FLAMMABLE AND COMBUSTIBLE LIQUIDS

- OSHA Changes
Introduction

- This module covers the two primary hazards associated with flammable and combustible liquids: explosion and fire.

- In order to prevent these hazards, this module and the standard upon which it is based (29 CFR 1910.106) address the primary concerns of design and construction, ventilation, ignition sources, and storage.
The Occupational Safety and Health Administration's (OSHA) Standard - 29 CFR 1910.106 applies to the handling, storage, and use of flammable and combustible liquids with a flash point below 200°F.

The two primary hazards associated with flammable and combustible liquids are explosion and fire.
The primary basis for Flammable and Combustible Liquids is the National Fire Protection Association's publication NFPA 30, "Flammable and Combustible Liquids Code."

29 CFR 1910.106 has changed and widened the definition of flammable liquids to four hazard categories, differing with the standard definition in NFPA 30.
1910.106 Flammable liquid

- Flammable liquid means any liquid having a flashpoint at or below 199.4 °F (93 °C). Flammable liquids are divided into four categories as follows:

1910.106(a)(19)
1910.106 Flammable liquid
Category 1

- 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).
1910.106 Flammable liquid
Category 4

- 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).
When vapors of a flammable or combustible liquid are mixed with air in the proper proportions in the presence of a source of ignition, rapid combustion or an explosion can occur.

The proper proportion is called the flammable range and is also often referred to as the explosive range.

The flammable range includes all concentrations of flammable vapor or gas in air, in which a flash will occur or a flame will travel if the mixture is ignited.
Flammable Limits

- There is a minimum concentration of vapor or gas in air below which propagation of flame does not occur on contact with a source of ignition.
- There is also a maximum proportion of vapor in air above which propagation of flame does not occur.
- These boundary-line mixtures of vapor with air are known as the lower and upper flammable or explosive limits (LEL or UEL) respectively, and they are usually expressed in terms of percentage by volume of vapor in air.
In popular jargon, a vapor/air mixture below the flammable limit is too "lean" to burn or explode, and a mixture above the upper flammable limit is too "rich" to burn or explode.

No attempt is made to differentiate between the terms flammable and explosive as applied to the lower and upper limits of flammability.
This section applies to flammable or combustible liquid storage in drums or other containers (including flammable aerosols) that do not exceed 60 gallons individual capacity. It also applies to portable tanks with less than 660 gallons capacity.

Portable tanks are closed containers of at least 60 gallons capacity.

The six topic areas covered in this module are listed to the left.
Only approved containers and portable tanks shall be used.

Metal containers and portable tanks meeting the requirements of and containing products authorized by chapter I, title 49 of the Code of Federal Regulations, shall be deemed to be acceptable.
<table>
<thead>
<tr>
<th>Container type</th>
<th>Category 1</th>
<th>Category 2</th>
<th>Category 3</th>
<th>Category 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glass or approved plastic</td>
<td>1 pt</td>
<td>1 qt</td>
<td>1 gal</td>
<td>1 gal.</td>
</tr>
<tr>
<td>Metal (other than DOT drums)</td>
<td>1 gal</td>
<td>5 gal</td>
<td>5 gal</td>
<td>5 gal.</td>
</tr>
<tr>
<td>Safety cans</td>
<td>2 gal</td>
<td>5 gal</td>
<td>5 gal</td>
<td>5 gal.</td>
</tr>
<tr>
<td>Metal drums (DOT specifications)</td>
<td>60 gal</td>
<td>60 gal</td>
<td>60 gal</td>
<td>60 gal.</td>
</tr>
<tr>
<td>Approved portable tanks</td>
<td>660 gal</td>
<td>660 gal</td>
<td>660 gal</td>
<td>660 gal.</td>
</tr>
</tbody>
</table>
Container Design, Construction, and Capacity

- 29 CFR 1910.106 also requires portable tanks to have provision for emergency venting.
- Top-mounted emergency vents must be capable of limiting internal pressure under fire exposure conditions to 10 psig or 30% of the bursting pressure of the tank, whichever is greater.

- Portable tanks are also required to have at least one pressure-activated vent with a minimum capacity of 6,000 cubic feet of free air at 14.7 psia and 60°F. These vents must be set to open at not less than 5 psig. If fusible vents are used, they shall be actuated by elements that operate at a temperature not exceeding 300°F.
Container Design, Construction, and Capacity

- A portable tank is not intended for fixed installations.
- Maximum allowable sizes of various types of containers and portable tanks are specified based on the class of flammable and combustible liquid they contain.
Storage Cabinet Design, Construction, and Capacity

- Regardless of the type of container, no more than 60 gallons of Class I and/or Class II liquids or no more than 120 gallons of Class III liquids may be stored in an individual wooden or metal cabinet.

- Storage cabinets shall be designed and constructed to limit the internal temperature to not more than 325°F when subjected to a standardized 10-minute fire test. All joints and seams shall remain tight and the door shall remain securely closed during the fire test. Storage cabinets shall be conspicuously labeled, "Flammable - Keep Fire Away."
Storage Cabinet Design, Construction, and Capacity

- The top, bottom, sides, and door of metal cabinets shall be at least No. 18 gauge sheet metal and double walled with 1½-inch air space.

- The door shall be provided with a three-point lock, and the door sill shall be raised at least 2 inches above the bottom of the cabinet.
Inside Storage Room Design and Construction

- Storage rooms serve the same purpose as storage cabinets, but can be much larger. Inside storage rooms have a variety of requirements which must be followed.

- An inside storage room must be designed and constructed so that it complies with the test specifications included in NFPA 251-1969, "Standard Methods of Fire Tests of Building Construction and Materials".
Inside Storage Room Design and Construction

- The inside storage room must meet requirements for:
  - Construction
  - Wiring
  - Ventilation
  - Rating and capacity
  - Storage.
Inside Storage Room Design and Construction

- Inside storage rooms must be constructed so that openings to other rooms or buildings shall be provided with non-combustible, liquid-tight, raised sills or ramps at least 4 inches in height, or the floor in the storage area shall be at least 4 inches below the surrounding floor. They will also be provided with approved self-closing fire doors.

- The room shall be liquid-tight where the walls join the floor.
Inside Storage Room Design and Construction

- A permissible alternative to the sill or ramp is an open-grated trench inside of the room which drains to a safe location. This method may be preferred if there is an extensive need to transfer flammable liquids into and out of the room by means of hand trucks.
Inside Storage Room Design and Construction

- Electrical wiring and equipment located in inside storage rooms used for Class I liquids shall be approved under Subpart S, Electrical, for Class I, Division 2 Hazardous Locations. Class II and Class III liquids shall be approved for general use.

- In addition to the wiring requirements there are also very important ventilation requirements.

- Every inside storage room shall be provided with either a gravity or a mechanical exhaust ventilation system designed to provide for a complete change of air at least six times per hour.
Ventilation is vital to the prevention of flammable liquid fires and explosions. It is important to ensure that air flow through the system is constant and prevents the accumulation of any flammable vapors.

Fire protection systems shall be provided by a sprinkler, water spray, carbon dioxide, or other system.
Inside Storage Room Design and Construction

- Inside storage rooms shall comply with the following rating and capacity requirements.
Inside Storage Room Design and Construction

- In every inside storage room that is used to store flammable and combustible liquids, an aisle at least 3 feet wide must be maintained.

- Easy movement within the room is necessary in order to reduce the potential for spilling or damaging the containers and to provide both access for fire fighting and a ready escape path for occupants.
Inside Storage Room Design and Construction

- Containers over 30 gallons capacity shall not be stacked one upon the other. Such containers are built to DOT specifications and are not required to withstand a drop test greater than 3 feet when full.

- Dispensing shall be only by approved pump or self-closing faucet.
Storage Inside Buildings

- There are specific requirements concerning storage of flammable and combustible liquids inside certain building types.

- Regardless of the building type, flammable or combustible liquids, including stock for sale, shall not be stored so as to limit use of exits, stairways, or areas normally used for the safe egress of people.
Storage Inside Buildings

- Click on the terms below to learn more about the requirements

  - General Purpose Public Warehouses
  - Office Occupancy
  - Warehouses or Storage Buildings
General Purpose Public Warehouses

- There are tables in the OSHA Standard summarizing the storage requirements for general purpose public warehouses.

- These tables refer to indoor storage of flammable and combustible liquids which are confined in containers and portable tanks.

- Storage of incompatible materials that create a fire exposure (e.g., oxidizers, water-reactive chemicals, certain acids and other chemicals) is not permitted.
Office Occupancy

- If the building is used for office occupancy, flammables used only for maintenance or operation of equipment can be stored in the building.

- Flammables shall be stored in closed metal containers stored in a storage cabinet, in safety cans, or in an inside storage room not having a door that opens into that portion of the building used by the public.
Warehouses or Storage Buildings

- Warehouses or storage buildings are sometimes referred to as outside storage rooms. Practically any quantity of flammable and combustible liquid can be stored in these buildings provided that they are stored in a configuration consistent with the tables in the OSHA Standard.

- Containers in piles shall be separated by pallets or dunnage where necessary to provide stability and to prevent excessive stress on container walls.

- Stored material shall not be piled within 3 feet of beams or girders and shall be at least 3 feet below sprinkler deflectors or discharge orifices of water spray, or other fire protection equipment.

- Aisles to access doors, windows or standpipe connections
Storage Outside Buildings

- Sometimes storage occurs outside of a building. Requirements covering "storage outside buildings" are summarized within tables in 1910.106.

- Associated requirements are given for storage adjacent to buildings. Also included are requirements involving controls for diversion of spills away from buildings and security measures for protection against trespassing and tampering.

- Certain housekeeping requirements are given which relate to control of weeds, debris, and accumulation of unnecessary combustibles.
Suitable fire control devices, such as small hoses or portable fire extinguishers, shall be available at locations where flammable or combustible liquids are stored.

At least one portable fire extinguisher having a rating of not less than 12-B shall be located:

- Outside of, but not more than 10 feet from, the door opening into any room used for storage.
- Not less than 10 feet, nor more than 25 feet, from any Class I or Class II liquid storage area located outside of a storage room but inside a building.
Fire Control

- Portable fire extinguishers must be located a minimum distance away from the storage room because fires involving Class I and Class II flammable liquids are likely to escalate rapidly. If the fire is too close to the storage area, it may be impossible to get to it once the fire has started.
Fire Control

- Open flames and smoking shall not be permitted in flammable or combustible liquid storage areas.

- Materials which react with water shall not be stored in the same room with flammable or combustible liquids.

- Many flammable and combustible liquid storage areas are protected by automatic sprinklers or water spray systems and hose lines.

- Consequently, any storage of water-reactive material in the storage area creates an unreasonable risk.
Incidental Flammable or Combustible Liquid Storage or Use

- In industrial plants where the use of flammable or combustible liquids is only incidental, flammable liquids shall be stored in tanks or closed containers.

- Sometimes flammable liquids may be stored inside a building either outside a storage cabinet or an inside storage room, or in any one fire area of a building.

- In these cases the amounts shall not exceed:
  - 25 gallons of Class IA liquids in containers
  - 20 gallons of Class IB, Class IC, Class II, or Class III liquids in containers
  - 660 gallons of Class IB, Class IC, Class II, or Class III liquids in a single portable tank.
Incidental Flammable or Combustible Liquid Storage or Use

- Incidental flammable and combustible liquids shall be stored in covered containers when not in use. When they are used or handled, leakage or spills shall be disposed of promptly and safely, except when the liquid is in a closed container.

- Flammable or combustible liquids shall be drawn from or transferred into vessels, containers, or portable tanks within a building only in the following manner:
  - Through a closed piping system
  - From safety cans
  - By means of a device drawing through the top
  - From containers or portable tanks by gravity through an approved self-closing valve.
Incidental Flammable or Combustible Liquid Storage or Use

- Transfer operations must be provided with adequate ventilation.

- Sources of ignition are not permitted in areas where flammable vapors may travel.

- Transferring liquids by means of air pressure in a container or portable tank is prohibited. This may result in overpressure which could exceed what the container or tank could withstand. In addition, a flammable atmosphere could be created within the container or tank that is more sensitive to ignition due to the pressure.
Tank vehicle and tank car loading or unloading facilities shall be separated from above-ground tanks, warehouses, and other similar facilities.

The separation distance varies depending on the class of liquid.

The tank vehicle and tank car must be separated by a distance of 25 feet for Class I liquids and 15 feet for Class II and Class III liquids measured from the nearest position of any fill stem.
Fire Control

- 29 CFR 1910.106 requires that hazards be evaluated and that the appropriate fire protection be provided.

- The evaluation must consider:
  - The hazards of the operation
  - The various materials used
Fire Control

- The design of the plant and equipment
- Materials handling and transfer requirements
- Any unusual conditions
- The available fire protection sprinkler systems
- Other types of protective systems that may be necessary to protect employees.
Sources of Ignition

- During the evaluation process, all sources of ignition should be identified.

- Adequate precautions shall be taken to prevent the ignition of flammable vapors. Click on the term below for a list of ignition sources.

  - Ignition Sources
Sources of Ignition

- Remember, control of ignition sources is the second line of defense.
- Many ignition sources will not be an issue if spills and leaks are prevented.
- Finally, Class I liquids shall not be dispensed into containers unless the nozzle and container are electrically interconnected.
- This will prevent static electricity from providing a source of ignition.
Locations where flammable vapor-air mixtures may exist under abnormal conditions and for a distance beyond Division 1 locations, are classified as Division 2 by Subpart S, Electrical.

These locations include an area within:
- 20 feet horizontally beyond a Division 1 area
- 3 feet vertically beyond a Division 1 area
- 3 feet above floor or grade level within 25 feet indoors or within 10 feet if outdoors, from any pump, bleeder, withdrawal fitting, meter, or similar device handling Class I liquids.
Electrical

- Click on the terms for more information about the requirements in these operations.
  - Class I, Division 1
  - Class I, Division 2
Repairs to Equipment and Housekeeping

- Hot work, such as welding or cutting operations, use of spark-producing power tools, and chipping operations shall be permitted only under supervision of an individual who is responsible for the operation.

- Maintenance and operating practices shall follow established procedures that control leakage and prevent accidental escape of flammable or combustible liquids.
Repairs to Equipment and Housekeeping

- Spills shall be cleaned up promptly.

- Combustible waste material and residues in a building or unit operating area shall be:
  - Kept to a minimum
  - Stored in covered metal receptacles
  - Disposed of daily
Bulk Plants - Introduction

- Bulk plants are considered to be a different category from industrial plants. However, the similar topics must be considered.
- The six topics of the Bulk Plant section are listed to the left.
- Because of the potential dangers of storing, handling, and using flammable and combustible liquids, each of these sections focuses on preventing fires or explosions.
Storage and Buildings

- All flammable and combustible liquid hazard classes shall be stored in closed containers, in storage tanks above ground outside of buildings, or underground in accordance with the requirements of the Bulk Plants section, in 1910.106.

- Rooms in which flammable or combustible liquids are stored or handled by pumps shall have exit facilities arranged to prevent occupants from being trapped in the event of fire.
Storage and Buildings

- Rooms in which Class I liquids are stored or handled shall be heated only by means not constituting a source of ignition, such as steam or hot water.
- Adequate ventilation shall be provided for all rooms, buildings, and enclosures in which Class I liquids are pumped or dispensed.
Tank vehicle and tank car loading or unloading facilities shall be separated by minimum distances from above-ground tanks, warehouses, and similar facilities. These distances are measured from the nearest position of any fill spout.

The required distances are listed here:

- Class I loading and unloading facilities must be separated by a distance of 25 feet
- Class II and III unloading and loading facilities must be separated by a distance of 15 feet.
Loading and Unloading Facilities

- Buildings for pumps or personnel shelters may be considered as a part of the loading and unloading facilities.

- Equipment such as piping, pumps, and meters used for the transfer of Class I liquids between storage tanks and the fill stem of the loading rack shall not be used for the transfer of Class II or Class III liquids.
Loading and Unloading Facilities

- Bonding is a technique that protects against static sparks during the loading of tank vehicles through open domes. Bonding should be provided when:
  - Class I liquids are loaded
  - Class II or Class III liquids are loaded into vehicles which may contain vapors from previous cargoes of Class I liquids.

- The OSHA Standard requires appropriate bonding equipment and procedures. Facilities for materials that do not have a static electricity hazard are not required to be bonded.

- Class I liquids shall not be dispensed into containers unless the nozzle and container are electrically interconnected.
Electrical Equipment

- The Electrical Equipment subparagraph of 1910.106 applies to areas where Class I liquids are stored or handled.
- This subsection includes a table which provides a classification of electrical equipment hazardous areas.
- For areas where only Class II or Class III liquids are stored or handled, the electrical equipment may be installed in accordance with requirements for ordinary (non-hazardous) locations.
Sources of Ignition and Fire Control

- Electrical equipment and static electricity are not the only sources of ignition. If flammable vapors can reach any source of ignition, Class I liquids shall not be handled, drawn, or dispensed.

- Smoking shall be prohibited except in designated locations. "No Smoking" signs shall be conspicuously posted where a hazard from flammable liquid vapors is normally present.
Sources of Ignition and Fire Control

- Suitable fire-control devices, such as small hoses or portable fire extinguishers, shall be available to locations where fires are likely to occur.
Drainage and Waste Disposal

- At loading or unloading points, provisions also shall be made to prevent spilled flammable or combustible liquids from entering public sewers and drainage systems, or natural waterways.

- Connection to such sewers, drains, or waterways by which flammable or combustible liquids might enter shall be provided with separator boxes or other approved means whereby such entry is precluded.

- Draining of crankcases and flammable or combustible liquids shall not be dumped into sewers, but shall be stored in tanks or tight drums outside of any building until removed from the premises.
The storage of flammable or combustible liquids in tanks shall be in accordance with the provisions of the Processing Plants section of 1910.106. Piping must be identified and meet safety requirements.

The transfer of large quantities of flammable or combustible liquids shall be through piping by means of pumps or water displacement. Except as required in processing equipment, gravity flow shall not be used.
Liquid Handling

- The use of compressed air as a transferring medium is prohibited.

- Equipment must be designed to assure containment. Where the vapor space is usually within the flammable range or other operational hazards indicate a need, equipment must be protected against explosion by construction or other appropriate measures.
A fire control analysis must be performed at processing plants. A primary purpose of this analysis is to ensure that sources of ignition are identified. Specific measures must be taken to prevent ignition of flammable vapors.

Appropriate fire control facilities or equipment must be provided as indicated by the analysis and special plant hazards.
Fire Control

Examples of fire control provisions include:
- Portable extinguishers
- Water supply
- Fixed extinguishing systems
- Alarm systems.

Combustible waste material and residues in a building or operating area are a potential fire hazard and must be kept to a minimum, stored in closed metal waste cans, and disposed of daily.
Questions