**Chapter 6: Fire Behaviour**

**Chief Concepts**

* Fire is a rapid chemical process that produces heat and light.
* Matter is made up of atoms and molecules.
* Matter exists in three states: solid, liquid, and gas.
  + A solid has definite capacity for resisting forces and, under ordinary conditions, retains a definite size and shape.
  + A liquid assumes the shape of the container in which it is placed.
  + A gas is a type of liquid that has neither independent shape nor independent volume, but rather, tends to expand indefinitely.
* Fuels are a form of energy. Energy exists in many forms, including chemical, mechanical, electrical, light, or nuclear.
  + Chemical energy is the energy created by a chemical reaction.
  + Mechanical energy is converted to heat when two materials rub against each other and create friction.
  + Electrical energy is converted to heat energy when it flows through a conductive material. Light energy is caused by electromagnetic waves packaged in photons and travels as thermal radiation.
  + Nuclear energy is stored in radioactive materials and converted to electricity by nuclear power–generating stations.
* The three basic conditions needed for a fire to occur are fuel, oxygen, and heat. A fourth factor, a chemical chain reaction, is required for a self-sustaining fire.
* The by-product of fire is smoke. Smoke includes three major components: particles, vapours, and gases. Smoke consists mainly of unburned forms of hydrocarbon fuels.
* Fire may be spread by direct contact, conduction, convection, and radiation.
* Direct contact is a flame touching a fuel.
* Conduction is the transfer of heat through matter, such as heat travelling up a metal spoon.
* Convection is the circulatory movement that occurs in a gas or fluid. Convection currents in a fire involve gases that are generated by the fire and travel along the ceiling of a room. Such convection currents carry superheated gases, which may ultimately heat flammable materials enough to ignite them.
* Radiation is the transfer of heat through the emission of energy in the form of invisible waves.
* The four principal methods of fire extinguishment are cooling the fuel, excluding oxygen, removing the fuel, and interrupting the chemical reaction.
* Fires are categorized as Class A, Class B, Class C, Class D, and Class K. These classes reflect the type of fuel that is burning and the type of hazard that the fire represents.
* Class A fires involve ordinary solid combustible materials, such as wood, paper, and cloth.
* Class B fires involve flammable or combustible liquids, such as gasoline, kerosene, diesel fuel, and motor oil.
* Class C fires involve energized electrical equipment.
* Class D fires involve combustible metals, such as sodium, magnesium, and titanium.
* Class K fires involve combustible cooking oils and fats in kitchens.
* Most fires encountered by fire fighters involve solid fuels. Solid fuels do not actually burn in a solid state. Instead, they must be heated or pyrolyzed to decompose into a vapour before they will burn.
* Solid-fuel fires develop through four phases: the ignition phase, the growth phase, the fully developed phase, and the decay phase.
* The growth phase occurs as the fuel starts to burn, increasing the convection of hot gases upward.
* The fully developed phase occurs when all available fuel has ignited and heat is being produced at the maximum rate.
* During the decay phase, the rate of burning slows down because less fuel is available.
* The growth of room-and-contents fires depends on the characteristics of the room and the contents of the room. Synthetic products are widely used in today’s homes. The by-products of heated plastics are not only flammable but also toxic.
* Special considerations related to room-and-contents fires include thermal layering, flameovers, flashovers, and backdrafts.
* Thermal layering is the property of gases in an enclosed space by which they form layers according to their temperature. The hottest gases travel by convection currents to the top level of the room.
* Flameover is the spontaneous ignition of hot gases in the upper levels of a room.
* Flashover is the near-simultaneous ignition of most of the exposed combustible materials in an enclosed area.
* Backdraft is caused by the introduction of oxygen into an enclosure where superheated gases and contents are hot enough for ignition but the fire does not have sufficient oxygen to cause their combustion.
* Modern structures tend to be more tightly sealed, be constructed of lighter-weight materials, and contain more plastics. These characteristics can lead to a greater risk of backdrafts when a fire occurs.
* Liquid-fuel fires require the proper mixture of fuel and air, an ignition source, and contact between the fuel mixture and the ignition.
* The characteristics of flammable vapours can be described in terms of vapour density and flammability limits. Vapour density reflects the weight of a gas compared to air. Flammability limits vary widely for different fuels.
* A BLEVE is a catastrophic explosion in a vessel containing both a boiling liquid and a vapour.
* Assessment of smoke volume, velocity, density, and colour enables fire fighters to predict the location of a fire and its stage of development.
* Smoke reading requires fire fighters to evaluate the effect of the building, the weather, and ventilation on the smoke.