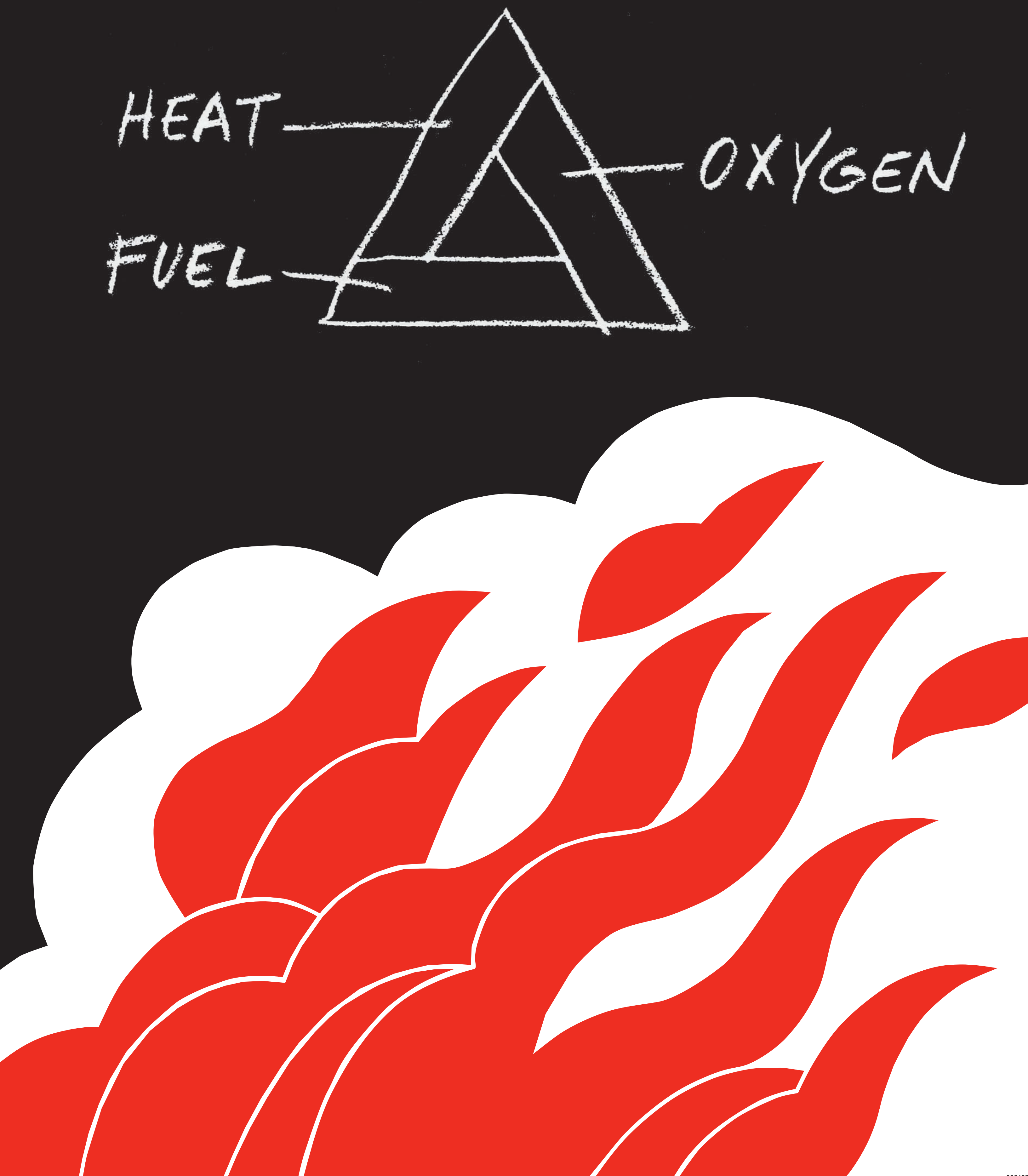
The Fundamentals of Fire Extinguishment



Basic Elements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FIRE

Fire burns because three elements are present – heat, fuel and oxygen. In technical language, fire is a chemical reaction: It happens when a material unites with oxygen so rapidly that it produces flame. Think of fire as a triangle. If any one of three sides – heat, fuel or oxygen – is taken away, the fire goes out. This is the basis for fire extinguishment. Heat can be taken away by cooling, oxygen can be taken away by excluding air, fuel can be removed to a place where there is no flame, chemical reaction can be stopped by inhibiting the oxidation of the fuel.


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REMOVE HEAT

Cooling a fire calls for the application of something which absorbs heat. Although there are others, water is the most common cooling agent. Water is commonly applied in the form of a solid stream, finely divided spray or incorporated in foam.


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REMOVE FUEL

Often, taking the fuel away from a fire is difficult and dangerous, but there are exceptions. Flammable liquid storage tanks can be arranged so their contents can be pumped to an isolated empty tank in case of fire. When flammable gases catch fire as they are flowing from a pipe, the fire will go out if the flow can be valved off.


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REMOVE OXYGEN

Oxygen can be taken away from a fire by covering it with a wet blanket, throwing dirt on it or covering it with chemical or mechanical foam. Other gases which are heavier than air, such as carbon dioxide and vaporizing liquid, can be used to blanket the fire, preventing the oxygen from getting to the fire.


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STOP THE REACTION

Studies made during recent years have indicated that the familiar statement, “Remove heat, remove fuel, or remove oxygen, to extinguish a fire” does not apply when dry chemical or halogenated hydrocarbons are used as the extinguishing agents. These agents inactivate intermediate products of the flame reaction resulting in a reduction of the combustion rate [the rate of heat evolution] and extinguishes the fire. A more detailed discussion of this action appeared in the April 1960 issue of the quarterly of the NFPA under the title of “The Chemical Aspects of Fire Extinguishment.”

Classification of Fires

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CLASS A fires occur in ordinary combustible materials such as wood, cloth and paper. The most commonly used extinguishing agent is water which cools and quenches. Fires in these materials are also extinguished by special dry chemicals for use on Class A, B & C fires. These provide a rapid knock down of flame and form a fire retardant coating which prevents reflash.

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CLASS B fires occur in the vapor-air mixture over the surface of flammable liquids such as grease, gasoline and lubricating oils. A smothering or combustion inhibiting effect is necessary to extinguish Class B fires. Dry chemical, foam, vaporizing liquids, carbon dioxide and water fog all can be used as extinguishing agents depending on the circumstances of the fire.

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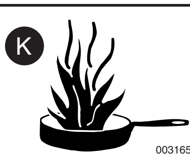
CLASS C fires occur in electrical equipment where non-conducting extinguishing agents must be used. Dry chemical, carbon dioxide, and vaporizing liquids are suitable. Because foam, water (except as a spray), and water-type extinguishing agents conduct electricity, their use can kill or injure the person operating the extinguisher, and severe damage to electrical equipment can result.



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CLASS K fires occur in cooking appliances that involve combustible cooking media (vegetable or animal oils and fats) UL test requires that the fire in the fryer be completely extinguished prohibiting the re-ignition of the vegetable oil for 20 minutes, or until the temperature decreases to at least 60 °F (16 °C) below the auto-ignition temperature, whichever is longer.

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CLASS D fires occur in combustible metals such as magnesium, titanium, zirconium and sodium. Specialized techniques, extinguishing agents and extinguishing equipment have been developed to control and extinguish fires of this type. Normal extinguishing agents generally should not be used on metal fires as there is danger in most cases of increasing the intensity of the fire because of a chemical reaction between some extinguishing agents and the burning metal.

CHARACTERISTICS OF FLAMMABLE LIQUIDS

Flammable liquids are always covered with a layer of vapors. When mixed with air and contacted by an ignition source, it is the vapor, not the liquid which burns.The fuel vapor and oxygen provide two sides of the fire triangle. A flammable liquid is usually more dangerous when temperatures are high because more vapors are generated. Four terms are commonly used with flammable liquids:

FLASH POINT: The lowest temperature at which a liquid gives off enough vapors to form a flammable mixture with air.

FIRE POINT: The lowest temperature at which the vapor-air mixture will continue to burn after it is ignited. This is generally a few degrees above the flash point.

IGNITION TEMPERATURE: The temperature at which a mixture of flammable vapor and air will ignite without a spark or flame. This term is also applied to the temperature of a hot surface which will ignite flammable vapors. The temperature varies with the type of surface.

FLAMMABLE OR EXPLOSIVE RANGE: The range between the smallest and largest amounts of vapor in a given quantity of air which will explode or burn when ignited. The amount is usually expressed in percentages. For instance, carbon disulfide has an explosive range of one to 50 percent. If air contains more than one or less than 50 parts of carbon disulfide vapor, the mixture can explode or burn.

GASOLINE AS A FIRE HAZARD

The most commonly known flammable liquid is gasoline. It has a flash point of about –50 °F (–65 °C). The ignition temperature is about 495 °F (232 °C), a comparatively low figure.

Burning gasoline has a temperature above 1500 °F (945 °C). Therefore, it can heat objects in the fire area above its ignition temperature. To prevent reignition after extinguishment, the agent should be applied for sufficient time to allow hot objects in the fire area to cool below the ignition temperature of the gasoline.

The flammable range of gasoline is only 1.3% to 6%. Gasoline vapors are heavier than air. They tend to flow downhill and downwind from liquid gasoline, making it possible for explosive mixtures to collect – in low points such as pipe trenches or terrain depressions.

If the amount of oxygen in a given atmosphere is reduced from its normal 21 per cent to 14 percent, by diluting with carbon dioxide, most petroleum products cannot burn. As a result, a gasoline fire can be “suffocated” by diluting the atmosphere with an inert gas.

It is dangerous to use water in a solid stream on a gasoline fire because it may spatter the fuel or raise its level in a container so it overflows.

A LAST WORD

Classification of fires is important. It determines the way fire must be put out. Smouldering embers must not be left in a Class A fire; water, which may spread gasoline or other flammable liquids, is dangerous on a Class B fire; conductors of electricity, such as water, should not be used on a Class C fire; and Class D combustible metals require special types of extinguishing agents.

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