Second Edition (Version 1)

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Saga Universal Training Corporation

Saga Universal Training Corp. is dedicated to reducing deaths caused by illness and injury. This course follows the established and accepted guidelines, principles, and recommendations of internationally recognized fire safety organizations.

This training manual is intended to supplement employer training programs. Readers should not assume that reviewing this manual alone constitutes complete self-contained breathing apparatus training.

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Saga Universal Training Corp. wishes to acknowledge the efforts of all the people who contributed to the writing, editing, and layout of this manual. It is our hope that this manual and the resulting training program will aide in the reduction of preventable injuries with the necessary knowledge, skills, and confidence to prevent and suppress fires safely.

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Local Emergency Plans

Everyone should understand what to do in the event of a fire emergency at home or at the workplace. Fire departments sometimes use the following acronym to help people REACT to fires:

Remove those in immediate danger
Ensure Containment
Activate Local Alarm
Call Emergency Number (9-1-1)
Try to extinguish the fire

Removing those in immediate danger

Realizing that at no time is there an expectation that someone should risk their life unnecessarily to rescue someone else, it is reasonable to consider those who may have difficulty leaving the affected area. For example, there may be people who have certain challenges such as walking with a cane or who use a wheelchair that may have difficulty evacuating.

Whether you're at home or at work, it is important to know the procedures for evacuating. In commercial buildings, legislation states that a plan is available to identify escape routes. Floor plans should include the layout of the room, emergency exits, fire extinguishers, pull stations to activate local alarms, and possibly first aid stations. Everyone in the building should know meeting places or "Muster Points" if an evacuation should occur.

The same thing should be applied to your home. Do your children know how to get out of their bedroom safely? Do they know what to look for? Do they know where they should meet? These are all questions parents should ask to get their families ready incase there is an emergency.

Emergency plans should be tested to see if they still work! Many plans are created in a commercial setting and are forgotten or neglected. Have there been renovations in your office? Have things been moved, such as extinguishers? The exits should all be in working order, free of debris, clutter, and snow.

In the event of a fire:

- People should crawl under the smoke
- They should check doors before they open them for signs of heat and smoke
- Close all windows & doors if possible. Do **NOT** lock doors behind you!

Ensure Containment

During evacuation it is very important to try and close windows and doors. Doing this restricts the fire to smaller areas, or containers therefore making suppression activities easier while reducing the fire's growth and the production of smoke.

Activating Local Alarms

Everyone should be aware of how their fire alarm system works, whether at home or at the workplace. Is it an electronic tone or a fire bell?
Fire alarms may be designed to:

- Sound in local areas only
- Automatically dispatch local Emergency Services
- Sound with a single stage alarm
- Sound with a multiple stage alarm
- Sound with different tones depending on the emergency

Most occupancy's have a local alarm that notifies people in the affected area only. This means that if an alarm sounds, it notifies everyone in the area that there is a fire emergency. It does not necessarily mean that the fire department has been called; someone may still need to call the fire department!

It's important that everyone understand how the system operates. If the alarm is tied to the local emergency system or a monitoring agency it is often dispatched automatically to the emergency services department.

Single stage alarms emit one tone once the mechanism as been activated, which in turn notifies people to vacate the area immediately. Some occupancies have a multiple stage alarm; this means that there is more than one level to their warning system. For example, the first stage alarm may indicate that an alarm pull station has been activated and people should get ready to leave the area. Security, or designated personnel are then sent to verify the alarm; if it is confirmed the second stage alarm will be activated. Once stage two has been activated people should evacuate the area immediately.

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Calling Emergency Services (9-1-1)

Notifying emergency services is a very important part of handling an emergency. Knowing what number to call will save crucial time in the event of a fire or a medical emergency. The sooner emergency services are notified, the better chance they have of successfully handling the problem.

In some businesses it may be necessary to call a local emergency number rather than 9-1-1. Emergency numbers should be posted on or near every phone so there is no delay in calling. Sometimes there an extension number that must be dialed before the emergency number, such as (9) 9-1-1?

Try to Extinguish the Fire

Depending on your comfort level, it is not unreasonable to consider extinguishing the fire. However, make sure that it is safe to do so! (This is referred to later in the program.)

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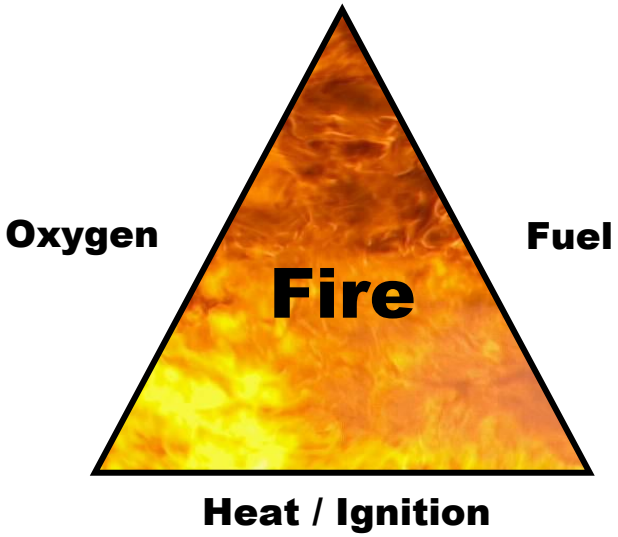
Elements of a Fire

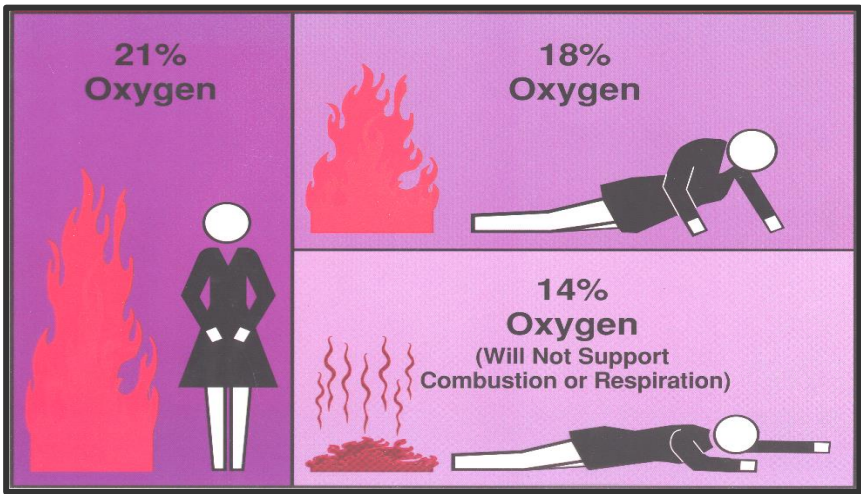
Fire Triangle

Fire is a rapid, self-sustaining chemical reaction that presents itself in the form of heat and light, while releasing other products of combustion.

There are three different elements that must come together for a fire to occur. The fire triangle outlines the elements of a fire that react. These elements include Oxygen, Fuel, and Heat.



Oxygen – The air we breathe contains about 21% oxygen. Fires burn very well at this concentration. However, fire only needs 16% oxygen to ignite. Oxygen concentrations above 21% allow the burning process to be enhanced. Concentrations below 14% will not support combustion of respiration.



Certain materials such as oxidizers including bleach, nitrates and iodine may further enhance the burning process or burn in an otherwise oxygen deficient atmosphere.

Additional examples include:

- Magnesium
- Titanium
- Zirconium
- Potassium
- Lithium
- Calcium
- Zinc
- Sodium

Oxygen Concentrations	Effects
23% and above	Increased flammability of materials. Entry is not allowed.
21%	Ideal.
20.9%	Normal.
18 – 19.5%	Minimum required concentration for safe working conditions.
16%	Increased pulse, decreased coordination, mental impairment, headaches.
14%	Minimum concentration to support combustion.
Less than 12%	Nausea, vomiting, loss of consciousness, convulsions and death.

Fuel – Essentially, everything on earth will burn. However, for things to burn they must first be vapourized and in the proper concentrations. It's important to remember the three states of matter; solids, liquids, & gases and how they change. Temperature and pressure cause states of matter to change; but different products require different temperatures and/or pressures to change.

Primarily, states of matter change with temperature. For example, if an ice cube is heated to 0ºC at sea level, the solid changes to a liquid. If the water is further heated to 100ºC it will change again to a vapour.

The other way states of matter change are through pressure. For example, propane will normally be found in its vapour state. However, if propane is pressurized and contained in a vessel, it changes to a liquid state, without adjusting the temperature. This explains why propane is found liquefied inside an ordinary propane barbeque tank but burns as a vapour.

Heat – Heat is defined as a type of energy transferred between two bodies of differing temperatures. Heat can be transferred through:

- Conduction; movement of heat through metal
- Convection; the vertical rise of heated air of liquid circulating currents
- Radiation; Heat transferred in straight lines as waves requiring no medium such as from the sun or a heater.

Heat changes products in one of the following ways:

- Solid state + Pyrolysis = Fuel Vapours
- Liquid state + Vaporization = Fuel Vapour
- Vapour state = Fuel Vapour

Some of the more common heat sources include include:

- Direct Flame contact
- Electrical
- Chemical
- Nuclear
- Mechanical
  - Sparks
  - Friction

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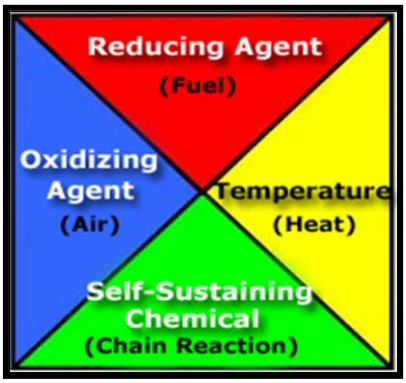
Fire Tetrahedron



The fire tetrahedron theory represents a four-sided object that looks like a pyramid. This takes into account all of the elements of the fire triangle with an additional component called the “chemical chain reaction”.

The elements of the fire tetrahedron are described as the following:

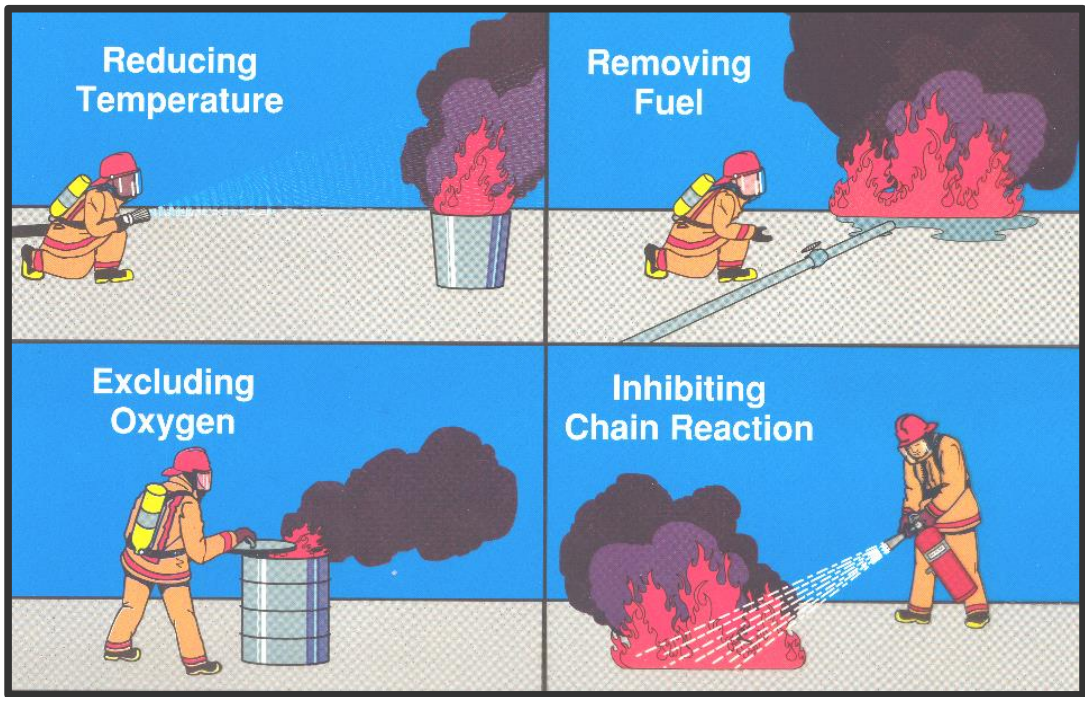
Oxidizing Agent (Oxygen) – This includes oxygen in air and oxidizing agents. Oxidizing agents produce oxygen through the chemical chain reaction of the substance burning.

Reducing Agent (Fuel) – Whenever a substance burns it changes its molecular composition. This is what we call the “reducing agent”, often solid substances turn into an ash when they are burned.

Temperature (Heat) – In order for something to catch fire, it needs to be exposed to some form of ignition source or heated up to its ignition temperature.

Chemical Chain Reaction – This occurs when oxygen, fuel, and heat come together in the right amounts and under the right conditions. Again, this chemical reaction presents itself in the form of heat and light and is known as a fire.

Eliminate any one element of the fire tetrahedron, and a fire cannot exist.



Characteristics of Fuels

Essentially every substance on this earth has some fire potential and will ignite under the right conditions. Understanding these conditions comes from knowing the characteristics of the product, which we can be found on a materials “Safety Data Sheet” (SDS). A list of some common materials and their characteristics is found below:

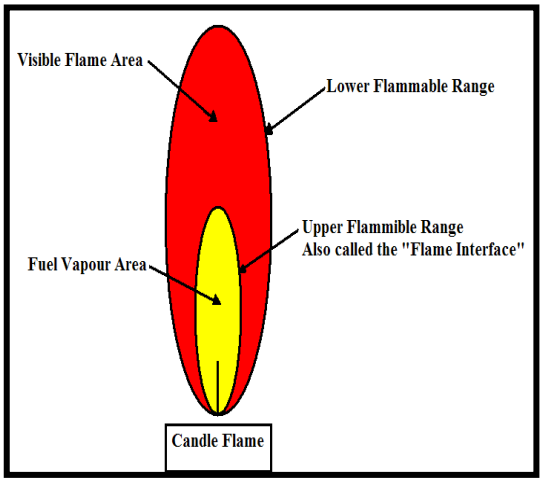
Flashpoint

The term flashpoint is defined as the lowest temperature at which enough fuel vapour is given off to create a mixture in air, which would simply flash on contact with an ignition source. The lower the flashpoint of a product, the greater the fire hazard.

Flammable / Explosive Ranges

Lower Flammable Limit – is the **lowest** concentration of flammable vapour in air that will support combustion. This is also referred to as the “Lower Explosive Limit”.

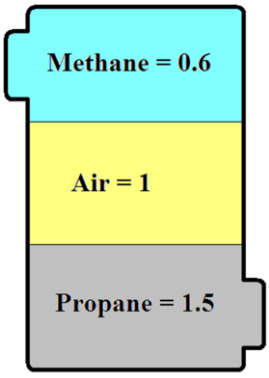
Upper Flammable Limit – is the **highest** concentration of flammable **vapour in air** that will support combustion. This is also referred to as the “Upper Explosive Limit”.



Candles for example are commonly made from paraffin wax. The wax is made mainly of carbon and hydrogen molecules that burn when you light the candle. Paraffin wax has a melting point between 43ºC (110ºF) - 93ºC (200ºF) and a flashpoint greater than 260ºC (500ºF).

Vapour Density

Vapour density is the weight of a gas (vapour) compared to air. Air (or hydrogen in some cases) is used as the medium and has a vapour density equal to one (1). If the gas has a vapour density **greater than** one (1) it will sink in air. Propane for example, has a vapour density of 1.5; therefore, propane will normally sink to the ground and seek low-lying areas. Hence the reason why propane powered vehicles are not allowed in underground parking garages. If the vapour density is **less than** one (1) the vapour will rise in air. An example is methane with a vapour density of 0.6.



Characteristics of common materials

Product	Flash - Point	Flammable Ranges (LFL - UFL)	Physical Description	Main Danger	*Maximum Level Permitted in Air	**IDLH	Specific Gravity (Water = 1)	Vapour Density (Air = 1)
Carbon Dioxide (CO_2)	N/A	N/A	Colourless Odourless	Displacement of Oxygen	5000 ppm	50,000 ppm	1.52	1.5
Carbon Monoxide (CO)	N/A	12.5% - 74%	Colourless Odourless	Toxic - Asphyxiant	25-200 ppm	1,500 ppm	N/A	0.97
Diesel Fuel	>40ºC	0.7% - 6%	Clear to yellow / brown	Toxic - system depressant	N/A	N/A	N/A	4.5
Unleaded Gasoline	-30ºC	1% - 7.6%	Colourless Sweet Odour	Toxic - system depressant	500-1500 mg/m³ 300-500 ppm	Avoid Explosive Levels	0.74	3.5
Hydrogen Sulfhide (H_2S)	N/A	4% - 44%	Colourless	Very Toxic - can cause Respiratory Failure	10-20 ppm	100 ppm	N/A	1.2
Methane (CH_4)	-188ºC	5% - 15%	Colourless Odourless	Fire and Explosion	20% of LFL	Avoid Explosive Levels	0.47	0.6
Nitrogen (N_2)	N/A	N/A	Colourless Odourless	Displacement of Oxygen	Ensure oxygen is at 19.5%	Displaces Oxygen	N/A	0.97
Nitrogen Dioxide (NO_2)	N/A	N/A	Reddish Brown Colour Pungent Odour	Toxic - sever Respiratory Irritant Disturbance	3-5 ppm	50 ppm	N/A	1.6
Propane (C_3H_8)	-104ºC (Boiling Pt. -42ºC)	2.1% - 9.5%	LPG Colourless Mercaptan Odour	Fire and Explosion	2500 ppm	Avoid Explosive Levels	N/A	1.5
Sulfer Dioxide (SO_2)	N/A	N/A	Colourless Suffocating Odour	Toxic - sever Respiratory Irritant	2-5 ppm	100 ppm	N/A	2.2

*** Also know as Occupational Exposure Limit Ceiling or 8 Hour Occupational Exposure Limit.**
**** IDLH - Immediately Dangerous to Life and Health**

Always refer to company specific Safety Data Sheets.

Fire Prevention

Remembering what we have learned so far, it takes the four elements of the fire tetrahedron to come together under the right conditions for a fire to occur.

Oxygen in air is normally found in the right concentrations for a fire, so there is not much we can do to control it. Oxygen can be found in hospitals, at home in medical oxygen cylinders, at work in welding and machine shops and at the farm in pesticides and herbicides.

We also know that a chemical chain reaction will only occur if the three elements of the fire triangle come together in the right amounts. Therefore, by limiting the fuel or ignition we can prevent a fire from occurring.

Information found on a materials Safety Data Sheet is an excellent source of information to prevent fires. Only by understanding a material's characteristics, and how it behaves, can we keep a fire from occurring.

To prevent a fire, one of the four elements needs to be kept isolated. Considering the fire tetrahedron there are only two elements we can control:

1. Fuels
2. Heat / Ignition sources

Isolating Fuels

Keeping your home or work area clean is one way to reduce a fire hazard. Limiting or reducing potential fuels in these environments is an excellent way to prevent fires. Flammable and combustible liquids should be stored in proper containers to prevent spills or leaks.
Do not store fuels:

- In unsuitable containers
- Near heat sources,
- In confined spaces,
- With other products that can react with them e.g., Fertilizers

Note: Fire Departments do not usually respond to clean houses!

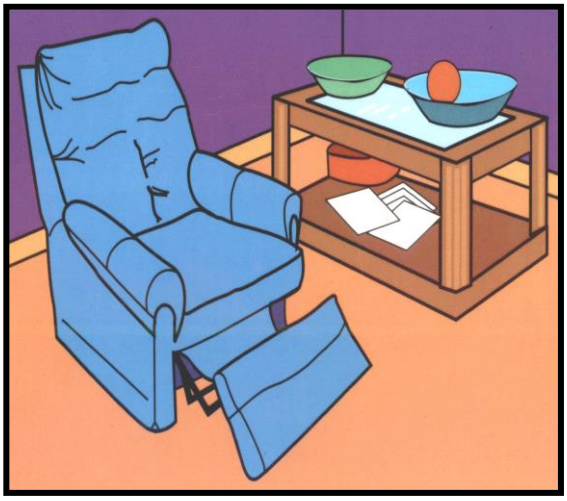
Ignition Sources

It is important to keep ignition sources isolated from any potential fuel. Electricity is a large part of everyday life and should be respected and used appropriately. Overloading electrical outlets could cause circuits to overheat. Electrical cords should be inspected and kept in good condition.

Keeping fuels away from ignition sources like heaters, lamps, and open flames is a good start to preventing unwanted and often deadly fires.

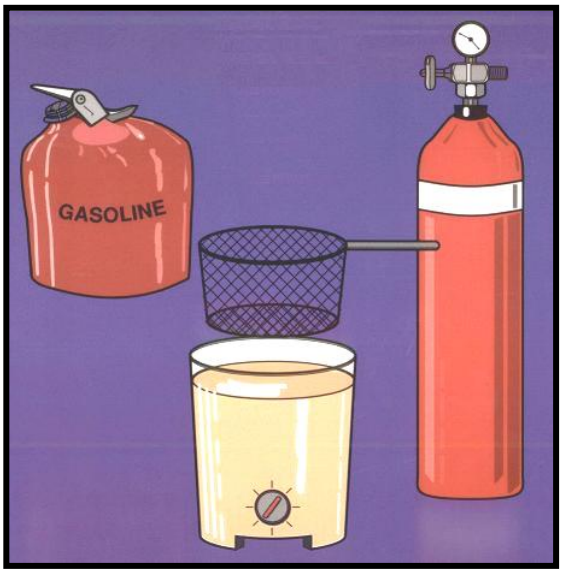
Classification of Fires

Class A Fires



Class A Fires involves "**ordinary combustibles**" such as wood, paper, cloth, rubber, and certain types of plastics. They can also be referred to as any substance that leaves an "**ASH**" when burned.

Class B Fires



Class B fires involve "**flammable or combustible gases and liquids**". Some examples include:

- Gasoline
- Diesel
- Kerosene
- Paint
- Paint Thinners
- Propane
- Natural Gas

An easy way to remember class "B" fuels is that they "**BOIL**" or are normally found in a "**BARREL**".

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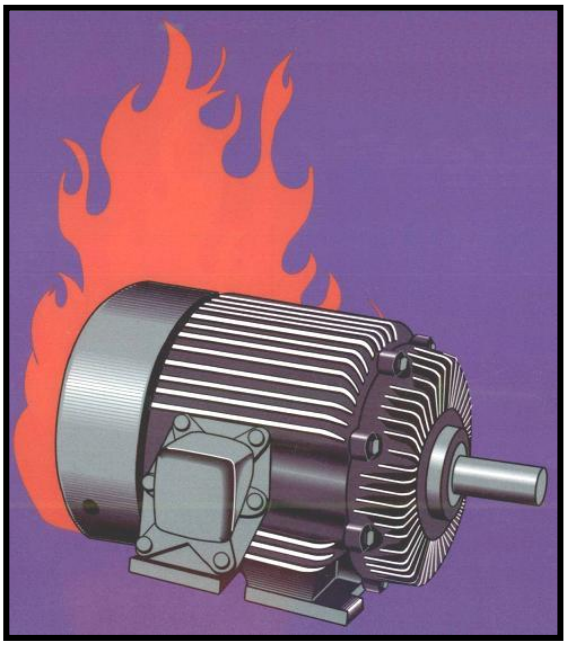
Class C Fires

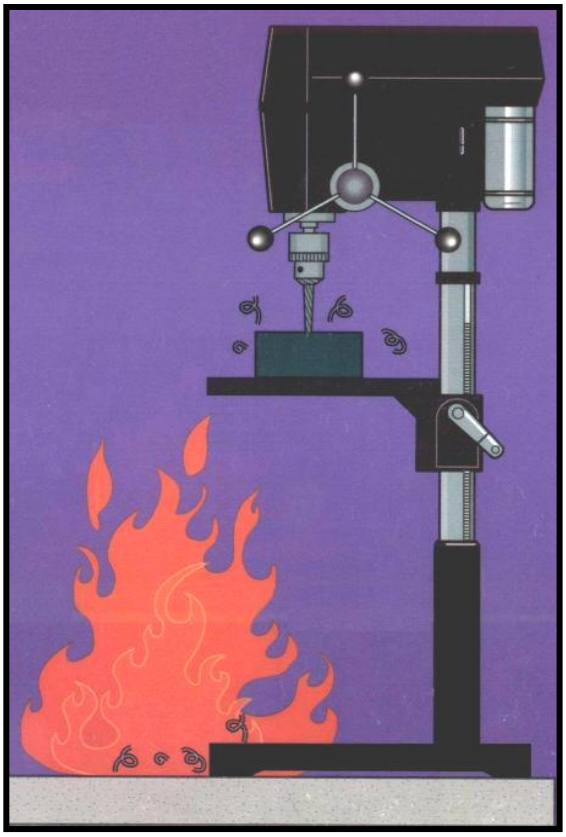


Class C Fires involve "**energized electrical equipment**" such as appliances, electric motors, switches, and power tools.

You can remember these fires because they all involve a "**CURRENT**" or a "**CHARGE**".

The most common type of fire in the workplace involves the misuse of energized electrical equipment.

Class D Fires



Class D Fires involve "**combustible metals**" such as magnesium, titanium, potassium, or sodium.

These fuels require special care and attention as they burn at relatively higher temperatures than ordinary combustibles.

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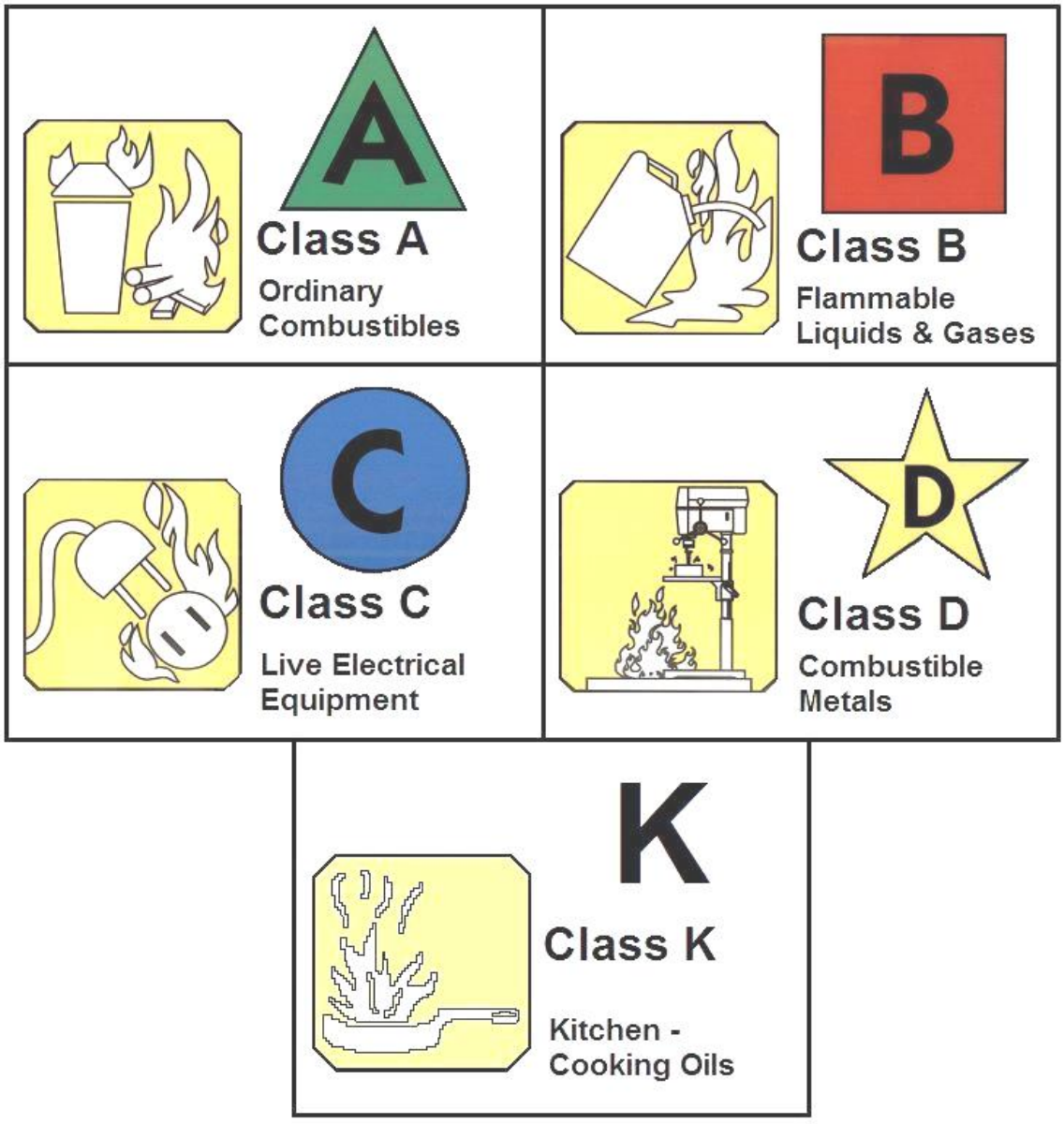
Extinguisher Characteristics

Extinguisher Pictographs

Extinguishers are Classified based on the fires they are designed to put out. Some extinguishers could be marked with multiple ratings such as “AB”, “BC” or “ABC”. You may find one or combinations of the following markings:

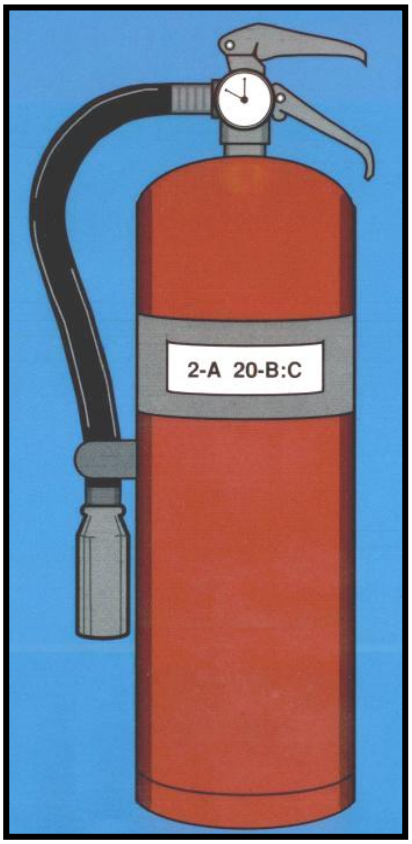
- A, B, C, D, K markings alone or in multiple combinations
- Standard shapes – triangle, square, circle, and star
- Pictograms representing the different classes of fire



Extinguisher Ratings

The Underwriters Laboratories of Canada rates extinguishers based on what an average person should be able to put out.

A trained or experienced person may be able to extinguish 2 ½ times the rating on the extinguisher. To find the rating on an extinguisher you must look for the "Underwriters Laboratory of Canada" symbol or marking.
You should find something that looks like the following: "**2-A, 30-B: C**". The ULC bases its rating on equivalent units of measure as defined below:



1 unit of class A = what the average person can suppress using not more than 5 litres of water. For example, if you find a 3-A rating on your extinguisher it has an equivalent rating equal to 15 litres of water even though the extinguishing agent may not be water.

1 unit of class B = enough extinguishing agent to put out 1/10th of a square meter of flammable liquid with a depth greater than 6 mm. For example, if you find a 30-B rating on your extinguisher it is rated for 3 square metres. But how can we estimate how large an area we have with a rating less than 10-B? To approximate the rating another way we can look at it as follows: 1/10th of a square meter is approximately equal to 1 square foot of flammable liquid. Therefore 1-B is equal to about 1 square foot. If we have a 5-B rating, we have a rating of approximately 5 square feet of flammable liquid.

Class "C" fires are not rated because once the electricity is removed the remaining fire is a Class A and/or B fire.

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Extinguishing Agents

There is a variety of agents available depending on the application for the extinguisher.

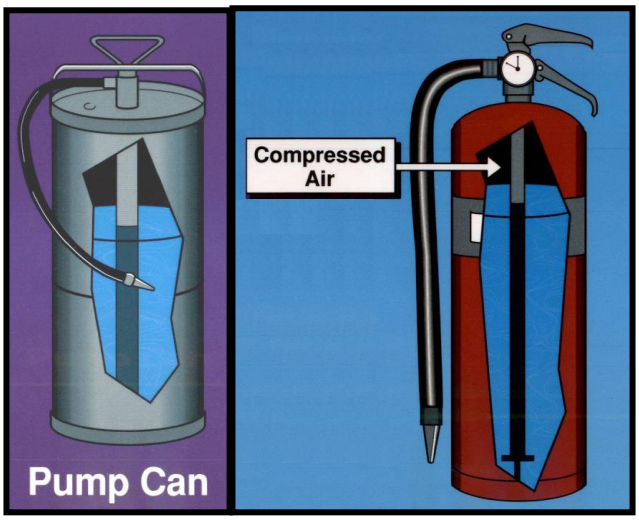
The following are the most common agents found in extinguishers:

- **Water** – is the most common agent used to extinguish class A fires
- **Mono-Ammonium Phosphate** – is a dry chemical used in multi-purpose, ABC extinguishers. It has a yellow appearance and no odour.
- **Sodium Bicarbonate** – is a dry chemical that is commonly used in BC extinguishers. It reacts with most cooking oils to form a type of soap that sits on the top of the oil. It has a white crystal appearance and no odour.
- **Potassium Bicarbonate (Purple K)** – is a dry chemical that is used in BC extinguishers. It is said to be 1-½ times more effective than its sodium bicarbonate counterpart. It has a purple crystal appearance and no odour.
- **Carbon Dioxide (CO2)** – is an inert gas most often used to displace oxygen in fires. It is most often found in electrical or computer locations. It is a colourless and odourless gas and when compressed turns to a liquid.
- **Halon** – is a toxic gas that is used to displace oxygen in fires. Halon is a chlorofluorocarbon and is being phased out for more environmentally friendly alternatives.
- **Potassium Acetate Solution** – is a liquid base solution found in Class K extinguishers. These extinguishers are found in commercial kitchens and are used to put out grease and oil fires.

Extinguisher Types

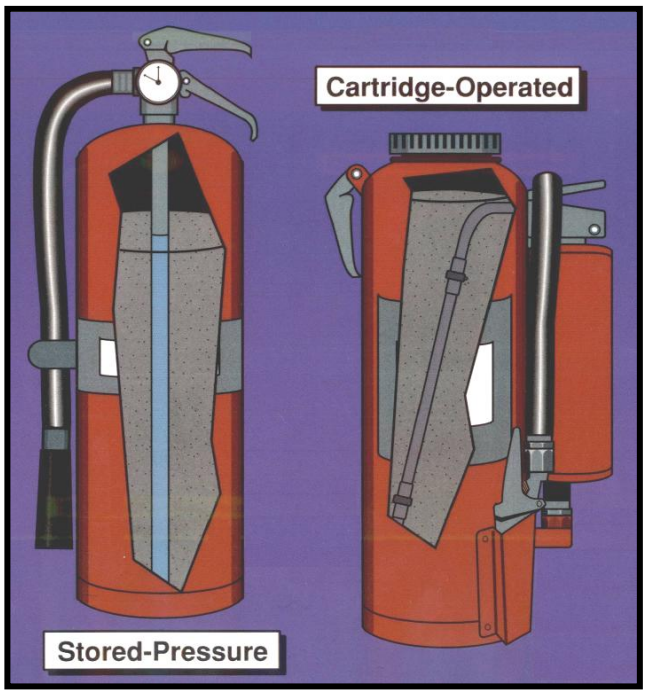
Class A Extinguishers

Class A types of extinguishers are usually water based. The most common type found is called the “stored pressure” type. This means that the agent (water) and compressed gas are found in the same vessel.



Class B Extinguishers

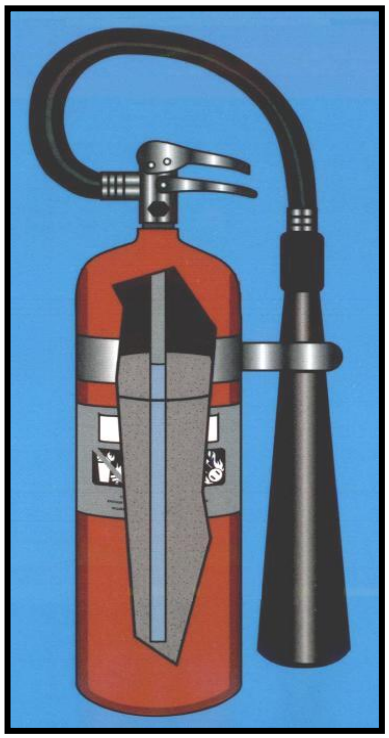
The most common extinguisher found in the home or workplace is what is termed a stored-pressure extinguisher, with the agent and the compressed gas in the same vessel.



The Cartridge operated extinguisher consists of a main vessel that stores the agent, and a compressed gas cartridge that stores the gas. This cartridge has a pressure greater than 1700 psi of inert gas. To use this type of extinguisher the operator needs to transfer the gas into the main product chamber. Once the main chamber is charged it is used the same as the stored pressure extinguisher.

Class C Extinguishers

To be classified as a class C extinguisher, the agent inside must be **non-conductive**. Any dry chemical or inert gas can be considered a class C extinguisher.

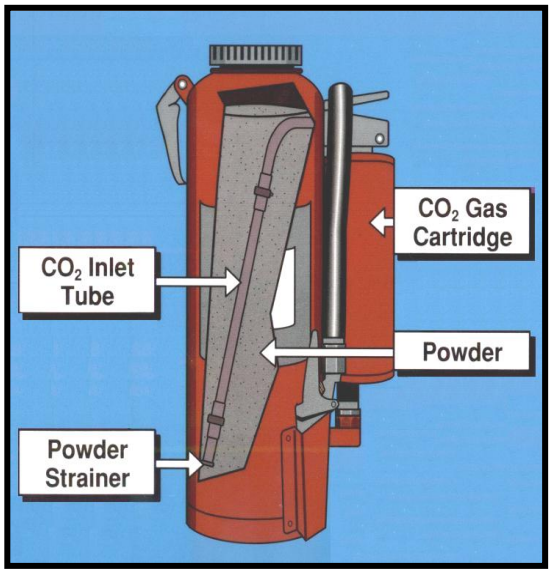


Class “C” extinguishers are often targeted for electrical and computer rooms, as it is possible for dry chemical to cause more damage to electrical components than the fire may have created.

Class D Extinguishers

Class D extinguishers are identical to the dry chemical extinguishers found in class B above. The primary difference is the agent inside the extinguisher. Class D extinguishers contain what is termed, "**Specially Made Dry Powders**".

These agents are designed to suppress combustible metal fires. Dry Powder agent may also be applied from a pail or box, with the idea that you could scoop the powder and sprinkle it on the fire.



Class K Extinguishers

Class K extinguishers are designed and intended for kitchen use only. Industry has found that modern cooking oils burn at much higher temperatures than others used in the past.

The traditional BC dry chemical extinguisher can extinguish these fires however the chance of re-ignition may occur because of the increased temperature. K class extinguishers are liquid based and designed to cool as well as extinguish the fire.

The only difference between the K extinguisher and the typical ABC stored pressure extinguisher is the nozzle; it is designed for liquid application verses the dry powder application.

Extinguisher Parts

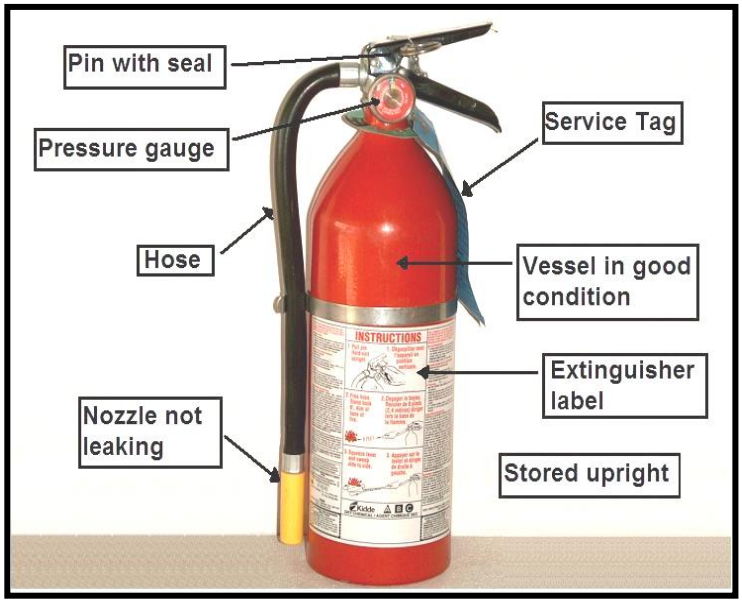
It is important to become familiar with the extinguisher in your area. The following diagram lists most of the items that you should see on the stored pressure type of extinguisher. Cartridge extinguishers have an added compartment on the side that houses the gas cartridge.

Although it is better to have an extinguisher stored in an upright position it may not be practical in some cases. However, when using the extinguisher, it **must** be used in the upright position!!

Pin with seal – the pin should be held in place with a plastic seal. The seal must be broken to remove the pin. Watch for long pins, as they may be bent and difficult or impossible to remove.

Pressure gauge – indicates that the vessel is charged. Typically, it should be pressurized to 195 psi.

Hose – should be present and in good condition.



Nozzle – there should be no powder present on the nozzle, as this would indicate a possible leak in the valve.

Service tag – this tag is placed on the extinguisher by a certifying agency. To be current, the date on the tag should be within one year.

Vessel – should be in good condition. If you find any cracks, dents, or anything else that might compromise the integrity of the vessel do not use the extinguisher.

Extinguisher label – should face outward, be legible and easy to read.

Fighting A Fire

Fighting a fire can be a very traumatic event, it is important to keep your wits about you. Before you consider fighting a fire you should ask yourself the following questions:

- ✓ Will I put my life in jeopardy if I fight the fire?
- ✓ Can I keep my back to an exit?
- ✓ Has the fire department been called?
- ✓ Do I have a properly classified extinguisher for the job?
- ✓ Is the rating on the extinguisher enough to put out the fire?

Pass Technique

If you do choose to fight the fire with an extinguisher you need to use the PASS technique.

Pull the pin
Aim the nozzle – base of the fire
Squeeze the handle
Sweep rapidly side-to-side

Fire Approach

When you choose to approach the fire, you need to consider the following:

- ➢ ONLY fight a fire when it is SAFE
- ➢ Always approach fire from UPWIND
- ➢ Always keep your back to an EXIT

****If in Doubt, GET OUT!!!**