AMERICAN SOCIETY OF
SAFETY PROFESSIONALS

Welcome to the September 2023 Meeting

Agenda Overview

- Welcome!
  - Emergency Actions
  - New Members / First Meeting Attendees
- Scholarship Recipient Asha-Leigh Ashton
- Tech Talk: Characteristics, Classes and Phases of Fire, Max Saunders, MFRI
- Refinery 101
- Technical Tour

AMERICAN SOCIETY OF SAFETY PROFESSIONALS

ASSP FOUNDATION

$2,000 ASSP Foundation ASSP Philadelphia Chapter Scholarship

Asha-Leigh Ashton

Drexel University
Master's Degree: Environmental and Occupational Health
ashajashton@gmail.com
LinkedIn: www.linkedin.com/in/asha-ashton/

What attracted you to the safety industry and how has your education affected your opinion of the field?

After graduating from my undergraduate program, I worked as an Environmental, Health and Safety Specialist; and I saw first-hand some of the negligent and at-risk behaviors that could have resulted in an injury or even a fatality. I've come to realize that without safety advocates, rates of workplace injury and fatality will remain high, and may even rise further. For three years I served as a safety advocate, facilitating the improvement of the organization's safety culture. This profession has allowed me to provide great value by helping those that I work with. My interest in the safety industry stems from being able to improve people's lives every day. Safety is often taken for granted because it is assumed. However, without the proper policies, procedures, and practices in place, human lives are at an increased risk.

By coordinating the development and implementation of specific controls, within my professional capacity, I can help prevent an injury or save a life. My practical experience has afforded me hands-on knowledge to promote and protect the safety and health of workers, and it is my hope that an advanced degree in Environmental and Occupational Health will allow me to gain the specialized knowledge and skills to progress within this field. The classes that I've taken as part of this Master's degree program at Drexel have served to affirm my choice of working in the safety industry; particularly as we get into the topics of Industrial Hygiene and Toxicology. I previously had some limited experience with both, but now I am getting a more in-depth look at their principles and applications.

Characteristics, Classes and Phases of Fire

Mr. Maxim Saunders, Training Coordinator in the Special Programs Section of the **Maryland Fire and Rescue Institute (MFRI)** will provide a general overview of the classes and phases of fires and present details on the characteristics of liquid fuel fires, gas fuel fires and interior structure fires.

MFRI is part of the University of Maryland and is the state's training and education system for all-hazard responses. The Institute plans, researches, develops and delivers quality programs to prepare agencies and individuals to protect life, property and the environment.

Refinery 101 and Tech Tour

The **Paulsboro Refinery** is located on approximately 950 acres on the Delaware River in Paulsboro, New Jersey, just south of Philadelphia and approximately 30 miles North of the Delaware City refinery.

The Paulsboro refinery works in combination with the Delaware City refinery to process a wide variety of crude oils. The East Coast refining system produces a variety of finished products including gasoline, heating oil and aviation jet fuel. Paulsboro specifically manufactures Group I lubricant base oils and is the largest producer of Asphalt on the East Coast.

Thank you to Ravi Jerecha and the PBF Team for hosting our September 2023 Meeting and the Refinery Tour!

Save the Date!!!

ASSP 2023 Holiday Party

December 1, 2023, at the Elmwood Park Zoo

Cocktail Reception in our own Private Event Space

Festival of Lights

Interior Structural Industrial Fire Brigade Member

Maryland Fire and Rescue Institute
University of Maryland

Lesson 2-1: Fire Behavior

Student Performance Objective

- Given information relating to fire behavior, the student will be able to describe the characteristics and development principles of fire behavior so that the concepts are applied at the site of the fire emergency.

Overview

- The Fire Tetrahedron
- The Chemistry of Combustion
- Products of Combustion
- Heat Transfer
- Characteristics of Liquid Fuel Fires

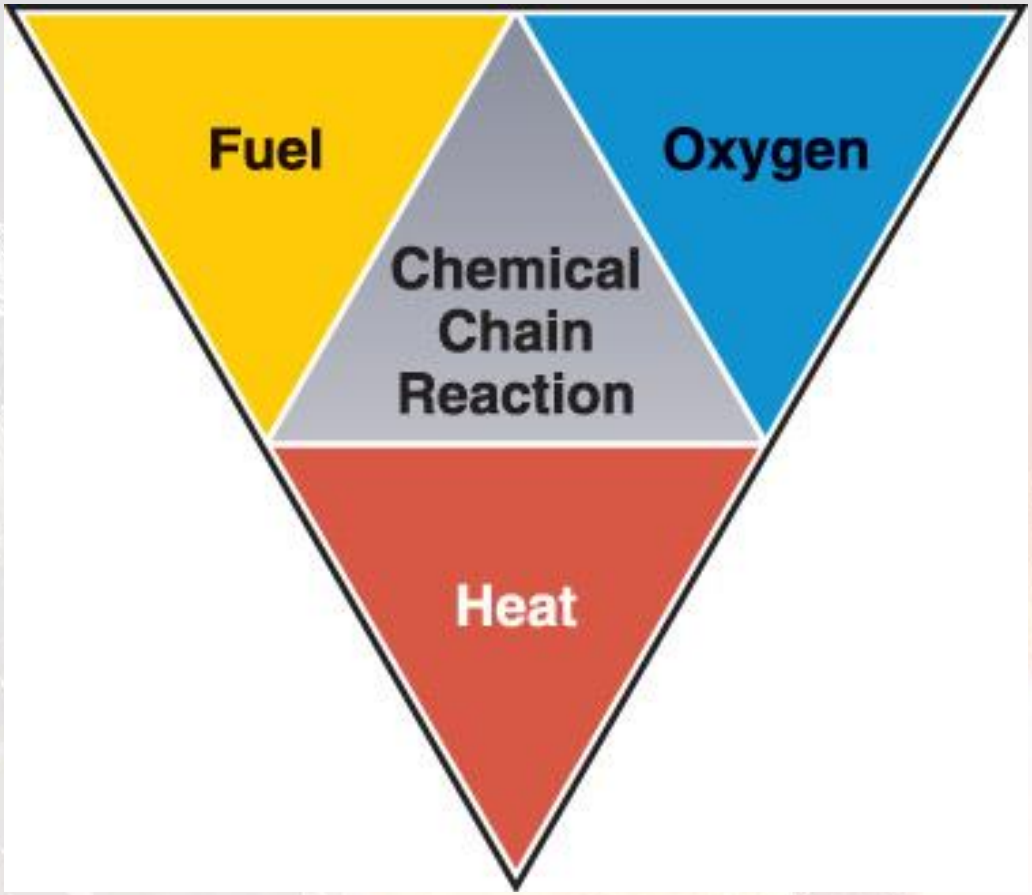
Overview

- Characteristics of Gas Fuel Fires
- Classes of Fire
- Phases of Fire
- Characteristics of an Interior Structure Fire

The Fire Tetrahedron

- Basic factors required for combustion:
  - Fuel
  - Oxygen
  - Heat
  - Self-sustaining chemical chain reaction

The Fire Tetrahedron

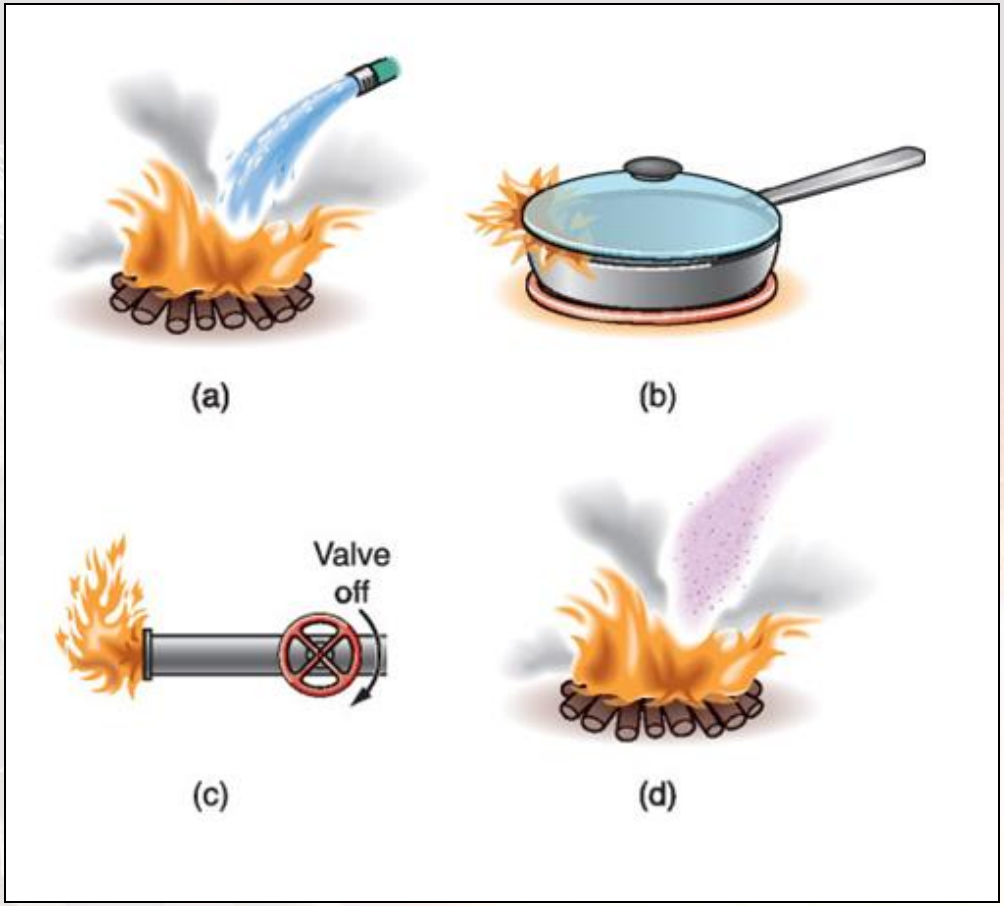


The Fire Tetrahedron

- Methods of extinguishment
  - Cool the burning material.
  - Exclude oxygen.
  - Remove fuel.
  - Break the chemical reaction.

The Fire Tetrahedron

Methods of extinguishment

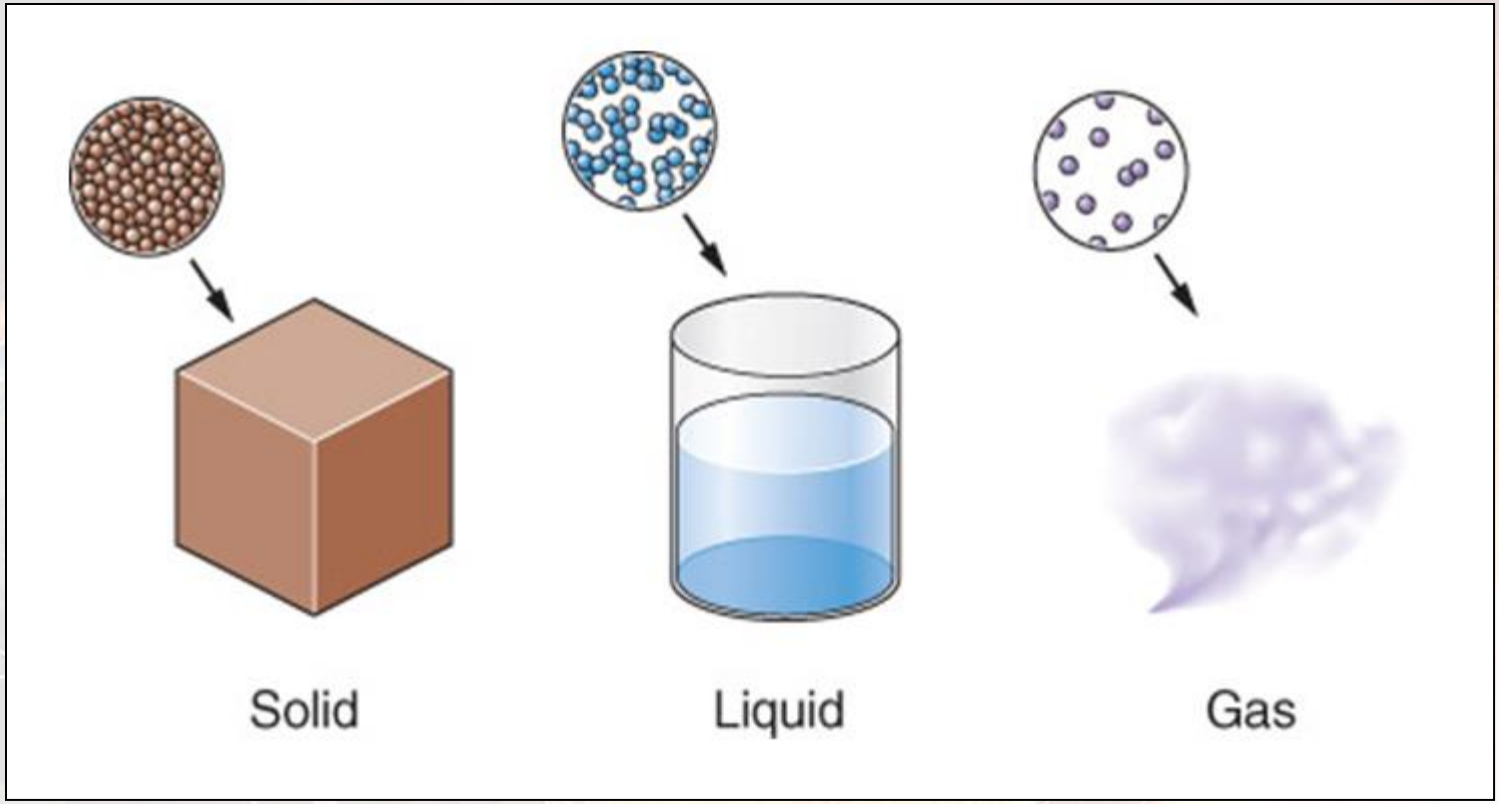


The Fire Tetrahedron

- Fuel
  - Is what is actually being burned
  - Consists of solid, liquid, or gas
- When combustion occurs fuel is in a gaseous state.

The Fire Tetrahedron

Fuel

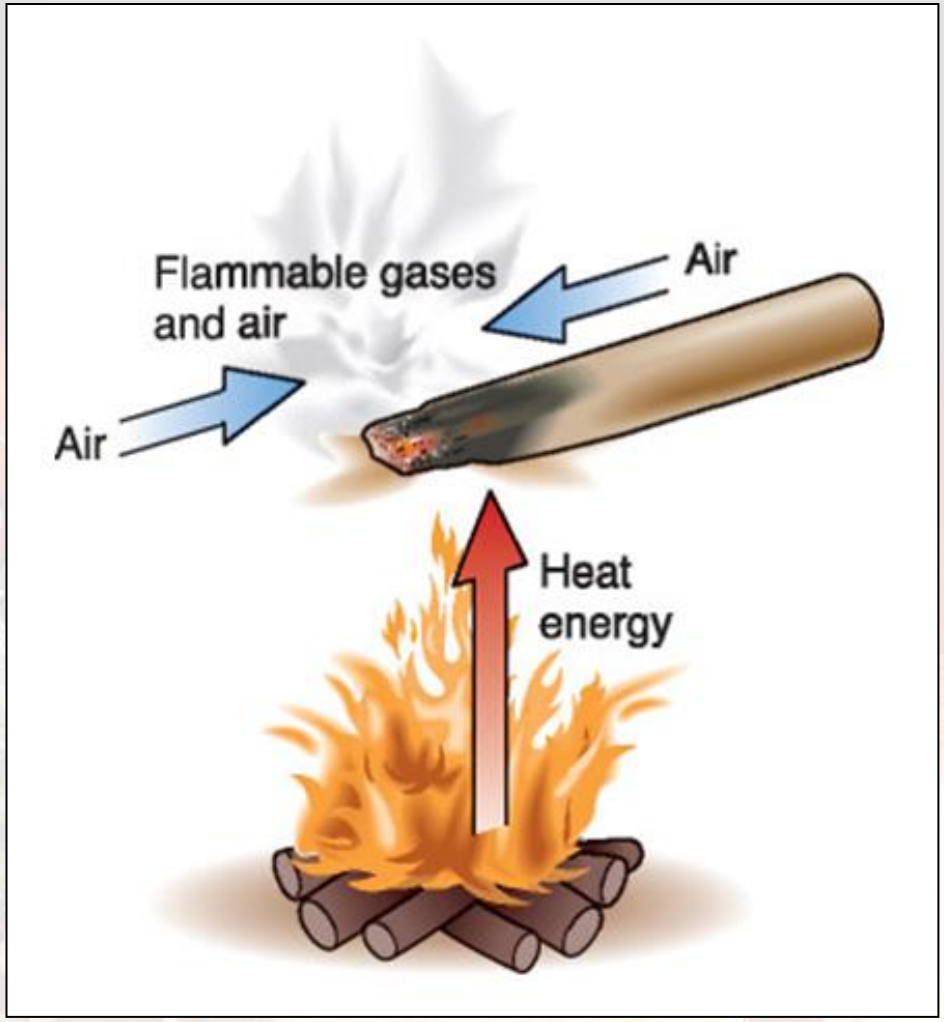


The Fire Tetrahedron

- Solids
  - Most fuels are solids.
  - Pyrolysis releases molecules into the atmosphere; converts solid to a gas.
  - Solids with high surface-to-mass ratio combust more easily and rapidly.

The Fire Tetrahedron

Solids



The Fire Tetrahedron

- Liquids
  - Liquids assume the shape of their containers.
  - Vaporization is the release of a liquid's molecules into the atmosphere.
  - Liquids with a high surface-to-volume ratio vaporize and combust more easily and rapidly.

The Fire Tetrahedron

- Gases
  - Have neither shape nor volume
  - Expand indefinitely

Fuel-to-air mixture must be within a certain range to combust.

The Fire Tetrahedron

- Oxygen and oxidizing agents
  - Oxygen is required to initiate and sustain combustion.
  - Materials classified as oxidizers will support the combustion of other materials, even if no oxygen is present.

The Fire Tetrahedron

- Heat
  - Heat is required to ignite a fire
  - Energy to produce an ignition comes from a variety of sources:
    - Mechanical energy
    - Chemical energy
    - Electrical energy

The Fire Tetrahedron

- Chemical chain reaction
  - Chain reactions continue to occur as long as there is sufficient fuel, oxygen, and heat.
  - Interrupting the chain reaction puts the fire out.

The Chemistry of Combustion

- Exothermic reactions
  - Reactions that result in the release of heat energy
- Endothermic reactions
  - Reactions that absorb heat or require heat to be added

The Chemistry of Combustion

- Oxidation
  - Chemically combining oxygen with another substance to create a new compound
- Combustion
  - A rapid, self-sustaining process that combines oxygen with another substance and results in the release of heat and light
- Pyrolysis
  - Decomposition of a material caused by external heating

Products of Combustion

- Combustion produces smoke and other substances.
- Specific products depend on:
  - Fuel
  - Temperature
  - Amount of oxygen available
- Few fires consume all available fuel.

Products of Combustion

- Smoke
  - Smoke is the airborne product of combustion.
  - Inhalation of smoke can cause severe injuries.

Products of Combustion

- Smoke particles
  - Are solid matter consisting of unburned, partially burned or completely burned substances
  - Can be hot and/or toxic

Products of Combustion

- Vapors and mists
  - Are small droplets of liquids suspended in air
  - Can be oils from the fuel or water from suppression efforts

Products of Combustion

- Gases
  - Most gases produced by fire are toxic.
    - Carbon monoxide
    - Hydrogen cyanide
    - Phosgene

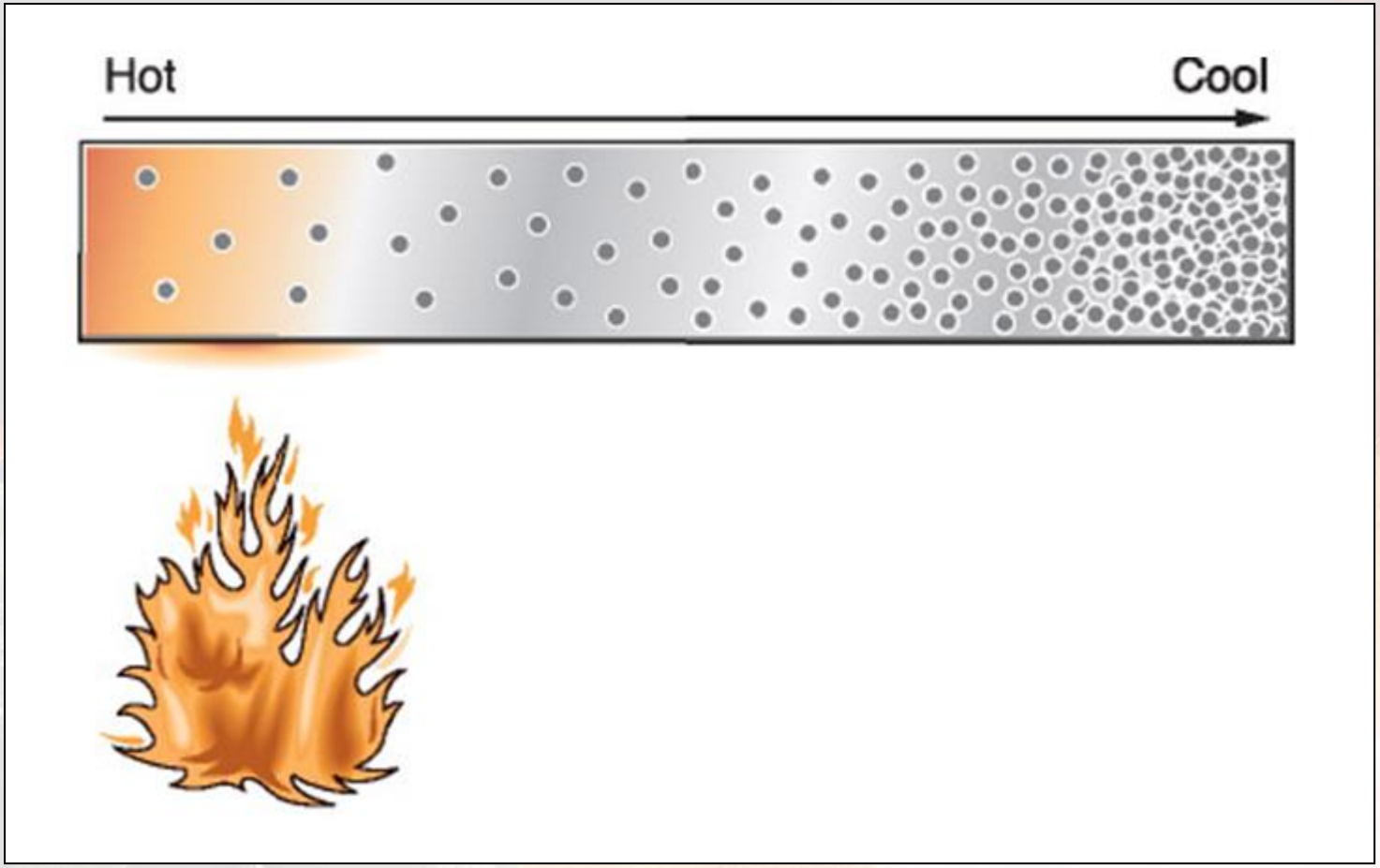
Heat Transfer

- Combustion gives off heat which can ignite other nearby fuels.
- Heat energy always flows from hotter to colder.
- Three methods of heat transfer are
  - Conduction
  - Convection
  - Radiation

Heat Transfer

- Conduction
  - Heat is transferred from one molecule to another (direct contact)
    - Conductors transfer heat well (e.g., metal)
    - Insulators do not transfer heat well (e.g., fiberglass)

Heat Transfer



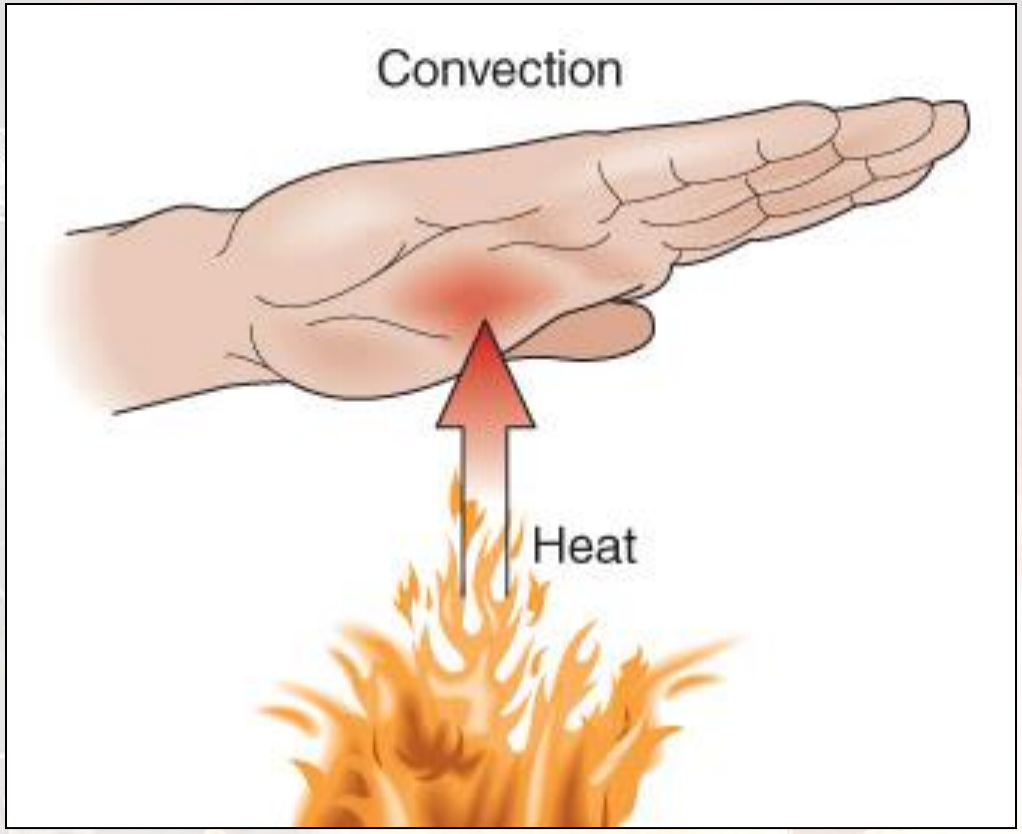
Conduction

Heat Transfer

- Convection
  - Convection is the movement of heat through a fluid medium such as air or a liquid
    - Convection currents are created
  - Hot gases rise then travel horizontally.
  - Gases then bank down a wall or move outside the room, horizontally or vertically.

Heat Transfer

Convection

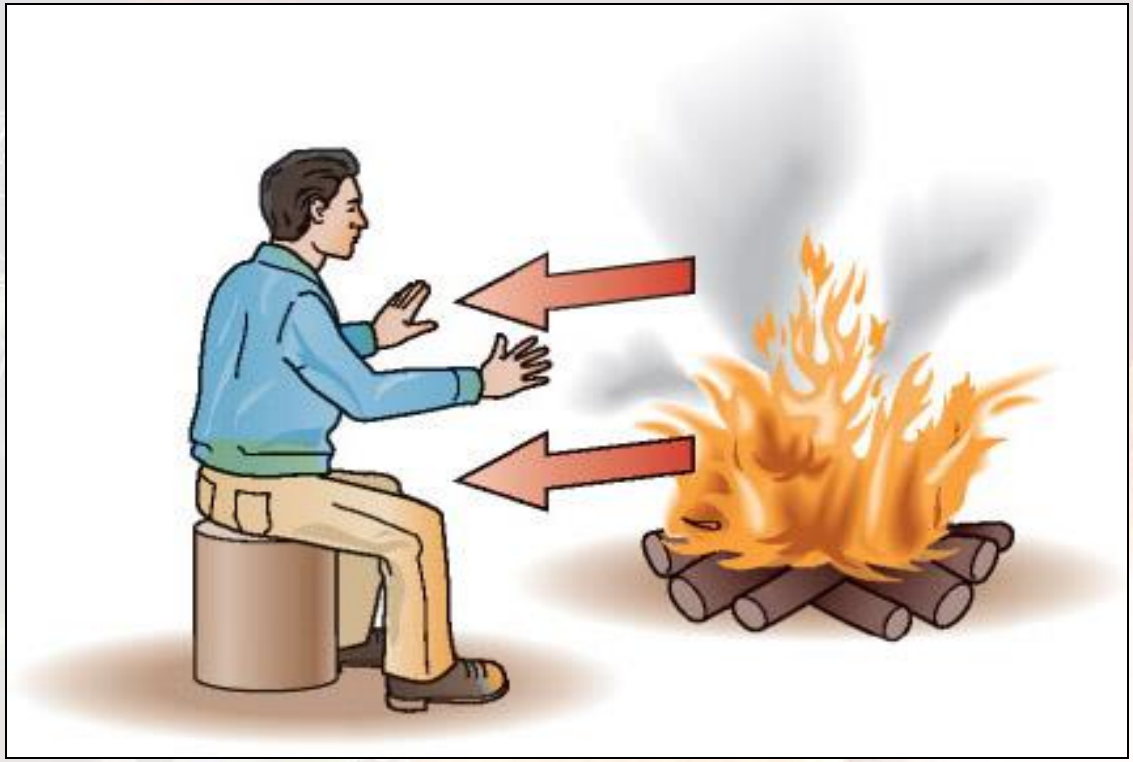


Heat Transfer

- Radiation
  - Radiation is the transfer of heat in the form of an invisible wave
  - Heat radiated to a nearby structure can ignite it.
  - Radiated heat passing through a window can ignite an object.

Heat Transfer

Radiation



Characteristics of Liquid Fuel Fires

- A liquid must vaporize before it burns.
- A minimum and maximum concentration of vapors must be present to ignite.
- Most flammable liquids can ignite well below their boiling point.

Characteristics of Liquid Fuel Fires

- Conditions required for ignition:
  - Fuel-air mixture within flammable limits
  - An ignition source with sufficient energy
  - Sustained contact between ignition source and fuel-air mixture

Characteristics of Liquid Fuel Fires

- Flash point: lowest temperature at which vapor is produced
- Flame point (or fire point): lowest temperature at which sufficient vapors are produced to support a small flame for a short time
- Ignition temperature: temperature at which the fuel-air mixture will spontaneously ignite

Characteristics of Gas Fuel Fires

- Vapor density
  - Vapor density is the weight of a gas fuel
  - Gas with vapor density less than 1.0 will rise.
  - Gas with vapor density greater than 1.0 will settle.
  - Knowing the vapor density helps predict where the danger of ignition will be.

Characteristics of Gas Fuel Fires

- Fuel-air mixtures only burn when mixed in certain concentrations.
- The range of mixtures of fuels that burn are called flammability/explosive limits.
  - Below the lower flammability limit
    - Too little fuel = too lean
  - Above the upper flammability limit
    - Too much fuel = too rich

Characteristics of Gas Fuel Fires

- BLEVE
  - Is an acronym for Boiling Liquid Expanding Vapor Explosion.
  - Occurs when a tank storing liquid fuel under pressure is heated excessively.

Characteristics of Gas Fuel Fires

- The BLEVE sequence:
  - The tank is heated.
  - Internal pressure rises beyond the ability to vent.
  - The tank fails catastrophically.
  - Liquid fuel at or above boiling point is released.
  - Liquid immediately turns into a rapidly expanding cloud of vapor.
  - Vapor ignites into a huge fireball.

Characteristics of Gas Fuel Fires

- BLEVEs can injure and even be fatal.
  - A fireball is created by the ignition of expanding vapors.
  - Large pieces of the tank are propelled great distances.

Classes of Fire

- Fires are classified according to type of fuel.
- Extinguishing agents are classified to match the type(s) of fires they extinguish.
- A fire can fit into more than one class.

Classes of Fire

- There are five classes of fires:
  - Class A
  - Class B
  - Class C
  - Class D
  - Class K

Classes of Fire

Class A

- Fuel: Ordinary solid combustibles
  - Wood
  - Paper
  - Cloth
- Extinguishing agents:
  - Water (cools the fuel)

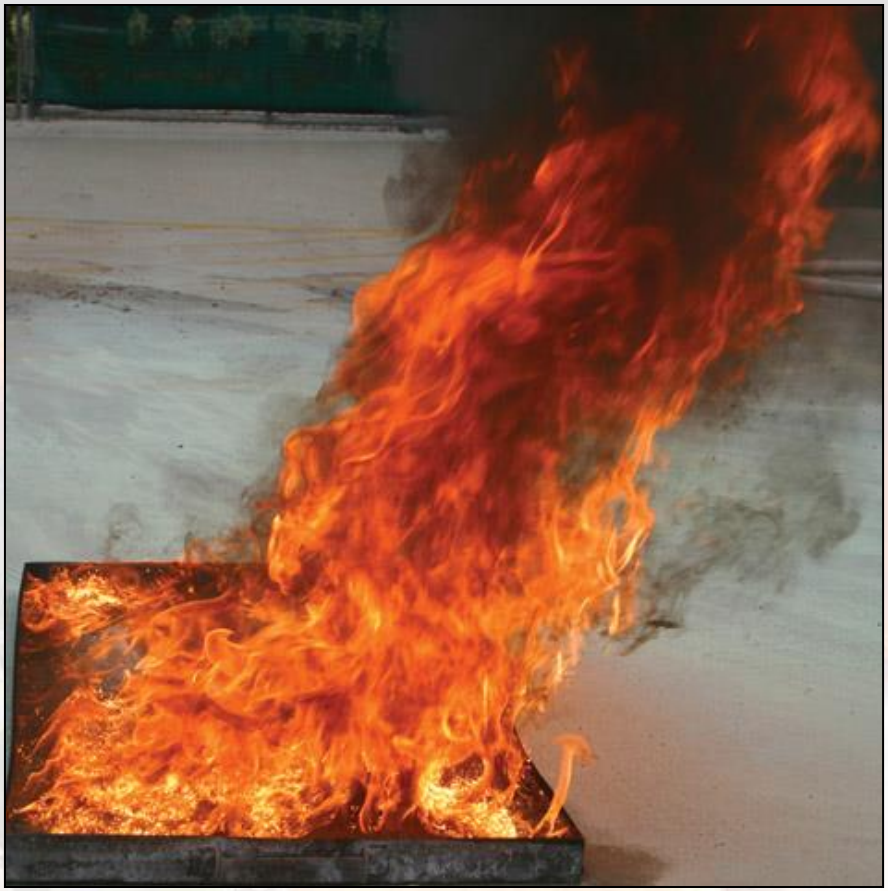
Class A Fires

Classes of Fire

Class B

- Fuel: Flammable or combustible liquids
  - Gasoline
  - Kerosene
  - Oils
- Extinguishing agents:
  - Foam or carbon dioxide
  - Dry chemicals

Class B Fires



Classes of Fire

Class C

- Fuel: Energized electrical equipment
  - Underlying fuel is often Class A or Class B
  - Special classification is required due to electrical hazards
- Extinguishing agents:
  - Carbon dioxide
    - Use of water is not advised.

Class C Fires

Classes of Fire

Class D

- Fuel: Burning metals
  - Potassium
  - Lithium
  - Magnesium
- Extinguishing agents:
  - Special salt-based powders or dry sand
    - Do not use water.

Class D Fires

Classes of Fire

Class K

- Fuel: Combustible cooking media
  - Cooking oils
  - Grease
- Extinguishing agents:
  - Designation is new and coincides with a new classification of Class K extinguishing agents.

Class K Fires

Phases of Fire

- The four distinct phases:
  - Incipient
  - Growth
  - Fully developed
  - Decay

Phases of Fire

- Incipient Phase
  - All four parts of the fire tetrahedron are present.
  - Fuel is heated to its ignition temperature.

Phases of Fire

- Growth Phase
  - Additional fuel is involved
  - The fire grows larger.
  - Convection draws more air into the fire.
  - Thermal layering occurs:
    - Hot gases collect at the ceiling and bank downward.

Phases of Fire

Growth Phase

Phases of Fire

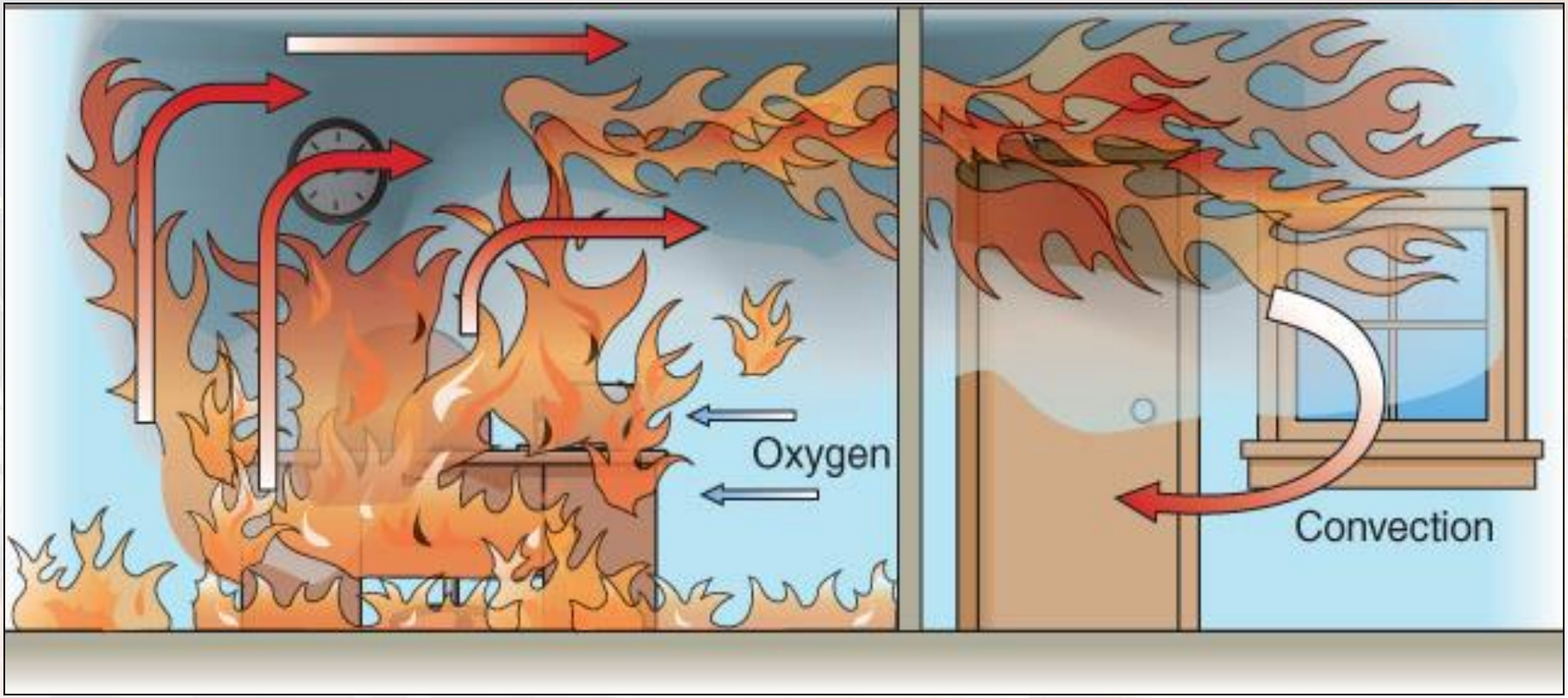
- Flashover
  - Flashover is the point between the growth phase and the fully developed phase
  - All combustible materials in a room ignite at once.
  - Temperatures can reach 1000˚ F (538˚ C).
  - Flashovers are deadly!

Phases of Fire

- Fully developed phase
  - Heat is produced at a maximum rate
  - Oxygen is consumed rapidly
  - The fire will burn as long as fuel and oxygen remain.

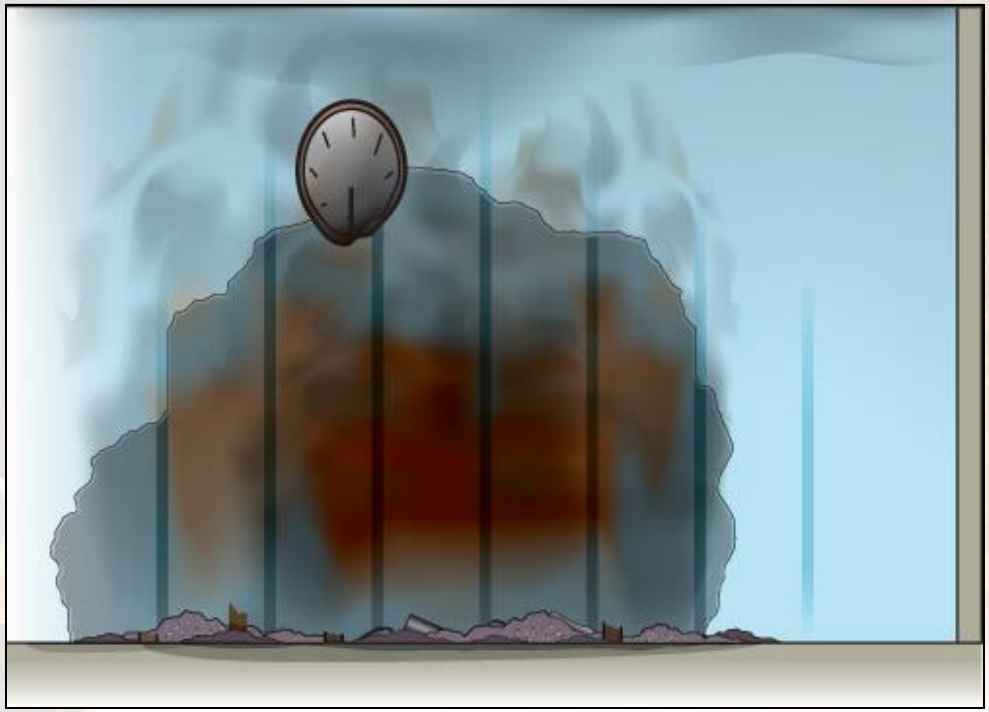
Phases of Fire

Fully Developed Phase



Phases of Fire

- Decay phase
  - Fuel is nearly exhausted.
  - Intensity reduces.
  - Eventually the fire will go out.



Characteristics of an Interior Structure Fire

- Fire is fully or partially contained within a building.
- The building acts as a box.
- Special considerations include
  - Room contents
  - Fuel load and fire spread
  - Flashover, rollover, backdraft, and thermal layering

Characteristics of an Interior Structure Fire

- Room contents
  - Many fires burn only the contents and not the structure itself.
  - Modern rooms contain many plastic and synthetic materials.
  - Furniture may have little resistance to ignition from flaming sources.
  - Wall and ceiling finishes can burn readily.

Characteristics of an Interior Structure Fire

- Fuel load and fire spread
  - Fuel load is the total quantity of combustibles in a room
  - Fuel load determines how much heat and smoke will be generated
  - The size, shape, and arrangement of fuel will affect combustibility and fire spread.

Characteristics of an Interior Structure Fire

- Special considerations
  - Four conditions particular to interior fires that affect brigade member (and civilian) safety are
    - Flashover
    - Flameover (rollover)
    - Backdraft
    - Thermal layering and thermal balance

Characteristics of an Interior Structure Fire

- Flashover
  - Flashover is sudden ignition of all contents of a room or space
  - Brigade members in full protective gear cannot survive a flashover for more than a few seconds.
  - Flashover often occurs just as brigade members arrive on the scene.

Characteristics of an Interior Structure Fire

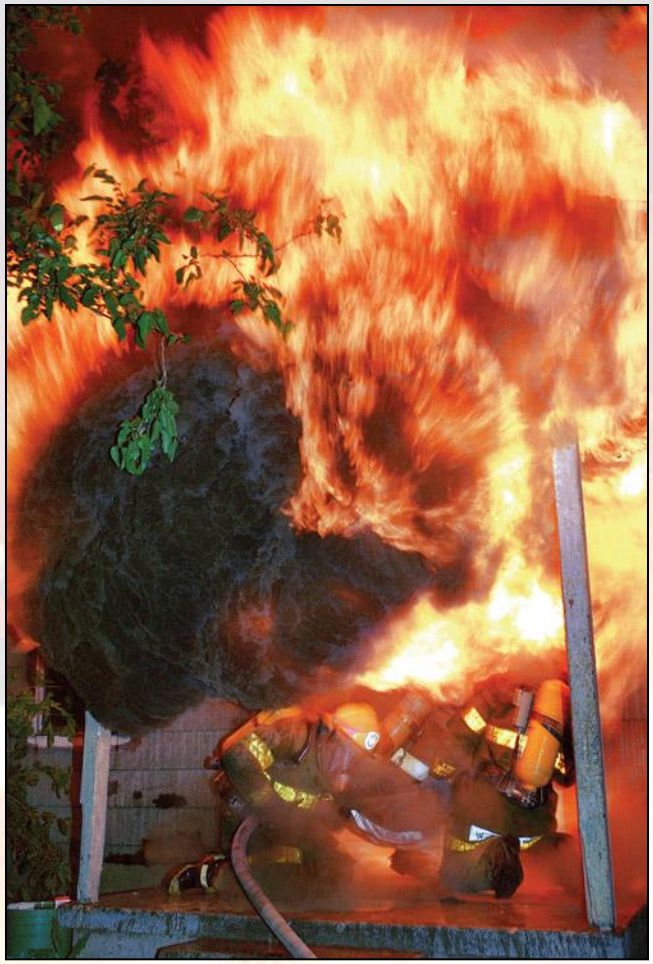
- Flashover
  - Signs of flashover include
    - Dense black smoke with tightly packed curls
    - Dense smoke filling over half of a door or window
    - Visible flameover (rollover)

Characteristics of an Interior Structure Fire

- Rollover/flameover
  - Rollover/flameover is a warning sign of imminent flashover.
  - Licks of flame ignite briefly in upper layers of smoke.
  - The situation calls for aggressive cooling of the atmosphere, immediate exit, or immediate ventilation.

Characteristics of an Interior Structure Fire

- Backdraft
  - Is an explosion that occurs when oxygen is suddenly admitted to a confined area that is very hot and filled with combustible vapors



Characteristics of an Interior Structure Fire

- Backdraft
  - Usually occurs when a fire is smoldering
    - The room is filled with carbon monoxide and other products of combustion.
    - The sudden introduction of air will explosively feed the fire.

Characteristics of an Interior Structure Fire

- Signs of impending backdraft
  - Little or no flame visible
  - Smoke emanating under pressure from cracks
  - No large openings

Characteristics of an Interior Structure Fire

- Signs of impending backdraft
  - Visible “living fire”
  - Unexplained change in color of smoke
  - Glass that is smoke-stained or blackened
  - Signs of extreme heat

Characteristics of an Interior Structure Fire

- Prevention of backdrafts
  - Ventilate at a high level to allow superheated gases to escape.
  - Perform a well-coordinated fire attack.

Characteristics of an Interior Structure Fire

- Thermal layering and thermal balance
  - Superheated gases collect near the ceiling.
  - Temperatures are lowest near the floor.
  - Fire streams create steam which expands and rises.

Student Performance Objective

- Given information relating to fire behavior, the student will be able to describe the characteristics and development principles of fire behavior so that the concepts are applied at the site of the fire emergency.

Review

- The Fire Tetrahedron
- The Chemistry of Combustion
- Products of Combustion
- Heat Transfer
- Characteristics of Liquid Fuel Fires

Review

- Characteristics of Gas Fuel Fires
- Classes of Fire
- Phases of Fire
- Characteristics of an Interior Structure Fire