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Flammable Liquids

Many flammable liquids are commonly used in the work environment. These include things like paints and paint thinners, fuel, cleaning solvents and degreasers as well as specific chemicals that may be used in a manufacturing process. Proper handling and storage of flammable liquids is essential to prevent fires and explosions causing property damage and worker injury.

The first place to start when evaluating the risk of using potentially flammable liquids is the container labels and SDSs (Safety Data Sheets). The container label will provide immediate information with the flame pictogram as well as signal words, hazard statements and precautionary statements.

The GHS (Global Harmonized System) definitions are now used on labels and in SDSs. There are four categories of flammable and combustible liquids under GHS.

Category 1 Flammable Liquids have a flash point <73˚F (23˚C) and initial boiling point ≤95˚F (35˚C). Labels contain the "Danger" signal word and the hazard statement "Extremely flammable liquid and vapor".

Category 2 Flammable Liquids have a flash point <73˚F (23˚C) and initial boiling point >95˚F (35˚C). Labels contain the "Danger" signal word and the hazard statement "Highly flammable liquid and vapor".

Category 3 Flammable Liquids have a flash point ≥73˚F (23˚C) and ≤140˚F (60.5˚C). Labels contain the "Warning" signal word and the hazard statement "Flammable liquid and vapor".

Category 4 Liquids are defined as Combustible and have no pictogram. They have a flash point >140˚F (60.5˚C) and ≤199.4˚F (93˚C). Labels contain the "Warning" signal word and the hazard statement "Combustible liquid".

It should be noted that these definitions of flammable and combustible liquids differ from the NFPA (National Fire Protection Association) 30- Flammable and Combustible Liquids Code.

Section 2 of the SDS will contain the same classifications, pictogram signal words, hazard statements and precautionary statements as found on the label. Additionally, critical information pertaining to the flammability of the material is found in Section 9- Physical and Chemical Properties. Important information to review in Section 9 includes:

- Initial boiling point and boiling range
- Flash point
- Evaporation rate
- Upper/lower flammability or explosive limits
- Vapor pressure
- Vapor density
- Auto-ignition temperature

The flash point is the lowest temperature at which a mixture of the material with air above the surface will ignite in the presence of an ignition source. The lower the flash point, the greater the risk of fire.

The upper and lower flammability or explosive limits are the range of concentrations of the liquid as a volume percent in air that are flammable. Each chemical has a different range of flammability limits. For example gasoline has limits between 1.4% and 7.6% as volume percent in air while ethyl alcohol's limits are 3.3% to 19%. When the

concentration is below the lower flammability limit, the mixture is too lean and won't ignite. When the concentration is above the upper flammability limit, the mixture is too rich and won't ignite as well. Flammability limits are dependent on temperature, pressure, humidity and are usually reported at 25° C. Flammability limits are an important consideration when working in confined spaces or inside vessels and containers where flammables are stored. Explosive gas meters should be used in these situations to evaluate the risk for fire and explosion and ensure flammable gas levels are below the lower flammability limit.

The vapor pressure is the pressure exerted by a saturated vapor above the surface of the liquid in a closed container. This is tied to the evaporation rate of the liquid which is dependent on temperature. Vapor pressure is usually expressed at 68°F (room temperature). The higher the vapor pressure, the more volatile the liquid and the higher the risk that vapors from the liquid will pose a fire hazard.

Vapor density is a measure of the weight of the vapors from the liquid as compared to the weight of an equal volume of air. Air is given a density of "1" so any chemical with a vapor density greater than 1 can settle near the floor and in low spaces posing a risk that the vapors may travel along the ground or floor to an ignition source.

The auto-ignition temperature is the minimum temperature at which a substance will ignite in air when there is no ignition source. The lower the auto-ignition temperature, the higher the risk for fire and explosion.

Other sections of the SDSs provide addition information relevant to the storage and handling of flammable liquids. Section 5 gives information about firefighting measures and suitable extinguishing agents and Section 7 provides information on proper storage.

Flammable Liquid Storage

Flammable liquids need to be stored properly to ensure they do not come in contact with ignition sources. Flammable liquids should be kept to a minimum in work areas and should not exceed a one day supply or 25 gallons of Category 1 flammables, 120 gallons of Category 2, 3 or 4 flammables or 660 gallons of Category 2, 3 or 4 flammable liquids in a single portable tank. If there are more than these quantities of flammable liquids, they should be stored in flammable storage cabinets.

These cabinets are designed to protect the contents and prevent them from contributing to the fire load until help can arrive to extinguish the fire. Flammable storage cabinets can vary in size but no more than 60 gallons of Category 1, 2 or 3 flammable liquids or 120 gallons of Category 4 liquids can be stored in a single cabinet. Cabinets should be made of metal of at least 18-gauge steel and be UL (Underwriters Laboratories) listed or FM (Factory Mutual) approved. Up to three approved cabinets can be present in a single fire area but the area must be protected by a properly designed sprinkler system. For large quantities of flammable liquids dedicated flammable storage rooms are required.

Where possible, larger quantities of flammable liquids should be stored in outside storage buildings to reduce the fire hazard to the rest of the facility. If stored in the main facility, properly designed inside storage areas are required to protect flammable liquids from ignition sources and help isolate the contents in the event of a fire. These rooms should be above grade and not immediately above a cellar or basement where vapors could accumulate. They should also be along an exterior wall. Inside storage rooms should meet the requirements of NFPA 30 and NFPA 251. Requirements include:

- Door openings should have raised sills of at least 4 in.
- Doors should be self-closing
- The room should be liquid tight at the wall/floor joint
- Electric wiring should be Class I Division 2 approved
- The room should have continuous mechanical ventilation
- Exhaust and inlet air should be on opposite sides of the room within 12 inches of the floor
- Exhaust should be vented outside the building and provide at least 6 air exchanges per hour
- Storage containers over 30 gallons should not be stacked on top of each other
- A three foot wide aisle should be maintained.

The amount of flammable liquid that can be stored in the room depends on whether there is a sprinkler system in place and fire resistance of the room.

If the room has a fire rating of 2 hours and is sprinklered, the maximum size of the room is 500 ft^2 and up to 10 gallons/ft^2 can be stored in the room.

If the room has a fire rating of 2 hours and is not sprinklered, the maximum size of the room is 500 ft^2 and up to 5 gallons/ft^2 can be stored in the room.

If the room has a fire rating of 1 hour and is sprinklered, the maximum size of the room is 150 ft^2 and up to 4 gallons/ft^2 can be stored in the room.

If the room has a fire rating of 1 hour and is not sprinklered, the maximum size of the room is 150 ft^2 and up to 2 gallons/ft^2 can be stored in the room.

Flammable Liquid Storage Containers

Flammable liquids in general use need to be protected from ignition sources and during a fire prevented from feeding the fire. Safety containers are specifically designed to provide this protection and should be FM or UL approved. Cans should be less than 5 gallon in size and have a spring-loaded, self-closing lid and spout cover so the container cannot be accidently left open. The containers are designed with a pressure relief device to prevent them from exploding when heated. They also have spark arrestors to prevent a fire from flashing back into the container.

There are a wide variety of safety cans. Plunger cans are used to dispense small amounts of solvent from the can onto a pan to moisten cleaning cloths. Other cans have small baskets to hold parts in the can for cleaning.

Bonding and Grounding

Most flammable liquids must be transferred from the shipping container to a smaller container for use at a workstation. Movement of liquids through piping or hoses or during pouring from one container to another can create electrostatic charges. If these charges are not controlled, they can build up to the point that they can create a spark. This spark can ignite the vapors of the flammable liquid causing a fire. Bonding and grounding is the term used to describe the process of controlling these electrostatic charges. Bonding is the process of connecting the two containers together with a conductive cable so that they are at the same static voltage. Grounding is the process of connecting a drum, tank or container to a ground-to-earth by means of connecting a conductive cable from the container to a grounded water pipe or stake leading to ground. Electrical wire should be substantial enough to carry the current and withstand manipulation. Clamps or clips on the ends of the wires make it convenient to bond containers. A permanent connection should be made to the earth end of the ground cable.

Control of ignition sources around flammable liquids is also important. Smoking should be prohibited and other ignition sources should also be controlled. These include open flames, welding operations, heating and electrical equipment. Other general safety precautions include:

- Store flammables away from incompatibles such as oxidizers.
- Work with flammables in well-ventilated area. Use hoods, fans and local exhaust systems as applicable.
- Make sure all containers are properly labeled to meet HAZCOM requirements.
- Keep fire extinguishers- carbon dioxide, halon or dry powder in in the areas where flammable liquids are used. Never use water to extinguish flammable liquid fires.

Waste disposal is an important consideration in the control of flammable hazards. Rags soaked with flammable liquids can undergo spontaneous combustion. This occurs when a chemical reaction generates enough heat to cause a fire. Rags should be disposed in self closing disposal containers. Contents of the containers should be disposed of on a daily basis.

Glove Selection

Gloves are probably the most commonly used piece of personal protective equipment after safety glasses. Selecting the right gloves for the hazards associated with a particular job is critical to a company's personal protective equipment program and is not as simple as it may appear.

Gloves provide hand protection by minimizing contact with physical and chemical agents. Physical agents include:

- Heat/cold
- Cuts/abrasions/punctures
- Electrical hazards

Gloves can also be used to provide better grip when handling certain objects.

One of the major uses of gloves is to provide protection form chemical agents. No single type of chemical resistant glove can be used for all applications. A thorough hazard evaluation must be made when choosing the right glove for a particular application. Things to consider when conducting the hazard analysis include:

- The type of chemicals
- Frequency and duration of chemical contact
- Nature of contact- incidental or immersion
- Concentration of the chemical
- Temperature of the chemical
- Grip requirements
- Length of gloves to protect arms
- Dexterity requirements
- Cuff edge- safety cuff or gauntlet
- Glove strength (abrasion, tearing, cut resistance)
- Price

Three factors are critical to glove effectiveness. These are degradation, permeation and breakthrough time. Degradation occurs when chemicals affect the physical characteristics of the glove. These include shrinkage, stiffening, softening or cracking of the glove surface. Often discoloration is a sign of degradation. Permeation is a measure of the speed that a chemical penetrates through the glove. Permeation is different from penetration. Penetration occurs through pin holes, seams and other imperfections. Permeation is a measurement of the movement of a chemical through intact gloves. Chemical resistant gloves are made from different polymers and movement of a particular chemical depends on the type of polymer. Permeation rates depend on:

- Chemical properties
- Chemical concentrations
- Chemical state (solid, liquid, gas)
- Thickness of the glove
- Temperature
- Humidity

Once exposed to a chemical, permeation continues even when the chemical is removed. Breakthrough time is the elapsed time between initial contact of a chemical on the outside of a glove and first detection of the chemical on the inside surface. Manufacturers test glove polymers and measure permeation rates and breakthrough times. This data is provided by glove manufacturers in charts and tables listing names of chemicals with permeation rates and breakthrough times. This data should be reviewed during the hazard analysis when selecting gloves for a particular application. Some common glove polymers are:

- Natural rubber
- Neoprene
- Nitrile
- Butyl rubber
- Polyvinyl chloride (PVC)
- Polyvinyl alcohol (PVA)

It should be noted that latex is another glove material but it provides little or no chemical protection and should not be used when working with chemicals.

All chemicals pass through protective gloves sooner or later so gloves need to be replaced often based upon the permeation rates, breakthrough times and characteristic of the chemicals is use. Different types of gloves may also look alike so employees need to make sure they are using the right glove for a particular application. No single type of glove is an absolute barrier to all chemicals. An employee may need to use many different types of gloves to perform their job. Proper training and supervision in the use of gloves is an important part of the glove safety program. Different departments or operations may need different types of gloves. Employees also come in different sizes so a variety of sizes need to be available for employees.

All gloves should be inspected before and after use as well as periodically during use. Look for signs of pin holes, punctures and signs of degradation. Damaged or defective gloves should be replaced immediately. Disposable type gloves should be changed frequently and not be reused. The outsides of reusable gloves should be washed with soap and water before removal. Gloves should be allowed to dry in a cool dry place away from chemicals. Employees should always wash their hands with soap and water after removing gloves.

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