

UNIT 2 LECTURE NOTES



Fire Hazards: Critical Terms and Phrases

Fire hazards are conditions that favor fire development or growth.

Fire or **combustion** is a chemical reaction between oxygen and a combustible fuel.

Ignition temperature or **combustion point** is the temperature at which a given fuel can burst into flame.

Exothermic chemical reactions create heat.

Endothermic reactions consume more heat than they generate.

Flammable and Combustible Liquids: Other Important Terms

Other important terms relating to flammable and combustible liquids as defined in OSHA's 29 CFR 1910.106 are:

- 1. Lower flammable limit:** The percentage of vapor in the air above which a fire cannot occur because there is insufficient fuel (the mixture is too lean).
- 2. Upper flammable limit:** The percentage of vapor in the air above which there is insufficient air for a fire (the mixture is too rich).
- 3. Vapor density:** The weight of a flammable vapor compared to air (in which air = 1).
- 4. PEL:** The Permissible Exposure Limit of a vapor expressed in parts of vapor per million parts of contaminated air. Important because many vapors present inhalation hazards as well as fire hazards.

Classes of Fire

■ Class A fires	Solid materials such as wood, plastics, textiles, and their products: paper, housing, clothing.
■ Class B fires	Flammable liquids and gases.
■ Class C fires	Electrical (referring to live electricity situations, not including fires in other materials started by electricity).
■ Class D fires	Combustible, easily oxidized metals such as aluminum, magnesium, titanium, and zirconium.
■ Special categories	Extremely active oxidizers or mixtures, flammables containing oxygen, nitric acid, hydrogen peroxide, and solid missile propellants.
■ Do not use water to extinguish.	

Source: osha.gov

Classes of Flammable or Combustible Liquids

Elements for a Fire in Different Modes

The elements required to start and sustain a fire in the smoldering mode:

- Oxygen
- Fuel
- Heat

The elements required to start and sustain a fire in the flaming mode:

- Heat
- An oxidizing agent
- A reducing agent
- A chemical chain reactive

Combustion

The product of combustion is energy in the form of heat. By-products of combustion include light and smoke.

Colors Used to Categorize Hazards

Red =

Flammability

Blue = Health

Yellow =

Reactivity

White = Special Information

Flammable Liquids

Class I–A Flash point below 73°F (22.8°C), boiling point below 100°F (37.8°C).

Class I–B Flash point below 73°F (22.8°C), boiling point at or above 100°F (37.8°C).

Class I–C Flash point at or above 73°F (22.8°C), but below 100°F (37.8°C).

Combustible Liquids

Class II Flash point at or above 100°F (37.8°C), but below 140°F (60°C).

Class III–A Flash point at or above 140°F (60°C), but below 200°F (93.3°C).

Class III–B Flash point at or above 200°F (93.3°C).

Automatic Fire Detection Systems

Thermal expansion detectors use a heat-sensitive metal link that melts at a predetermined temperature to make contact and sound an alarm.

Photoelectric fire sensors detect changes in infrared energy that is radiated by smoke or smoke particles, obscuring the photoelectric beam.

Ionization or radiation sensors use the tendency of a radioactive substance to ionize when exposed to smoke. The substance becomes electrically conductive with the smoke exposure and permits the alarm circuit to be completed.

Ultraviolet or infrared detectors sound an alarm when the radiation from fire flames is detected. When rapid changes in radiation intensities are detected, a fire alarm signal is given.

Major chemical products of combustion

FIGURE 15-7 Major chemical products of combustion.

Product	Fuels	Pathology
Acrolein	Cellulose, fatty substances, woods, and paints	Highly toxic irritant to eyes and respiratory system
Ammonia (NH ₃)	Wool, silk, nylon, melamine, refrigerants, hydrogen–nitrogen compounds	Somewhat toxic irritant to eyes and respiratory system
Carbon dioxide (CO ₂)	All carbon and organic compounds	Not toxic, but depletes available oxygen
Carbon monoxide (CO)	All carbon and organic compounds	Can be deadly
Hydrogen chloride (HCl)	Wool, silk, nylon, paper, polyurethane, rubber, leather, plastic, wood	Quickly lethal asphyxiant
Hydrogen sulfide (H ₂ S)	Sulfur-containing compounds, rubber, crude oil	Highly toxic gas; strong odor of rotten eggs, but quickly destroys sense of smell
Nitrogen dioxide (NO ₂)	Cellulose nitrate, celluloid, textiles, other nitrogen oxides	Lung irritant, causing death or damage
Sulfur dioxide (SO ₂)	Sulfur and sulfur-containing compounds	Toxic irritant

Reducing a Fire Hazard

One means of reducing a fire hazard is the isolation of the three triangle elements:

- Fuel
- Oxygen
- Heat

Proper Storage of Liquids as a Fire Prevention

Fires may also be prevented by the proper storage of flammable liquids. Liquids should be stored as follows:

- In flame-resistant buildings that are isolated from places where people work. Proper drainage and venting should be provided for such buildings.
- In tanks below ground level.
- On the first floor of multi-story buildings.

Eliminating Ignition Sources

Ignition sources can be eliminated or isolated from fuels by:

- Prohibiting smoking near any possible fuels.
- Storing fuels away from areas where electrical sparks from equipment, wiring, or lightning may occur.

- Keeping fuels separate from areas where there are open flames. These may include welding torches, heating elements, or furnaces.
- Isolating fuels from tools or equipment that may produce mechanical or static sparks.

More Strategies for Reducing Risk of Fires

Other strategies for reducing the risk of fires are as follows:

- Clean up spills of flammable liquids as soon as they occur. Properly dispose of materials used in the clean-up.
- Keep work areas free from extra supplies of flammable materials (i.e., rags, boxes, etc.). Have only what is needed on hand with remaining inventory properly stored.
- Routinely test fire extinguishers.
- Run electrical cords along walls rather than across aisles or in other trafficked areas. Cords that are walked on can become frayed and dangerous.
- Turn off the power and completely de-energize equipment before conducting maintenance procedures.
- Don't use spark- or friction-prone tools near combustible materials.

Fire Extinguisher Classifications

Fire Class	Extinguisher Contents	Mechanism	Disadvantages
A	Foam, water, dry chemical	Chain-breaking cooling, smothering, and diluting	Freezes if not kept heated.
B	Dry chemical, bromotrifluoromethane, and other halogenated compounds, foam, CO ₂ , dry chemical	Chain-breaking smothering, cooling, and shielding	Halogenated compounds are toxic.
C	Bromotrifluoromethane, CO ₂ , dry chemical	Chain-breaking smothering, cooling, and shielding	Halogenated compounds are toxic; fires may ignite after CO ₂ dissipates.
D	Specialized powders such as graphite, sand, limestone, soda ash, sodium chloride	Cooling, smothering	Expensive cover of powder may be broken with resultant reignition.

OSHA Regulations for Fire Brigades (29 CFR 1910.156, Subpart L, Appendix A)

Scope: Employers are not required to form a fire brigade, but if one does decide to organize a fire brigade, the requirements of this section apply.

Prefire Planning: Have prefire planning conducted by the local fire department or workplace fire brigade.

Physical Capability: The physical capability requirement applies only to fire brigade members who perform interior structural firefighting.

Organizational Statement containing:

- A description of the duties members are expected to perform
- The line authority of each fire brigade officer
- The number of officers and number of training instructors
- A list of the types of awards and recognition that the brigade members are eligible to receive

OSHA Regulations (continued)

Training and Education may be commensurate with those functions that the fire brigade is expected to perform.

Protective Clothing: Consideration is given to the types of hazardous environments to which the fire brigade member may be exposed; therefore the protective clothing requirements apply only to fire brigade members who perform interior structural firefighting operations.

Firefighting Equipment must be removed from service and replaced if damaged or unserviceable.

Respiratory Protective Devices are required when fire brigade members are working inside buildings or confined spaces where toxic products of combustion or an oxygen deficiency are likely to be present or in emergency situations involving toxic substances.

Disaster Preparations

Training employees may be the most successful lifesaving preparation for a fire disaster.

Disaster preparations require:

- Management commitment and planning
- Continued response and recovery practice by the fire brigade on a regular basis
- Integration of company planning with community plans
- Consultation with and informing police, fire department, Red Cross, and hospitals

Strategies to Prevent Office Fires

Confine smoking to designated areas with nontip ash trays and fire-resistant furnishings.

Check electrical circuits and connections periodically and replace worn cords.

Make sure that extension cords and other accessories are UL-approved and used correctly.

Make sure there is plenty of air space around office machines that can overheat.

Inspect personal appliances such as hotplates and coffee pots frequently. Assign responsibility for turning off such appliances.

Keep aisles, stairwells, and exits clear.

Trends in Development of Fire Safety Standards

A trend in fire safety standards is toward performance-based standards and away from the traditional specification-based approach. An example of each to illustrate the difference:

- A **specification-based** standard may require that brick, concrete, or steel materials be used in a given type of building.
- A **performance-based** standard may specify that materials used have a one-, two-, or four-hour fire resistance rating.

OSHA Fire Standards

OSHA standards for fire protection appear in 29 CFR 1910.156 (Subpart L). The standards in Subpart L are as follows:

- Fire protection
- Portable fire suppression equipment
- Fixed fire suppression equipment
- Other fire protection systems

Fire Prevention and Suppression Strategies

Use least-flammable materials whenever possible.

Analyze the company to determine potential fire dangers and provide appropriate sprinklers and/or extinguishers.

Develop a database of the flammability of materials available in the company.

Store containers or flammable materials away from sources of heat or sparks and away from humans.

Do not permit smoking near flammable materials.

Include a venting mechanism in storage containers and locate them near a drain.

Minimize fuel storage container size to reduce the size of potential fires.

Make sure sources of heat have controlling mechanisms are near fire detection equipment.

Check fire extinguishing equipment regularly.

Isolate fuels from sources of heat.

Include a smoke detection system and a fire extinguisher for each workstation.

Perform periodic inspections for fire hazards and reappraisal of fire hazards.

Train plant personnel in basic fire prevention and include periodic drills.

Make sure fire brigade personnel are well-trained, tested, and practice regularly.

Stress cleanliness and an organized method of disposal of flammable materials.



Life Safety Requirements

Every structure, new and existing, that is to be occupied by people must have a **means of egress** and other fire protection safeguards to:

- Ensure that occupants can promptly evacuate or be adequately protected without evacuating
- Provide sufficient backup safeguards to ensure that human life is not endangered if one system fails

Structural Standards

Every structure must be constructed or renovated, maintained, and operated in a way that occupants are:

- Protected from fire, smoke or fumes
- Protected from fire-related panic
- Protected long enough to allow a reasonable time for evacuation
- Protected long enough to defend themselves without evacuating.

Means of Egress and Other Fire-Protection Safeguards

In providing structures with means of egress and other fire protection safeguards, the following factors should be considered:

- Character of the occupancy
- Capabilities of occupants
- Number of occupants
- Available fire protection
- Height of the structure
- Type of construction
- Any other applicable concerns

Obstruction of Exits

No lock or device may be allowed to obstruct egress in any part of a structure at any time it is occupied, with the exception of mental health detention and correctional facilities. In these, the following criteria are required:

- Responsible personnel available in case of fire or other emergency
- Procedures must be in place to ensure that occupants are evacuated in the event of an emergency.

Other Exit Criteria

All exits in structure must satisfy the following criteria:

- Be clearly visible or marked in such a way that an unimpaired individual can readily discern the route of escape.
- All routes to a place of safety must be clearly marked.
- Any doorway and passageway that may be mistaken must be arranged or clearly marked in such a way as to prevent confusion in an emergency.
- All appropriate steps must be taken to ensure that occupants do not mistakenly enter a dead-end passageway.

- Egress routes must be included in lighting design whenever artificial illumination is required in a structure.
- In any structure in which a single means of escape may be blocked, at least two methods of escape must be provided.

Life Safety Code of the NFPA

The Life Safety Code section of the NFPA refers to these means of egress issues:

- Doors
- Capacity and number of means of egress
- Arrangement of means of egress
- Measurement of travel distance to exits
- Discharge from exits
- Illumination of means of egress
- Emergency lighting
- Marking a means of egress
- Special provisions for high hazard areas

Fire Safety Programs

A comprehensive fire safety program should have at least the following components:

- Assessment
- Planning
- Awareness/prevention
- Response

Explosives-Related Concepts

A **flammable substance** is any substance with a flash point below 37.8°C (100°F) and a vapor pressure of less than 40 psi at that temperature. Such liquids are also known as **Class I Liquids**.

A **combustible substance** is any substance with a flash point of 37.8°C (100°F) or higher. Such liquids are also known as **Class II Liquids**.

The **flash point** is the lowest temperature at which a substance gives off sufficient vapors to combine with air to form an ignitable mixture.

Common Uses of Flammable and Combustible Substances

Dip tanks

Japanning and drying ovens

Oil burners

Cleaning solvents

Internal combustion engines

Spray-painting booths

Other Hazards of Explosive Materials

Skin irritation

Intoxication

Suffocation

OSHA's Firefighting Options

There are three options available to companies that wish to have their employees participate in firefighting.

- Option 1: All employees fight fires.
- Option 2: Designated employees fight fires.
- Option 3: Fire Brigades fight fires.

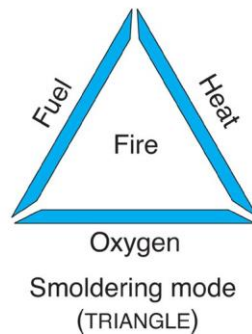
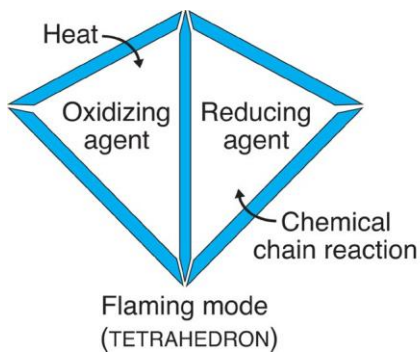
Self-Assessment in Fire Protection

Safety and health personnel cannot be everywhere at the same time. Consequently, it is wise to enlist the assistance of supervisors and employees in fire protection. An excellent way to accomplish this is through self-assessment checklists.

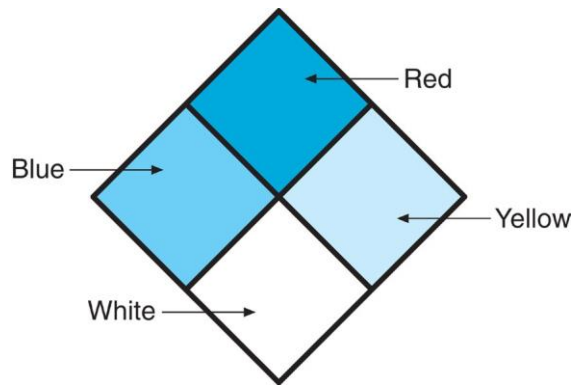
A self-assessment checklist should include questions concerning:

- Portable fire extinguisher mounting requirements, accessibility, and availability in adequate numbers and types
- Inspection of extinguishers, standpipes and valves, avenues of ingress and egress, fire doors, shutters, automatic sprinkler systems, and fusible links
- Testing of alarm systems
- Employee training
- Frequency of fire hydrant flushing / maintenance

Fire Tetrahedron (L) and Fire Triangle (R)



Identification of Fire Hazards



Major Chemical Products of Combustion

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