signs and “No Smoking” signs.



COMMON SOURCES OF IGNITION:

- ▶ open flames
- ▶ lightning
- ▶ smoking
- ▶ cutting and welding
- ▶ hot surfaces
- ▶ frictional heat
- ▶ sparks (static, electrical, and mechanical)
- ▶ spontaneous ignition
- ▶ chemical and physicalchemical reactions
- ▶ radiant heat

Other safe storage fundamentals include identifying incompatible chemicals to ensure they are stored separately and paying attention to exits. Flammable liquids should not be stored near exits, stairways, or other walkways needed for people to exit the building. At 29 CFR 1910.37, OSHA says “Exit routes must be arranged so that employees will not have to travel toward a high hazard area, unless the path of travel is effectively shielded from the high hazard area by suitable partitions or other physical barriers.”

Waste products, such as oily rags, must be stored in closed metal containers and should be disposed of daily.

Storing flammable liquids near or under stairways, near elevators, or in exit routes could prevent or complicate workers from being able to safely use an exit route and use the stairway if the liquids caught fire. Usually, local fire and building codes also have limitations on storing flammable liquids near stairways.

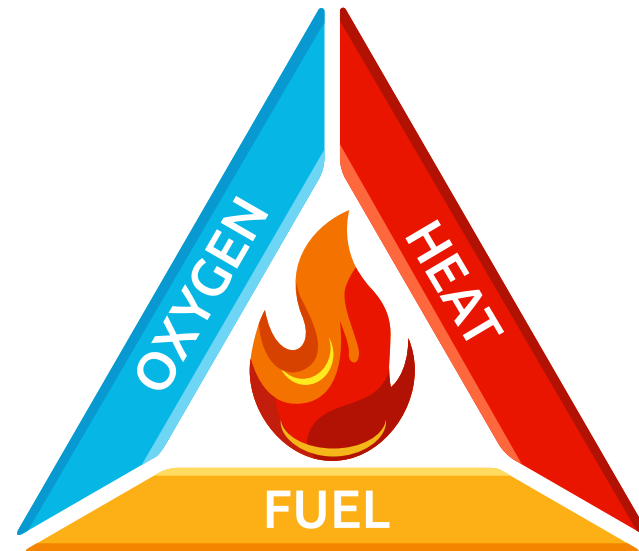




FIRE PREVENTION AND CONTROL

A fire needs three elements to burn: Oxygen, fuel, and heat. In some cases, a chemical chain reaction can also result in fire. With flammable liquids in the workplace, the first two elements are present - oxygen (the air) and fuel (the flammable liquid). All a fire needs to start is heat (an ignition source).

SOURCES OF IGNITION. Where flammable vapors may be present in the workplace, you must take precautions to prevent a fire by eliminating or controlling sources of ignition.



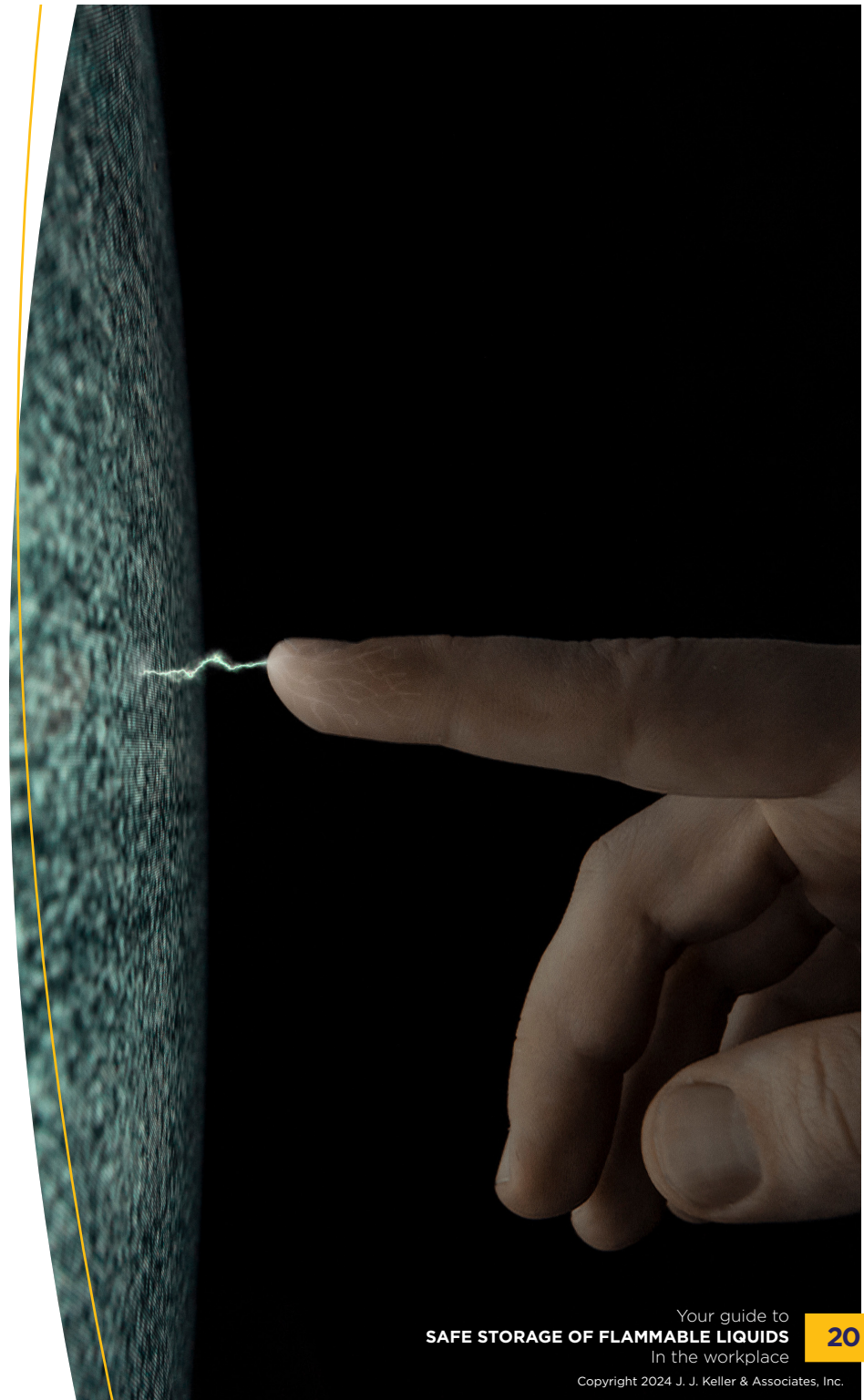
STATIC ELECTRICITY

Static electricity occurs when an electrical charge is generated from friction. When it comes from a load of laundry being removed from the dryer or from touching a metal object after walking across carpeting, static electricity is usually nothing more than bothersome. However, around flammable liquids in the workplace, static electricity can cause fires or explosions.

To prevent sparks from static electricity, OSHA requires containers of flammable liquids to be properly bonded and grounded during the transfer or pouring of liquids. In addition, NFPA 77 addresses the control of static electricity and its hazards.

OSHA requires containers to be bonded and grounded (29 CFR 1910.106(e)(6)(ii)) when transferring Category 1 and 2 flammable liquids or Category 3 flammable liquids with a flashpoint below 100°F. “Bonding” means physically connecting two conductive objects with a bond wire. The bond wire equalizes the static charge between the two objects.

Also, be sure to use equipment that is intrinsically safe or “spark-free” in areas where liquids are transferred.




BONDING

Bonding may include:

- ▶ **Use of a stranded or braided cable and clamp with hardened steel points.** The wire doesn't have to be large but has to be large enough for the mechanical fasteners to be attached. A clamp with hardened steel points will penetrate paint, rust, or other coating to contact the metal of the containers.
- ▶ **Use of a lance.** If the container is plastic, use a metal spigot and connect the wire to that. Then, you can place a metal lance or just the end of the wire placed into the container being filled. You could also pour through a metal screen attached to the original container.

Note that grounding or bonding just the metal cage on the plastic container will not completely prevent static discharge and ensure static equalization. Grounding or bonding ensures that the static electricity between the tote and line are equalized. For this to happen, there must be a metallic-to-metallic connection where the fluid is in contact with the metallic part, like a nozzle or grounded dip pipe.



For plastic containers, either a grounded dip pipe or a grounded wire should be in the container while transferring the flammable liquid. Another option is to bond the valve to equalize the static charge properly and prevent static discharge. Local suppliers are an excellent resource to help you acquire the grounded dip pipe or ground wire (no special equipment is necessary). Larger volume environments may need certain bonding facilities to reduce fire hazards properly. Again, always check your local fire codes.

GROUNDING

Grounding equalizes the static charge between the container of flammable liquid and the ground. To ground a container, it must be connected to earth by a ground wire. (Note that bonding only eliminates the difference in potential charge between objects. It does not eliminate the difference between the objects and the ground unless one of them is connected to the ground with a ground wire.)

Pouring flammable liquids can create static electricity. NFPA 30 calls for all metal parts on or near the place where flammable liquids are transferred to be grounded. And remember, static electricity generates more easily in cold, dry air.

Note: Many flammable cabinets come with a “grounding screw” as a convenience to the purchaser. You can connect the grounding screw to the building ground and use the cabinet-mounted ground-point as needed to ground individual containers from which liquids are dispensed.



APPROVED CONTAINERS

You should only use approved containers and portable tanks for flammable liquid storage. These are metal containers and portable tanks that meet the requirements of the Department of Transportation and/or a nationally recognized testing laboratory (NRTL). Portable tanks must also comply with OSHA's requirements for emergency venting.

“Safety cans,” specifically, are approved containers that hold five gallons of flammable liquid or less, having a spring-closing lid and spout cover that will relieve internal pressure when subjected to fire. Safety cans must be red, as required by 29 CFR 1910.144, and properly labeled under the Hazard Communication Standard.

A “portable tank” is a closed container that can hold 60 gallons or more of a liquid and is not intended for fixed installation.





INDOOR STORAGE OF FLAMMABLE LIQUIDS

Flammable liquids must be stored in:

- ▶ A flammable storage cabinet,
- ▶ An inside storage room or cut-off room, or
- ▶ A flammable storage warehouse.

STORAGE LIMITS

The amount of flammable liquid that may be stored in a particular area depends on the type of business and the location. Quantities are limited by the size of the room, its construction and fire resistance, and by its fire protection. Allowable quantities are given in total gallons per square foot of floor space.

For instance, flammable liquid storage is prohibited in office areas, except for maintenance or operating the building or equipment.



INCIDENTAL STORAGE

An exemption exists for “incidental storage” of flammable liquids for operations where “the use and handling of flammable liquids is only incidental to the principal business.” Examples of these operations include automobile assembly, construction of electronic equipment, and furniture manufacturing.

OSHA allows up to 25 gallons of Category 1 flammable liquid and 120 gallons of Category 2,3, or 4 flammable liquids in containers in any one fire area of a facility outside of protected storage. It also allows up to 660 gallons of a Category 2, 3, or 4 flammable liquid in a single portable tank. Note that your Fire Marshal or liability insurance carrier may not allow you to keep this much flammable liquid outside of a flammable storage cabinet or inside storage room

FLAMMABLE STORAGE CABINETS

In general, OSHA expects that all flammable liquids will be stored in a flammable storage cabinet, inside storage room, or flammable storage warehouse. Flammable storage cabinets can be metal or wood, and they are manufactured to limit the internal temperature of the cabinets to 325°F during a 10-minute fire test. During the test, the joints and seams must stay tight and the doors must remain closed.

The door must have a three-point lock and the sill must be raised at least 2 inches above the bottom of the cabinet.

The amount of flammable liquids that may be stored in any one flammable cabinet is no more than 60 gallons of Category 1, 2, or 3 liquids or 120 gallons of Category 4 liquids. You can store a mixture of Category 1, 2, and 3 flammable liquids in one cabinet, but the amounts may not be more than 60 gallons total.

Flammable cabinets must be labeled, “Flammable - Keep Fire Away.”

Note that OSHA doesn't require flammable cabinets to be grounded, but NFPA 77 does. In addition, your local fire code or insurance company may require you to ground flammable storage cabinets.



Good housekeeping is important around flammable cabinets. OSHA's housekeeping regulation at 29 CFR 1910.22 requires you to keep the workplace "clean and orderly," which includes removing combustibles and combustible residues from around storage cabinets. In addition, NFPA 30 prohibits storage of combustible materials on or near the cabinet. However, you can keep a flammable liquid in its original packaging or shipping box inside the cabinet.

Flammable cabinets are sometimes sold with "vent holes." These holes should not be opened unless the cabinet will be vented directly to the outside per NFPA 30.

In a 2011 letter of interpretation, OSHA answered a common question on the intermingling of flammable and combustible liquids in a storage cabinet. The agency says it is perfectly fine to store both flammable and combustible liquids in a storage cabinet as long as not more than 120 gallons of flammable and combustible liquids are stored in a single cabinet.



INSIDE STORAGE ROOMS

Inside storage rooms must meet the requirements of 29 CFR 1910.106, which include self-closing fire doors, liquid-tight floor joints, and raised ramps or sills (or the floor needs to be at least four inches lower than the surrounding floor).

OSHA has defined areas in indoor storage rooms where flammable vapors may be expected as Class 1 areas. Class 1 areas are further classified as Division 1 or Division 2 areas.

A DIVISION 1 AREA IS A LOCATION WHERE:

- ▶ Ignitable mixtures are normal and frequent, and
- ▶ Gases, vapors, and flammable liquids are present and below grade, or the ventilation is inadequate.

DIVISION 2 AREAS ARE LOCATIONS THAT ARE:

- ▶ Next to and open to a Division 1 location, or
- ▶ Places where gases, vapors, and fumes may collect and a failure of the ventilations system could allow an ignitable mixture.



STORAGE INSIDE ROOMS – TABLE H-13

Fire Protection (1) Provided	Fire Resistance	Maximum Size	Total Allowable Quantities - (gals./sq. ft./ floor area)
Yes	2 Hours	500 Sq. Ft.	10
No	2 Hours	500 Sq. Ft.	5
Yes	1 Hour	150 Sq. Ft.	4
No	1 Hour	150 Sq. Ft.	2

Footnote (1) Fire protection system shall be sprinkler, water spray, carbon dioxide, or other system.

OSHA continues to reference older NFPA standards. However, the agency also accepts later editions of consensus standards, which may not perfectly match the listings in this table.

Source: OSHA



ELECTRICAL WIRING: Electrical wiring in an indoor storage room has to meet OSHA specifications in the electrical standard for use around flammable liquids.



AISLES: Every inside storage room must have an aisle at least 3 feet wide to allow easy movement in the room. The aisle space also reduces the potential for damaging containers and spilling their contents and provides an easy way out of or into the room in an emergency.



STACKING: Containers of 30 gallons or more may not be stacked on top of one another in indoor storage rooms.



STORAGE AMOUNTS: Table H-13 in the standard lists the total allowable quantities in an inside storage room. Allowable quantities are based on the amount of fire protection the room provides.



VENTILATION: Ventilation in inside storage rooms must be able to remove or reduce vapor build up to prevent an explosive atmosphere from developing. OSHA requires every inside storage room to provide for a complete change of air within the room at least six times per hour. This air exchange can be accomplished by either a gravity or mechanical exhaust ventilation system.

Finally, you cannot store materials that react with water in the same room with flammable liquids, especially if the area is protected by a sprinkler system or a water spray system.



WAREHOUSE OR STORAGE BUILDINGS

OSHA allows almost any quantity of flammable liquid storage in “warehouses or storage buildings.” Containers in piles must be separated by pallets or dunnage to provide stability and to prevent excessive stress on container walls. The agency doesn’t define “piles,” but the general understanding is a pile is a group or assemblage of containers.

You must keep these piles at least 3 feet away from beams, girders, sprinklers or other fire protection equipment.



OUTSIDE STORAGE

Make sure that areas where flammable liquids are being used or stored have adequate fire controls such as working hoses, portable fire extinguishers, and other fire control devices. It's important to have the correct type of fire extinguisher for the type of flammable liquid being stored. Fires involving some types of materials cannot be extinguished by using water or carbon dioxide. If you expect employees to use fire extinguishers, they must be trained on the proper use of each type of extinguishers they may use.

OSHA requires at least one portable fire extinguisher with a rating of not less than 12-B units to be placed:

1. Outside of indoor storage rooms, but not more than 10 feet from the door to the storage room.
2. Not less than 10 feet and not more than 25 feet from and Category 1, 2, or 3 flammable liquid storage area inside a building.

OSHA says the reason for the distance requirement is because fires involving flammable liquids are likely to escalate rapidly. If the extinguisher is located too closely to the storage area, it may be impossible to reach it if a fire starts.

You can keep up to 1,100 gallons of flammable liquids next to building located on the same premises as long as you keep at least 10 feet of space between buildings and the nearest container of flammable liquid.





The storage area must be sloped or graded to keep spills from reaching buildings or you can install a curb at least 6 inches high. If you use a curb, keep in mind that you may have to empty the area after a rainfall. You should also have a plan to safely remove any spills from the containment area.

Be sure the area is protected from trespassers and ne'er-do-wells. You don't want anyone tampering with the containers. Also, keep the storage area free from weeds, debris, and other combustible materials.

Storage in trailers

One common scenario is storing flammables such as propane cylinders in outside trailers. OSHA doesn't have a specific rule prohibiting the storage of propane cylinders in trailers, but the real possibility of fires must be considered. If the temperature in the trailer rises to high enough levels, the propane in the cylinders can expand, causing a release from the safety release valve. In adequate concentrations, a flammable atmosphere could build up and ignite. To prevent this, many employers leave one of the trailer doors open if it's in a secured area or use vented trailers in these cases.

Whether you're storing flammable liquids indoors in cabinets or inside storage rooms, or if you store them outdoors, you must follow industry consensus standards, OSHA's requirements, and your local fire and building codes to protect your workers and your property from the very real possibility of fires.

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