**Chapter 1: Basic Concepts of Fire Engineering**

**1. Introduction:**

Fire can be devastating. Burning, injuring and even killing people. Damaging buildings and equipment. Interrupting business activities. Of course, fire prevention is the best way to make sure that fire doesn't impact persons or business. But one should always have a plan in place for dealing with fires if they do happen. If a fire does start, it can spread quickly. Knowing how to attack a fire before it grows, isn't always straightforward. Not every fire is the same. Different fires can have different hazards and risks. Use the wrong type of fire extinguisher could do more harm than good.

**2. Classification of fire**

There are 6 different classes of fire, and each should be attacked in a different way.

Class A: Fire involving solids

Class B: Fire involving liquids

Class C: Fire involving gases

Class D: Fire involving metals

Class E: Fire involving electrical fires

Class K: Fire involving kitchen related cooking oils and fats

**Class A (Solids)**

Class A fires are fires involving solids. This type of fuel could be paper and cardboard, common in offices and manufacturing. It could be furniture, or fixtures and fittings. It could even be the structure of the building. This is one of the most common types of fire because solids are the most common type of fuel and one that is hard to eliminate.

**Class B (Liquids)**

Class B fires are fires involving liquids. Many of the fluids, liquids and chemicals used in workplaces can be flammable or explosive. Like cleaning fluids, solvents, fuels, inks, adhesives and paints. According to statistics, flammable liquids accounted for only 2% of fires, but a massive 21% of fatalities. These fires are rare but more deadly than other types of fire.

**Class C (Gases)**

Class C fires are fires involving gases. This could be natural gas, LPG or other types of gases forming a flammable or explosive atmosphere. The most common flammable gases involved in fires are propane, butane and methane, and they form the ‘fuel’ aspect of the fire triangle, which is required for the fire to start, spread and continue to burn. Flammable gases, whether kept in cylinders or bulk storage areas, pose a significant fire risk when not stored correctly. They are usually involved in accidental or arson-related highly dangerous fires. Additionally, as flammable gases are often heavier than air, they can travel a significant distance to an ignition source, which means fire can rapidly propagate and spread. This can often cause explosions, as the gases can erupt violently, causing severe and immediate impact. Class C fires occur most commonly in environments which store and use large quantities of flammable gases, such as chemical plants and industrial warehouses. However, as they are also used in heating systems, they are also a risk in a host of other properties, including hospitals, schools and homes.

**Class D (Metals)**

**Class D fires are** something that are not much talked. They're not that common. Class D fires are fires that occur in combustible metals. Metals are not often thought of as a combustible material, some types of metal can be, like sodium. Metals are also good conductors, helping a fire spread. All metals will soften and melt at high temperature, which can be a big problem when metal joists and columns are present in a fire as structural elements. Metals like magnesium, sodium, potassium, aluminum, titanium etc Those metals, when they're in a fine form, like chips or powdered form, are combustible, and they're really hard to put out, because water won't put that type of fire out. In fact, water makes it worse.

**Class E (Electrical Fires)**

This is not strictly a class (class E) of fire, because electricity is more or a source of ignition than a fuel. However, fires in live electrical equipment are an additional hazard. Water cannot be used, or any other conductor as that could be fatal.

**Class K (Kitchen related cooking Fats & oils)**

Class K fires are fires which involve cooking oil or fat. Though technically a sub-class of fires caused by flammable liquids or gases, they differ from conventional fires due to the extremely high temperatures involved. Whereas flammable liquids, such as petrol, usually have low flash and auto ignition temperatures, cooking oil or fats require temperatures in excess of 340°C to ignite. As such, the special characteristics of cooking oil and fat fires – specifically their higher flash point – have been recognised as important enough to categorise them separately. Due to their nature, Class K fires occur in kitchens and food preparation facilities. Most of these fires are as a result of negligence in the kitchen – such as leaving pans unattended, not cleaning oil and fat from surfaces and not regularly changing the oil in deep fat fryers.

**3. Causes of fire and their preventing measures**

An accidental fire can ignite with frightening unpredictability, spread uncontrollably in seconds, and can decimate a home within minutes. Fires either at house or offices or factories endanger everyone in the home (or offices) and even small fires that are put out quickly often result in huge damage of money and lives. Having a proper insurance policy is essential to help mitigate the financial losses associated with a fire, but it is far better to prevent the circumstances that lead to fires in the first place. According to statistics from various Fire Protection Associations, there are more than thousands of fires each year in the countries, leading to damage of many lives and crores of rupees. Fires can be started in a number of ways, but they generally fall into one of two categories:

* fires caused by heat igniting combustible materials, and
* those caused by chemical reactions.

We can study causes of fire and their preventing measures as

1. Fires at home
2. Industry fire

**3.1 Fires at home:** Home are full of objects and materials that can combust under the right conditions. Some of the common causes of house fires are familiar to everyone, while there are many other causes which are unorthodox. Identifying and lowering these risks help people lower the chance of house fire, keeping families and properties safer.

Following can be listed out as the causes of a fire:

1. **Cooking related fires:** Cooking fires are among the most common types of house fires, causing around 49 percent of all residential fires. They are very often caused by greases that become overheated on a stove or in an oven. Grease is highly flammable when it gets hot enough (about 600 degrees Fahrenheit, on average) and when it reaches that point, it can combust spontaneously, even without direct flame contact. Once grease is ignited, it is very difficult to smother the flames. So it is also advisory not to leave the kitchen unattended when cooking in oil or when cooking a food that produces grease. Most kitchen fires start because when a homeowner leaves food cooking unsupervised on a stove or in an oven. By the time the fire is discovered, it’s usually too late. Cookware should be thoroughly cleaned to prevent grease from building up over time.Portable cooking appliances, such as toasters and electric griddles can also be a source of fires. These portable appliances should never be left unsupervised, and it should be made sure that they are cool to the touch before storing them away. Toasters should be regularly cleaned of crumbs that might ignite if they build up inside the appliance. During the outdoor cooking season, barbecue grills left unattended on a wooden deck or near the exterior walls of a home can also be a source of fire. A heated grill next to a wooden fence can easily cause fire, and grills have been known to ignite the exterior walls of a home or garage if positioned too close. Small grease fires can be extinguished quickly by turning off the heat and smothering the fire with a metal lid. Sprinkling baking soda or salt on the fire will also put it out, as well. A class-B or class-K fire extinguisher is also recommended, although the chemicals can create a notable clean-up issue. With serious fires, no attempt should be made to put out the fire. Instead, fire department should be called immediately. Under no circumstances water should be dumped over the grease fire, as this can cause the hot grease to explode and throw burning grease over the area.
2. **Heating appliances:** Home space heaters and baseboard heaters can cause fire when fabrics and other combustibles are left too close to them. Heating and cooling appliances of various types are the second leading cause of residential fires, responsible for approximately 12 percent of all home fires. Heaters that require fuel, such as kerosene are especially dangerous, as they can ignite or blow up if not properly watched. Electrical heaters can cause fires if the electrical wiring is faulty, or if draperies or other fabrics overheat when they come in contact with the coils. For prevention of such fires one should always follow the instructions on any heating device one use, and inspect it regularly to ensure it is in good condition. One should ever leave the house with a heater running. Space heaters almost always have instructions warning against unsupervised use, but thousands of house fires each year can be attributed to such appliances left running when homeowners are absent. It should be made sure that flammable materials are kept well away from space heaters.
3. **Electrical fires:** Various types of electrical faults in home wiring cause thousands of fires each year, accounting sever damages of lives and properties. Most typically, electric fires occur because of short circuits causing arcing (sparking) that ignites building materials, or from circuits that are overloaded with current, causing wires to overheat. Electrical problems account for about 10 percent of all residential fires, but this type of fire is often deadly, accounting for about 18 percent of deaths due to home fire. This is likely because electrical fires often ignite in hidden locations and build into major fires before residents are aware of them and such fires frequently may ignite while residents are sleeping. Properly installed electrical systems are very safe, with a number of built-in protective features, but old, faulty wiring systems can be susceptible to short circuits and overloading. It's a good idea to have the wiring checked out by a professional electrician, especially if people live in an older home.
4. **Chemical fires:** Although fires caused by chemical reactions are more common in industrial/commercial locations, they are also a common cause of home fires. Residential chemical fires occur most commonly when volatile vapors from gasoline and other petroleum liquids reach a flash-point temperature or when the fumes contact a source of open flame. Another common type of chemical fire is spontaneous combustion—the reaction of chemicals combining with oxygen in the air to produce enough heat to reach a flashpoint and ignite in flame. Chemical fires of various types cause thousands of fires each year and while a relatively small number of these are residential fires, they can be especially deadly because they are so unexpected. One should store all fuels and other chemicals in their proper containers and keep them in locations that are protected from heat. A common source of this kind of fire is the gasoline or other fuel used to power lawn equipment. Following points are for safely storing gasoline:

* Use an approved container. The best storage container for gasoline is a red plastic container that is printed with labelling identifying it as an approved container.
* The container should be filled no more than 95 percent full. This allows a space for vapors to expand without rupturing the container.
* Keep containers tightly sealed to prevent gas vapors from escaping and possibly reaching a source of flame or spark.
* Container should be stored at least 50 feet away from pilot lights and ignition sources, such as the heat, sparks, and flames from a water heater, space heater, or furnace. A detached garage or shed is an ideal spot to store these fuels. If no such space exists, then store fuel containers on the outside wall of an attached garage, as far as possible from living spaces.

Another cause of chemical fires is when oily rags spontaneously heat up. So oil-soaked or chemical-soaked rags should not be stored after they are used, and especially they should not be stacked them in a pile, because heat can be spontaneously generated as the fumes combine with oxygen. Oily rags should be spread out in an outdoor location until the oil evaporates. Once thoroughly dry, they can be washed for reuse. If possible, we should store paint thinners, mineral spirits, and other flammable liquids in a fireproof cabinet, well separated from living spaces. We should make sure individual containers are kept tightly sealed.

1. **Smoking or candles:** Houses are best to be kept off limits for smoking. A cigarette that is not put out properly can cause a flame, as the butt may stay alit for a few hours. It could burst into flames if it came into contact with flammable materials, such as furniture. Candles look and smell pretty, but if left unattended they can cause a room to easily burst into flames. Keep candles away from any obviously flammable items such as books and tissue boxes. Always blow a candle out before leaving a room.

**3.2 Industry fires:** Industrial fires and explosions cost companies and governments billions of dollars every year, not to mention the loss of life, which can’t be described in monetary terms. These disasters happen for many reasons, often because employees aren’t aware of the risks that surround them at work every day. Following are the most common causes of industrial fire and explosions:

**(1) Combustible dust:** Often overlooked, and highly deadly, combustible dust is a major cause of fire in food manufacturing, woodworking, chemical manufacturing, metalworking, pharmaceuticals, and just about every other industry you can name. The reason is that just about everything, including food, dyes, chemicals, and metals — even materials that aren’t fire risks in larger pieces — has the potential to be combustible in dust form and these explosions aren’t easy to contain. In a typical incident, a small fire will result from combustible material coming into contact with an ignition source. This may be a dust explosion, but it doesn’t have to be. In fact, it could be most any other type of explosion on this list. However, this small explosion isn’t the problem. The problem is what happens next. If there’s dust in the area, the primary explosion will cause that dust to become airborne. Then, the dust cloud itself can ignite, causing a secondary explosion that can be many times the size and severity of the primary explosion. If enough dust has accumulated, these secondary explosions have the potential to bring down entire facilities, causing immense damage and fatalities.

The key ingredient in combustible dust fires and explosions is the presence of the dust itself. Although it is not possible to eliminate dust entirely, one can make sure it does not accumulate to a dangerous level simply by following a regular housekeeping regimen.

**(2) Hot work:** Hot work is one of the leading causes of industrial fires across all industries. Although hot work is commonly equated with welding and torch cutting, there are many other activities — including brazing, burning, heating, and soldering — that pose a fire hazard. This is because the sparks and molten material, which reach temperatures greater than 1000°F, can easily travel more than 35 feet. Hot work is also a major culprit in combustible dust fires, as the sparks generated from the work can ignite dust in the surrounding area.

Like combustible dust incidents, hot work disasters are preventable by following proper safety procedures:

* **Avoid hot work if possible:** This isn’t always a feasible solution, but if there’s an alternative, take it.
* **Train personnel** on the hazards associated with hot work, any site-specific hazards, the proper policies and procedures, and the use of safety equipment.
* **Ensure that the area is clear of flammable or combustible materials** including dusts, liquids, and gasses.
* **Use a written permit system** for all hot work projects, even where permits aren’t required. Better safe than sorry!
* **Supervise the work** especially if one use outside contractors, make sure a safety professional is on hand to provide supervision.

**(3) Flammable liquids and gases:** These fires, which often occur at chemical plants, can be disastrous. There is certainly some danger inherent in any work involving flammable liquids and gasses, but all available safety precautions should be taken to mitigate these risks.

* **Know the hazards.** One major component of prevention is simply knowing the safety information for every liquid on your premises. This information is available on the material safety data sheet (MSDS) that comes with such products.
* **Store flammable liquids properly.** Make sure all hazardous materials are stored according to guidelines.
* **Control all ignition sources.** Except for when you’re intentionally heating the flammable materials, keep ignition sources as far away from them as possible.
* **Provide personal protective equipment.** This is a must across all categories of fire hazards but especially when liquids and gasses are involved.

**(4) Equipment and machinery:** Faulty equipment and machinery are also major causes of industrial fires. Heating and hot work equipment are typically the biggest problems here — in particular, furnaces that aren’t properly installed, operated, and maintained. In addition, any mechanical equipment can become a fire hazard because of friction between the moving parts. This risk can be brought down to practically zero simply by following recommended cleaning and maintenance procedures, including lubrication. Even seemingly innocuous equipment can be a hazard under the right circumstances and, in many cases, the equipment least likely to be thought of as a fire risk turns out to be the biggest problem. This is because companies may not recognize the risk and therefore won’t take the necessary precautions.

Strategies for preventing fires due to equipment and machinery issues fall into three main categories:

* **Awareness:** Awareness programme should be conducted as, if employee do not know the risk involved they cannot prevent the causes too.
* **Cleaning and housekeeping:** Equipment and machinery and the area surrounding it must be kept clean. Equipment, especially electrical equipment that is covered with dirt or grease constitutes a huge risk. By keeping the equipment and machinery clean, one will up their chances that, should a fire start, it won’t have enough fuel available to burn for long.
* **Maintenance:** The manufacturer’s recommended maintenance procedures for all of the equipment and machinery in the plant should be followed. In addition to reducing fire risk by preventing overheating, regular maintenance will also keep equipment working in satisfactory shape.

**(5) Electrical hazards:** Electrical fires are one of the top five causes of fires in manufacturing plants. Here a non-exhaustive list of specific electrical hazards:

* Wiring that is exposed or not up to code
* Overloaded outlets
* Extension cords
* Overloaded circuits
* Static discharge

The damage caused by these fires can quickly compound thanks to several of the other items on this list. Any of the above hazards can cause a spark, which can serve as an ignition source for combustible dust, as well as flammable liquids and gases.

As with the previous risks, the key to preventing electrical fires is awareness and prevention. This involves training, maintenance, and following best practices. Here are a few to put into practice right:

* Don’t overload electrical equipment or circuits.
* Don’t leave temporary equipment plugged in when it’s not in use.
* Avoid using extension cords, and never consider them permanent solutions.
* Use antistatic equipment.
* Follow a regular housekeeping plan to remove combustible dust and other hazardous materials from areas that contain equipment and machinery.
* Implement a reporting system so that anyone who observes an electrical fire risk can report it without consequences.

**4. Fire extinguishing methods**

To understand how best to extinguish a fire, there must first be an appreciation of the three elements that make up the ‘fire triangle’: heat, fuel and oxygen. As fire is primarily a chemical reaction, removing one or more of these three factors will prevent the combustion from taking place.

A fire needs three elements to ignite:

1. Heat
2. Fuel and
3. Oxygen

**Heat:** Heat is required to ignite a fire, and will continue to be generated as the fire burns. For intentional fires, this could be as simple as the striking of a match. For accidental fires however, ignition can occur as a result of obstructing ventilation on machinery that heats up, or flammable materials being too close to heaters.

**Fuel:** Fuel can be anything that is combustible, such as wood, petroleum and spirits, and a number of gases. Solid fuels must reach a critical temperature in order to ignite, while many liquids release flammable vapours even when cold. Gases are the most hazardous and temperamental state, and can combust instantaneously.

**Oxygen:** The air feeding a fire only needs to be made up of 16% Oxygen in order to react with the heat and fuel. Generally, at low/normal altitude, the level is over 20%.

If the three parts of the ‘fire triangle’ are kept in mind, extinguishing a small blaze should be a matter of common sense. The principles of fire extinction state that a fire will be put out if one of the three elements are removed, and this can be done using three different approaches, as detailed below:

1. **Cooling:** Removing the heat is one of the most effective methods of fire extinction available, which is why water is a popular extinguishing material. The fire will go out so long as the heat generated by the fire is less than that which is absorbed by the water. Although we should keep in mind the fact that water is not an appropriate extinguishing material to use on electrical fires, as well as those caused by cooking oils/fats or other flammable liquids.
2. **Starving:** While cooling removes the heat/ignition element of the ‘fire triangle’, starving the blaze of its fuel source approaches extinction from a different angle. A raging fire will burn itself out if it runs out of flammable materials, such as a bonfire out in the open that isn’t in contact with any other wood or dry grass. Similarly, a gas fire will immediately extinguish if the gas supply is cut off – you only have to look at a gas stove or Bunsen burner to see that.
3. **Smothering:** As the other key component present in the chemical reaction that causes combustion, removing oxygen from the equation is the final way of extinguishing a fire. For example, smothering a frying pan blaze with a fire blanket reduces the oxygen to below the 16% required to react, while covering a candle with a glass will snuff it out in a vacuum. Smothering is a technique that is mostly applicable to solid fuel fires, although some materials may contain enough oxygen within their own chemical makeup to keep the blaze burning.

**5. First aid**

The characteristics of relief action in a burn disaster are closely linked to the particular nature of the damage that fire causes in living persons and material goods, the manner of its occurrence, the dangers to which the rescue workers are exposed, and the specific type of care that has to be given to the victims. The timeliness and the effective impact of relief work depend on both general and local factors.

In the specific case of the "burn disaster", particular circumstances - such as the moment when the disaster occurs (night, day-time, public holiday, unfavourable weather conditions), the place of the disaster (residential area, skyscraper, isolated locality), the degree of accessibility, and the distance from operational rescue forces - all acquire importance because any delay will prevent relief work from being immediately available. A decisive role is therefore played by local intervention factors which chiefly depend on the behaviour of the people present at the scene of the disaster, and on the action of the operative teams that arrive rapidly on the scene. The peculiar nature of the burn disaster therefore necessitates well-defined chronological and qualitative operative phases. A person with burns of the airways and associated trauma needs immediate care of a different type from that given to the victim of an earthquake, flood or cyclone. It is also of fundamental importance, for prognostic reasons, that pending the arrival of organized relief some medical and/or surgical first aid must be given within a very short time according to the type of pathology present. The prognosis of burn disaster victims is thus conditioned by the degree of preparedness of the population facing the fire emergency and by the operational capacity of volunteers, physicians and nurses present in the area or in the immediate vicinity who have received previous training in this specific type of relief work. If people are to be able to give immediate care either to themselves or to others, they must know precisely what they have to do, they must have information not only about behaviour guidelines that will enable them to save themselves (self-rescue) but also about some elementary principles necessary for immediate help to others. Understanding the danger represented by fire also means how to tackle it and how to defend oneself from it. The more specific aim of first aid is to contain the injury and to reduce the risk of mortality. This is the responsibility of the already mentioned trained groups who get organized within two or three hours of the disaster. These groups, consisting of physicians, nurses and volunteers with well-defined tasks, perform the first emergency triage and, bearing in mind the particular evolution of the initial phase of the bum disease, set into motion all the procedures necessary for initial resuscitatory therapy and local treatment of the burns.

Following are the ten guidelines for the immediate care of burn victims by rescue workers

1. **Self-control**

The first rule to follow in the event of a fire is: "Don't panic". Rescuers must behave rationally and avoid any heedless action. The first thing to do is to examine the situation, assess the gravity of the fire and opt for the appropriate behaviour. To help others one must first be able to protect oneself

1. **Self-protection**

Rescue workers must know how to protect themselves from flames, fumes, toxic gases, falling masonry and other hazards to their personal safety. Therefore they must:

* not walk over ground covered with easily flammable material (paper, sawdust, brushwood, etc.);
* keep away from anything containing flammable liquid that might explode. Open containers holding liquids that burn at low temperature (e.g. petrol or kerosene) radiate heat that may be sufficient to ignite them;
* not cross floors or lofts, or use stairs, or walk under ceilings exposed to the flames;
* not stand downwind from the flames and must anticipate a sudden change in the direction of the fire. Even in the absence of wind, crossing zones exposed to air currents (tunnel exits, air-shafts, narrow passageways) becomes risky;
* consider the possible direction in which the fire may spread to protect themselves from the flames;
* if possible, use protective clothing and devices: for example, helmets, which protect the head and prevent the hair from catching fire; dark glasses, even ordinary sun-glasses, to protect the eyes from glare, sudden blazes and flying flaming particles; gloves, a welder's apron, etc.; a safety-belt, if available, which can be worn and tied to a rope held by another rescue worker, when carrying an injured person; and dust-masks, which prevent the inhalation of solid particles liberated by the fire and thus prevent irritation phenomena of the upper airways.

1. **Diminishing the action of the fire**

Pending the arrival of the fire brigade the rescue worker must:

* evacuate all people at risk, beginning with those in places most immediately threatened;
* remove from the area of the fire all flammable material, gas cylinders, etc.
* switch off ventilation and air-conditioning systems to keep out fresh air which feeds the fire and to prevent the flammable and toxic gases and vapours from spreading;
* switch on any fixed extinguishing equipment such as water-jets and sprinklers;
* use correctly the available portable fire extinguishers;
* avoid using water to extinguish flames on or near electric plants (the material that such structures are made of can react by considerably increasing in temperature or by releasing flammable and noxious gases).

1. **Extraction and transfer of victims to the open air**

Before entering a burning room one must:

* put a wet cloth over the mouth, or wear a gas-mask;
* enter the room on all fours and crawl forward in this position, as smoke tends to rise;
* if there are flames in the room, wrap oneself in a blanket and advance on all fours;
* crawl backwards down any stairs in order to avoid tripping;
* before a closed door, feel the handle or the door itself before opening it; one could be caught in a blast of flames and smoke as soon as it is opened;
* watch out for glass surfaces (doors, windows) because the heat and pressure generated by fire can cause them to explode;
* approach cautiously air-shafts or small rooms without any ventilation. Before doing so, a rope guide is useful;
* avoid passenger or goods lifts as a power breakdown can transform them into traps and they also become flame shafts;
* if trapped in a room remember that the best thing to do is to shout for help from the window;
* not stay any longer than necessary in a room, not be too sure of oneself, in other words not do anything rash.

1. **What to do when clothing is on fire**

It is extremely distressing to feel oneself wrapped in flames or to see another person transformed into a human torch. In these circumstances it is more than ever essential to remain calm and to know precisely what to do:

* to extinguish flames in one's own clothing, one must clasp one's arms around the chest, and roll about on the floor;
* to extinguish other people's clothing, it is best to throw them to the ground (tripping them up if necessary), to get them into a horizontal position, and to wrap them in a blanket or carpet or any other heavy material that can be rolled up (if they remain standing or sitting the flames will rise to their face and inevitably they will inhale hot air, smoke, etc.);
* burning clothing should not be extinguished with violent jets of water aimed directly at the person: this can increase pain and the state of shock. Jets of water containing large amounts of oxygen can increase the combustion of petroleum and of synthetic clothes.

1. **Removal of burning clothing**

It is advisable:

* to cut away belts, sleeves and tight clothing with great care;
* to remove rings, bracelets and other constricting items: as the burn oedema develops these can cause ischaemia;
* not to tear off violently clothing, especially socks and shoes, adhering to burned surfaces, as this would also tear away skin that would be useful in the healing process;
* to remove at once, having first cooled them, if possible, with cold water, clothes impregnated with boiling liquids.

1. **Emergency treatment of burned areas**

To prevent burn lesions from deteriorating, it is essential:

* not to burst any blisters, or remove the epidermis. Exposure of the dermis only increases the loss of body fluids and heat, besides increasing pain and the risk of infection;
* to cool the burned parts with water or wet cloth. This stops the action of the thermal agent and considerably reduces pain. Very extensive burns must be treated either by immersing the part in water at room temperature or by covering the part with damp cloth. The cooling operation should generally not exceed 20 minutes. It should be guided by the patient's general condition and the degree of pain relief achieved. Cooling a patient must be stopped if he begins to shiver, as this can lead to hypothermia. Children and elderly persons and those in a state of shock must be treated with even greater care, with less energetic and shorter cooling. Non-extensive burns can be soothed with ice-packs or by placing the part under a running tap;
* to use clean plastic bags, if available, to wrap burned hands and feet, or to spread out like adhesive flaps over burns on the thorax, limbs, etc.;
* to wrap burned parts or the entire body in a freshly laundered dry sheet, towel or cotton or linen cloth, and not to apply dressings as these would cause constriction as the burn oedema increases;
* not to medicate burned parts with ointments or other drugs as these would only mask the picture.

1. **Pending more complete relief**

It is necessary to:

* check for other associated trauma, such as bleeding, fractures, head injury and respiratory distress;
* use a belt, cord, etc., as a tourniquet to stop haemorrhage;
* plug the wound with a tampon, if available;
* lay the patient flat and apply splints to fractures;
* clear the airways by extending the head of the victim and to begin mouth-to-mouth respiration;
* give just coffee or tea or even a little water (but not more than 100-150 cc). Stop giving liquids if the patient vomits. No alcohol;
* keep the patient warm by covering him with a blanket;
* reassure the patient.

1. **Chemical burns**

The following three rules are helpful:

* First, wash the part that has been exposed to the chemical with copious amounts of water (eyes and face with greater care). Remove impregnated clothing and wash any parts previously covered;
* Without delay establish the chemical's pH by one of the following simple tests:
* Tip- of- the- tongue test. Touch the burned skin and place the finger on the tip of the tongue; if the chemical is acid, there will be a bitter taste; if it is alkaline there will be no particular taste but a pungent and dry sensation. This test is safe and reliable.
* Saliva test. Spread a little saliva with the fingers over the burned skin. If the chemical is alkaline a soapy emulsion will form between the fingers. An acid will cause no reaction.
* Bicarbonate test. Sprinkle some bicarbonate over the burned skin. An acid, not an alkali, will produce effervescence.
* If possible, apply mildly tamponading substances to the washed parts: kitchen vinegar ( 1 acetic acid) diluted with 50% . water in alkali bums; household sodium bicarbonate (two teaspoonfuls in a litre of water) for acid burns. The eyes must be washed using water only.

It is important to obtain all information on the nature of the chemical and to relay it to the hospital where the victim is taken, so that the appropriate antidote can be applied.

1. **Electrical burns**

When faced with a bum due to electrical power it is necessary to:

* switch off the current if the victim is still in contact with a conductor. If this is not possible, and if the current is less than 500 V, separate the part of the body in contact using a pole, broom-handle, wooden plank or any other insulating material, or with insulating gloves, rubber shoes, etc.;
* lay the victim flat on the ground;
* if fainted but breathing, lay him on one side;.
* if unconscious and not breathing, place one hand under the back of his neck and stretch the head back. This will allow air to pass through the upper airways which have been obstructed by the root of the tongue or by the dropping of the jaw;
* if still not breathing, start mouth-to-mouth respiration immediately;
* if unconscious, not breathing, no carotid pulse and dilated pupils, start artificial respiration and external cardiac massage and continue until medical relief arrives.

**5. Fire fighting equipment**

Following is the list of fire fighting equipment:

1. Fire extinguishers
2. Smoke detectors
3. Fire extinguisher cylinders
4. Fire suit
5. Fire hydrants
6. Fire sprinklers
7. Fire beater
8. Fire blankets