Paper-1

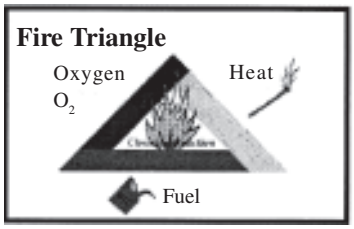
Fire Safety & Industrial Hazards

Unit-1 ❑ Introduction of Fire Safety & Management

Structure

1.1 Chemistry of Combustion

FIRE CHEMISTRY



CONVENTIONALLY THE BASIC REQUIREMENT FOR A FIRE TO OCCUR IS OXYGEN, HEAT AND FUEL REPRESENTED AS **"FIRE TRAINGLE"**

FIRE CHEMISTRY

BUT IT IS RECOGNISED THAT CHAIN REACTIOIN IS ALSO REQUIRED FOR AFIRE TO CONTINUE. THUS FIRE IS PICTORIALLY REPERSENTED IN THE FORM OF "FIRE TETRADEDRON"

FIRE CHEMISTRY

IN SHORT FOLLOWING IS REQUIRED FOR FIRE TO OCCUR

1. FUEL: PRESENCE OF SOME FUELIOR COMBUSTIBLE MATERIAL
2. OXYGEN: ENOUGH OXYGEN TO SUSTAIN COMBUSTION REACTION (OR PRESENCE OF AN OXIDISING AGENT)
3. HEAT/ENERGY: THE COMBUSTIBLE MATERIAL MUST BE HEATED TO ITS PILOTED INGINTION TEMPERATURE OF SUFFICIENT ENERGY TO IGNITE/ PRODUCE HEAT TO SUPPORT FLAME SPREAD.

FIRE CHEMISTRY

4. SUSTENANCE OF CAHIN REACTION

TAKE AWAY ANY ONE OF THESE THINGS AND THE FIRE WILL BE EXTINGUISHED

FIRE SAFETY, AT ITS MOST BASIC, IS BASED UPOON THE PRINCIPLE OF KEEEPING FUEL SOURCES AND IGNITION SOURCES SEPARATE.

FIRE CHEMISTRY

ONCE FIRE STARS SUBSEQUENT BURNING OF COMBUSTIBLE MATERIAL IS DERCTLY DEPENDED ON THE HEAT FEED BCK FROM THE FLAME TO THE COMBUSTIBLE MATERIAL

1. THE BURING WILL CONTINUE UNTIL;
2. THE COMBUSTIBLE MATERIAL IS CONSUMED OR;
3. THE OXYGEN (OR OXIDISING AGENT) CONCENTRATION IS LOWERED TO BELOW WHAT IS REQUIRED TO SUPPORT COMBUSTION OR;
4. SUFFICIENT HEAT IS REMOVED OR PREVENTED FROM REACHING THE COMBUSTIBLE MATERIAL TO PREVENT FURTHER FUEL PYROLYSIS OR;
5. THE FLAMES ARE CHEMICALLY INHIBITED OR SUFFICENTLY COOLED TO PREVENT FURTHER REACTION.

FIRE CHEMISTRY

HAZARDS ASSOCIATED WITH HYDROCARBON

1. HYDROCARBON VAPOURS ARE HEAVIER THAN AIR
2. LOW FLAMMABILITY LIMIT
3. SMALL ENERGY REQUIRED TO IGNITE VAPOUR/AIR-MIXTURE
4. LIGHER HYDROCARBONS HAVE VERY LOW FLASH POINT

FIRE CHEMISTRY

FLAMMEBLE LIMITS

IT IS THE RANGE OF MIN AND MAX PERCENTAGE OF HYDROCARBON VAPOURS IN AIR WHICH CAN IGNITE IN PRESENCE OF IGNITION SOURCE.

HYDROCARBON	LIMIT (%)
HYDROCARBON	4.1-74
NAPHTHA	1.1-5.9
GASOLINE	1.3-7.6
KEROSENE	0.72-5.0
DIESEL	0.72-5.0
LPG	1.8-9.6
ACETYLENE	2.0-82.0

FIRE CHEMISTRY

AUTO OR SELF IGNITION

TEMPERATURE GIVING OFF GAS AND VAPOURS WHICH WILL IGNITE WITHOUT ANY EXTERNAL SOURCE OF IGNITION.

HYDROCARBONS	AUTO IGNITION TEMP
HYDROGEN	585
LPG	405-405 (Propane 466; Butane)
NAPHTHA	288
GASOLINE	350
SKO	254
HSD	256
LSHS	316
FO	262-407

FIRE CHEMISTRY

FLASH POINT

TEMPERATURE GIVING OFF GAS AND VAPOURS TO IGNITEMOMENT BY AN OUTSIDE SOURCE OF HEAT:

HYDROCARBON	FLASH POINT
NAPHTHA	–18
BENZENE	–11
GASOLINE	–7
HSD	32
LD	66
LSHS	66-166
BITUMEN	205
MINERAL TURPENTINE OIL	322

FIRE CHEMISTRY

FIRE POINT

TEMPERATURE GIVING OFF GAS AND VAPOURS TO SUSTAIN FLAME WHEN IGNITED BY AN OUTSIDE SOURCE OF HEAT.

Class of Petroleum Products

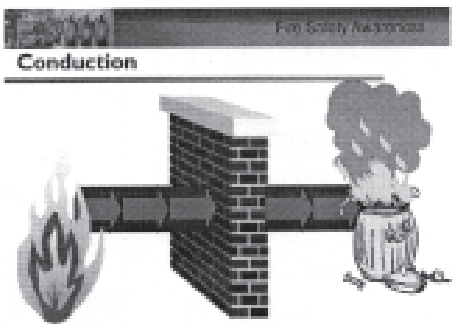
Class-A : FP Less than 23 deg. Cen

Class-B : FP 23-65 deg. Cen

Class-C : FP 65-93 deg.Cen

Excluded : FP More than 93 deg. Cen

FIRE CHEMISTRY SPREAD OF FIRE



FIRE CHEMISTRY

INCIPIENT STAGE:

THTE INCIPIENT STAGE IS AN REGION WHERE PREHEATING. DISTILLATION AND SLOW PYROLYSIS ARE IN PROGRESS. GAS AND SUB-MICRON PARTICLES ARE GENERATED. AND MOVEMENT, AND TRANSPORTED AWAY FROM THE SOURCE BYU DIFFUSION, AIR MOVEMENT, AND WEAK CONVECTION MOVEMENT, PRODUCED BY THE BOUYANCY OF THE PRODUCTS OF PYROLYSIS.

SMOULDERING STAGE

THE SMOULDERING STAGE IS A REGION OF FULLY DEVELOPED PYROLYSIS THAT BEGINS WITH IGNITION AND INCLUDES THE INITIAL STAGE OF COMBUSTION. INVISIBLE AEROSOL AND VISIBLE SMOKE PARTICLES ARE GENERATED AND TRANSPORTED AWAY FROM THE SOUCE BY MODERATE CONVECTION PATTERN AND BACKGROUND AIR MOVEMENT.

FIRE CHEMISTRY

FLAME STAGE

THE FLAMING STAGE IS A REGION OF RAPID REACTION THAT COVERS THE RERIOD OF INITIAL OCCURRENCE OF FLAME TO A FULLY DEVELOPED FIRE. HEAT TRANSFER FROM THE FIRE OCCURS PREDOMINANTLY FROM RADIATION AND CONVECTION FROM THE FLAME.

FIRE CHEMISTRY

IGNITION SOURCES

1. OPEN FLAMES
2. HOT SURFACES
3. SMOKING
4. RADIATN HEAT
5. CUTTING & WELDING
6. SPONTANEOUS/AUTO IGNITION
7. FRICTIONAL HEAT OR SPARKS
8. ELECTRICAL SPARKS
9. OVENS/FURNACES/HEATING EQUIPMENT
10. SPARKS FROM VEHICLE EXHAUSTS
11. STATIC ELECTRICITY
12. LIGHTNING
13. HOT SURFACES

FIRE CHEMISTRY

FIRE

FIRE IS A RAPID SELF SUSTAINED OXIDATION PROCESS INTENSE ENOUGH TO RELEASE OF ENERGY IN THE FORM HEAT AND LIGHT. COMBUSTION IS AN EXOTHERMIC, SELF-SUSTAINING REACTION.

EXPLOSION:

1. OXIDATION REACTION PRECEEDS AT A GREATLY ACCELERATED RATE.
2. THE HIGH PRESSURE DISSIPATES IN THE FORM OF SHOCK WAVE.
3. IT IS HIGH PRESSURE SHOCK WAVE THAT CAUSES THE DAMAGING EFFECT.

DEFLAGRATION:

RESULTNAT SHOCK WAVE WHAT PROPAGATE FROM THE POINT OF IGNITION AT A VELOCITY LESS THAN THE SPEED OF SOUND/ SHOCK WAVE VELOCITIES IN EXCESS OF THE SPEED OF FIRE.

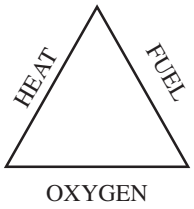
1.2 Chemistry of Combustion & Causes of Fire

Introduction : One of the best preparations one can have from and emergency situation is to have studied the general aspects of the situation before it happens. All the major disaster have happened recent and past, remind us because the people involved did not know what to expect and so had wrong plans and had erros in their operating procedures during fire fighting and before.

Combustion : Combustion is a chemical process that involves oxidation sufficient to produce heat or light, i.e., combustion is an exothermic reaction.

Triangle of Combustion : All combustion process involves three important factors :

1. A combustible material or fuel must be present
2. Oxygen, either from air or from some other Oxygen, supplying substance must be present
3. Heat (a portion of the two materials must be heated to temperature at which combustion will be initiated).



Combustion will occur as long as the three factors present. Removal of one of them caused the triangle collapse and further combustion stop.

Fuel : The fuel may be solid, a liquid or a gas. The burning of most materials produces a flame. This is caused by ignition of the gases or vapour given off by liquid or a solid.

Exthermic Reaction : A chemical reaction in which heat is produced:

Example: $C + O_2 \rightarrow CO_2 + 94{,}300$ calorie

or (Carbon + Oxygen) $\rightarrow$(Carbon dioxide) + 94,300 calorie

Endothermic Reaction: A chemical reaction in which heat is absorbed.

Example: $C + 2S \rightarrow CS_2 - 19{,}800$ calorie

Carbon + Sulphur Carbon disulphure – 19,800 calorie

Heat : Heat may be defined as energy possessed by substance due to motion of molecule. Total heat contained by a body is equal to the product of its mass, temperature and its specific heat.

Heat is most necessary to raise the temperature of the fuel to its ignition temperature in the particular circumstances encountered at the time of combustion. The amount of heat, needed will depend on various factors, such as , physical state, whether it is a powder or a solid lump or liquid or a gas. The concentration of supporter of combustion and the chemical nature of fuel.

The heat may come from spark, a flame or an exothermic chemical reraction.

1.2.1 Factors Involved in Combustion

1) **Oxidation :** An oxidation is said to be reaction which involves the addition of oxygen or any other electronegative element or radical or removal of Hydrogen of electro-positive element other than hydrogen.

   Example:

   a) **Addition of Oxygen :** The burning of Sulphur in presence of Oxygen (may be supplied by air to form Sulphur dioxide as:

   $$S + O_2 \xrightarrow{\text{Heat}} SO_2\uparrow$$

   or Sulphur + Oxygen + Heat Sulphur Dioxide Gas

   b) **Removal of Hydrogen :** Manganese dioxide removed Hydrogen from Hydrochloric acid is an example or Oxidation:

   $$MnO_2 + 4HCI \rightarrow MnCl_2 + 2H_2O + Cl_2$$

   Manganese dioxide + Hydrochloric Acid →Manganese chloride + Water + Chlorine

2) **Reduction:** Reduction is the reverse of oxidation, i.e., it involves the addition of Hydrogen or any other electropositive element or the removal of oxygen or any other electro-negative element or radical.

   Example :

   a) **Addition of Hydrogen:** The combination of Hydrogen with Chlorine to form Hydrogen :

Chloride Sunlight

$H_2 + Cl_2 \rightarrow 2HCl\uparrow$

Sunlight

or Hydrogen + Chlorine Oxygen $\rightarrow$Hydrogen Chloride

b) **Removal of Oxygen** : The reduction of cupric oxide to metallic copper by heating the former in a current of Hydrogen:

$CuO + H_2 \rightarrow Cu + H_2O \rightarrow$Copper + Water

Note : The term oxidation and reduction are complementary and one can take place without the other.

Example: $2HgCl_2 + SnCl_2 \rightarrow Hg_2Cl_2 + SnCl_4$

In this reaction $HgCl_2$ reduced into Hg_2Cl_2 and $SnCl_2$ oxidized into $SnCl_4$

3) **Oxidizing Agent**: The material that provides the oxygen necessary for the oxidation-reduction reaction of the diffusion flame combustion process is called oxidizing agent.

Following materials are oxidizing agents.

a) Oxygen and ozone (Air)

b) Hydrogen peroxide.

c) The halogens, such as fluorine, chlorine, bromine and iodine.

d) Concentrated Nitric Acid and Sulphuric Acid.

e) Manganese dioxide and Led dioxide.

f) Sodium Nitrate, Potassium Nitrate, Sodium Chromate, Potassum Chlorite, Potassium Chlorate, Silver Nitrate.

g) Sodium Chromate, Potassium Chromate, Sodium Dichromate, Potassium Permanganate, Sodium Hypochlorite and Hypochlorite.

4) **Reducing Agent:** A reducing is a substance which has tendency take up oxygen or any electronegative element or radical.

The following are some of the most important reducing agents:

a) Hydrogen and Nascent Hydrogen.

b) Carbon, Carbon Monoxide and Hydrocarbon.

c) Hydrogen Sulphide and Sulphurous acid.

d) Certain metal like, Sodium, Potassium, Alluminium, Zinc, Magnesium etc.

e) Metallic salt like, Ferrous sulphate and Stamous Chloride in Ageour Solution.

5) Combstible material plus a supporter of combustion other than Oxygen.

Example :

(a) Carbon dioxide has is projected on burning magnesium, the magnesium "break down" the carbon dioxide burn vigorously in the oxygen leaving free carbon.

$2Mg + CO_2 \rightarrow 2MgO + C$

Magnesium + Carbon →Magnesium Oxide + Carbon

(b) Many organic materials will burn readily in halogen gases. Such as a paper moisten with Turpentine oil, burns vigorously in presence of Chlorine gas.

$C_{10} H_{10} + 8C_{12} \rightarrow 16HCI + lOC$

Turpentine oil + Chlorine →Hydrogen Chloride + Carbon

(c) Nitrogen is not usually a reactive element but some metal like magnesium and aluminium will burn vigorously in this gas to form their Nitrides.

$3 Mg + N_2 \rightarrow Mg_3 N_2$

Magnesium + Nitrogen →Magnesium Nitride

1.3 Acids, Bases and Salts

Acids and bases are widely used in industry and are amongst the mast frequently encountered chemical hazards. The concept of acids and bases involves aqueous solution.

Acid: For aquous solution acid may be defined as a substance which will dive H + (H_3 + 0) ions in solution.

Strong Acids: Acids which are extensively dissociated (effectively 100%) into ion are described as strong acid. Strong acid will have a pH of 0 to 2. Hydrochloric acid (HCI), Nitric acid and Sulphuric acid (H_2SO_4)

Weak acids: Acids which are less than 100% dissociated are described as weak acid. Weak acids will have a l h. Of say 36. Examples are the organic acids such as acetic acid (CH_3COOH) oxalic acid (H_2C_2)

Base : A base may be defined as substance which react with a acid to give as salt and water only.

i.e., Acid + Base →Salt + Water

$HCl + NaOH \rightarrow NaCl + H_2O$

Hydrochloric acid + Sodium hydroxide →Sodium chloride + Water

This process frequently referred to a **neutralization.** This process can be used to reduce the harmful reflects of an acid if a spillage occur. Thus we say that an acid will **neutralize** a base will **neutralize** an acid.

A soluble base is referred to as a n alkali and its solution is referred to as alkaline.

Common alkalies:

(i) Caustic Alkalies :-

a. Sodium Hydroxide (NaOH)

b. Potassium Hydroxide (KOH)

(ii) Carbonates and Bi-carbonates

These are sodium carbonate (Na_2CO_3) calcium carbonate ($CaCO_3$), sodium bicarbonate ($NaHCO_3$) treated as weaker alkalies and with acid give carbon dioxide.

General Properties of Acids

a) Acids are substances which contains hydrogen which may be replaced by metal.

Example : Sulphuric acid react with zinc to from zinc sulphate and hydrogen gas evolved.

Reaction : $Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$

Zinc + Dil. Sulphuric acid $\rightarrow$Zinc sulphate + Hydrogen

b) Acids will librate carbondioxide from a carbonate or bicarbonate.

Example: Sodium bicarbonate react with sulphuric acid to form sodium bisulphate, water and carbon diox ce gas.

Reaction: $2NaHCO_3 + H_2SO_4 \rightarrow Na_2SO_4 + H_2O + 2CO_2$

(Sodium bi-Sulphuric $\rightarrow$Sodium Sulphate + Water + Carbondioxide

Carbonate) acid

(c) Acids are often corrosive, attacking the eyes and the skin.

(d) All acids turn blue litmus to red

(e) All acids have a sour taste in Dilute solution.

Sulphuric Acid (H_2SO_4)

Physical Properties:

(a) Sulphuric acid is colourless oil liquid.

(b) It is heavier than water.

(c) It has a specific gravity of 1.84.

(d) **Reactive towards water:** Sulphuric acid in concentrated solution is a very powerfull dehydrating agent, that is, it has an ability to absorb large quantities of water. When mixed with water considerable heat is evolved. Thus reaction occurs is exothermic reaction. If concentrated sulphuric acid is to be diluted, it is very dangerous to pour water into the acid. The reason is that being than the acid, it does not get easily mixed up. Owing to the diffinity of the acid much heat is evolved and water vapour is formed.

This vapour splash up together with the concentrated acid and causes burn if it comes in contact with the body. The concentrated acid should be added to water very slowly to prepare dilute sulphuric acid and the mixtures stirfed.

1.4 Types of Fire Extinguishes with Extinguishment

Introductory: Chemical Extinguishers are essentially a class of handy portable fire-fighting appliances, with a limited capacities of Fire Extinguishing media. 'They are also called portable fire extinguishers or First-Aid, fire-fighting appliances for use only on certain types of fire in the incipient stages .

Portable is applied to manually operated fire-extinguishers used especially on small fires, or in the interim between discovery of fire and the functioning of automatic equipment, or arrival of professional fire-fighters.

They are generally small and light in weight and can be carried easily from place to place. Larger Models of certain types know as trolly units and chemical engines are mounted on simple two wheeled chassis, fitted with length of hose to extend the available range. The extinguishing agents might be chemicals in the form of very fine solid particles, liquid or gas contained in the cylinders .

Fire can be divided into two groups-wanted and unwanted. The first group includes fires which provide various utilities to man, such as fires for cooking and warmth for power and locomotion for a travel to moon and back to earth etc. The Second Group of fires are the ones which are dreaded to lay man, the uncontrolled fires which burn down his dwellings, his work places, his forest wealth, his hard earned precious goods, and cause death, and misery to his near and dear ones. It is this group of fire for which the methods have been developed for their suppression and prevention.

The fire fighter of today, living in a world which is fast advancing in science and

technology-is far removed from his counter part of by - gone years. He confronts an increasing variety of fires, involving both natural and man made materials in ever growing complex combinations. His job involves much more than just throwing water on each and every fire. It has become necessary for him to know the nature and type of combustible materials and their behaviour in a fire in order to select the correct extinguishing medium and to achieve extinguishments at the minimum time without any risk to his own person.

He has therefore, to acquire an adequate knowledge in many diversified field and the range specialisation has expanded from use of plane water to the use of most modem vatpourising liquids.

1.5 Classification of Fires

The fire scientists have classified all fires into various categories on the basis of the nature of combustible materials, and to situations in which they might be found. As per I.S.S. 2190-1979 the classification of fires is given as under :

1 Class 'A' Fires Fires in ordinary combustible materials such as wood paper, textiles etc. where the cooling effect of water is essential for the extinction of fire.

2. Class CB' Fires Fires in inflammable liquids such as acids, organic solvents, petroleum products, varnishes, paints etc. where a blanketing effect is essential for the extinction of fire.

3. Class 'C' Fires Fires involving gaseous-substances Such as methane, propane, butane, acetylene, cooking gas including Natural gas. (Under Pressure), where, it is necessary to dilute the burning gas at a very fast rate with an inert gas or dry chemical powder.

4. Class 'D' Fires Fires involving burning and powders of combustible metals, such as magnesium, aluminium, zinc, or alkali metals, like sodium and potassium etc., where the burning metal is reactive to water and require special extinguishing agents and techniques.

TABLE-1

Suitability of Different Type of Portable Fire Extinguishers for Different Classes of Fires

Sr No	Types of Fire Extinguishers	A	B	C	D
1.	Water Type (Soda Acid) Fire Extinguisher (IS : 934-1976)	Suitable	Unsuitable	Unsuitable	Unsuitable
2.	Water Type (gas pressure) Fire Extinguisher (IS : 940-1976)	”	”	”	”
3.	Water Type (bucket pump) Fire Extinguisher (IS : 1924-1961)	”	”	”	”
4.	Water Type (constant air pressure) Fire Extinguisher (IS : 6234-1976)	”	”	”	”
5.	Foam Type Fire Extinguisher (IS : 933-1976)	Non-suitable	Suitable	”	”
6.	Carbon dioxide type Fire Extinguisher (IS : 2878-1976)	-do-	”	Suitable	”
7.	Dry powder Type Fire Extinguisher	-do-	”	”	Suitable

1.5.1 Extinguisher which expel water or dilute-chemical solution

A. Soda Acid Extinguisher : This extinguisher essentially consists of a cylindrical or conical container which is normally filled with water to an indicating mark. This water is ejected on to the fire by the Pressure of gas generated by chemical action setup by allowing a charge of acid to reach with a carbonate or bicarbonate which has previously been dissolved in the water. The gas thus generated experts a downward force on the surface of the liquid and drives it out of the extinguisher through a nozzle. Sodium-bi-carbonate and sulphuric acid are the two chemicals normally used for generating the gaseous carbon-dioxide, which is used as the expelling medium. The reaction takes place according to the equation.

Sodium-carbonate + Sulphuric Acid = Sodium Sulphate + Carbon dioxide + Water

Equation : 2 Na HCO_3 + H_2SO_4 = $2H_2$ + $2CO_2$ +Na_2 SO_4 2NaH CO_3 + H_2SO_4 = Na_2SO_4 + $2CO_2$ + $2H_2$

Note : It is the water in the form of dilute chemical solution, which extinguishes the fire by cooling effect and the CO_2 does not play any part in the extinction of fire.

Discharge Performance : (IS : 934-1976)

When the extinguisher is set in operation under normal conditions of temperature 27 + 2°C, the solution shall be expelled in the form of a jet which shall-maintain the effective throw of not less than 6 m for the minimum period given below provided that the solution shall be 95% discharged within maximum period specified.

(a) Minimum period during which jet shall be maintained at a length not less than 6 m- 60 seconds.

(b) Maximum period for discharge (95% Solution)- 120 seconds.

The Charge :

The charge shall consist of :

(a) Carbonate or dicarbonate of soda in solution of such strength that no Precipitation shall take place at 45°F (7.29°C) and

(b) An acid (in a Bottle) in such proportions that when the extinguisher is operated In the normal manner at 60°F. (15-6°C) the discharge liquid is alkaline.

Note : It is recommended that standard charge shall consists of 125 to 140 gr. Of sulphuric acid of specific gracity 1.833 and 1 lb. 2oz. (o.5kg.) if bicarbonate of soda for a 2 gl. (91trs.) extinguisher.

1.5.2 Soda Acid extinguisher in Upright Position

1. Conical type with plunger on the top : One of the common type is conical in shape with a nozzle near the top. Inside the body is a discharge tube, fitted at its lower and with a strainer to prevent small particles of glass etc. Clogging the discharge tube or nozzle. At the top is a screwed cap a cause will be found holding a glass phial and the outer-container water with bicarbonate in solution. Striking the plunger breaks the phial and allows the acid to escape and the us set up the necessary chemical reaction.

2. Cylindrical type with plunger on the top : this is same as above type, except that the body is cylindrical in shape.

3. Conical type with the puinger at base : This is conical in shape. It has a plunger at the bottom instead of at the top. This type of extinguisher is normally aduated in an upright position but operated almost horizontally.

4. Turn over type of Soda Acid Extinguisher : This types of extinguisher operate on a different principle, it is inverated to initiate the action and operated in this position.

Turn over type with plunger : This type is operated by first turning upside down and then driving in a plunger which shatters a glass phial.

It should be noted that the turn over types do not required sniffer valve as they are not fitted with a discharge tube. Any pressure which might be built up through temperature changes escapes immediately to atmosphere through nozzle.

Note : If a types operated in the upright position is inadvertently used in the turnover position the gas pressure will escape, through the discharge tube leaving the liquid contents behind whilst if a turnover type is brought into operation and then returned to its normal upright position, the CO_2 will be ejected through the nozzle and the liquid will remain in the extinguisher.

1.5.3 Testing

1. Check the Poll swing :
   1. Vent holen in the cap
   2. Nozzle
   3. Sniffer valve (where fitted)
   4. Washer in the cap :
   5. Liquid
   6. Acid phial:
   7. Plunger.

Must be kept clear of dirt, Metal polish etc.

2. Annual discharge test must be carried out on a due from last occasion when used at a fire or for test purpose.

3. Each extinguisher should be subjected to a hydraulic pressure test of 17 5 kg./cm. In rotation at an interval of 2 year,. (IS . 100 : 72).

1.5.4 Uses

1. Should not be used on live electrical wiring etc., as the jet is a conductor of electricity.

2. When using in a soda acid extinguisher in burning oils, Spirit or highly inflammable liquids, the jet will splash and spread the fire and the burning liquid with float on the top of the extinguishing medium.

3. When using a Soda Acid Extinguisher, wait until you are as near to the fire as possible

before actuating it. Direct the jet on to the burning material in the heart of the fire, disregarding flames and smoke.

1.5.5 Safety Devices

Usually the following safety devices are incorporated in the design of Soda Acid Extinguishers.

(a) Vent Holes : These are small holes drilled in the side of the head through the screw threads. As the cap unscrewed, these holes communicate with the interior of the container and the design is such that any residual gas pressure will discharge through them while the head is still held in position by the threads. They must be kept clear of dirt and metal polish and capable of fulfilling their function.

(b) Sniffer Valve : This is a valve communicating between the air space in the extinguisher and the atmosphere outside and permits the very small quantity of air to escape where the internal pressure rises slightly due to increase in the ambient temperature. It is a ball of rubber composition disc., which rest rightly on an office connecting with the body of the extinguisher. When the extinguisher is operated, the high internal pressure lifts the ball or disc firmly and seals the outlet.

Other similar devices in the form of expansion chamber or a thin rubber diaphragm might also be provided.

B. Water (Gas Cartridge) Type

In this type the outer container is similar to soda acid Extinguisher and holds 2 gallons (9 litres) of water but the gas (excellent) is released from aninner container (cartridge), it has a sealing disc at the top which is pierce by a pointed striker at the lower end of the plunger, when the extinguisher is operated. The extinguisher is usually operated upright. The details of discharge rate tube, and safety devices are precisely the same as for Soda Acid Extinguishers.

Types :

(a) Low pressure type : The cartridge normally contains about 2 oz. of C02 at just below 500 Ibs./sq. inch (35 kg/cm2).

(b) High pressure omitted.

The uses are the same as for Soda Acid Extinguisher and since the expelled liquid consists of pure water only, there is no possible damage such as caused by chemically charged water discharged by a soda acid extinguisher

Test : The test specified are the same as for Soda Acid Extinguisher except that the gas cartridge should be weighed every three months to detect any loss.

Main Advantages :

(i) Normally only water is expelled, thus risk of damage to cotton fabric etc. is reduced.

(ii) Cartridge can be easily and rapidly recharged.

(iii) Other liquids may be used to deal with special risk.

(iv) Non coffosive anti-freezing chemicals may be used in cold weather.

(v) Low temperature do not rated the discharge.

C. Chemical Foam Extinguisher (2G.S.) Liters Capacity :

The appliance essentially consists of :-

(i) An inner container (ii) An outer container made of sheet metal lead coated inside to prevent corrosion and tested to a hydraulic pressure test of 17.5 kg./sq. inch for at least 2.5 minutes without leakage or distortion, in rotation at an interval of 2 years. (IS:2190-1979)

Expansion Space :

The level of the liquid in the outer container is permanently indicated so that there is an air space above of not less than 5% of the total volume.

Main body & Inner Container :

1. Outer Container : Hold a Solution 8% Sodium-bi-carbonate with about 3% of stabilizer such as Seponin, Liquioriees Turky red oil etc. dissolved in water.

2. Inner Container : Contains a solution of about 13% aluminium sulphate.

Action : When the extinguisher is brought into action, the two solution mix and a chemical reaction is set up which produces carbon-dioxide and foam.

The gas acts as the expellent as well as filling the foam bubbles.

The reaction is deplected below :-

Aluminium Sulphate + Sodium-bi-carbonate ; Sodium Sulphate + Almunium Hydroxide + Carbon-dioxide.

(Equation): $Al_2(SO_4)_3 + 6NaHCO_3 \rightarrow 2AL(OH)_3 + 3Na_2SO_4 + 6CO_2$

Note : The foam produced is a frothy produce which retains its texture for a comparatively long time. It is relatively insoluble in most liquids and owing to its weight, floats on the surface of the liquid, when applied correctly and in sufficient quantities it foams a blanket capable of covering the surface of the burning liquid and this normally effective in completely extinguishing the fire by smothering principle.

Discharge Performance : IS 933 – 1976

The nozzle shall be incorporated with the cap in the double seal type and with the top end (dome) in the break seal in the plunges. The design of the area of office shall be such that when the extinguisher is operated in normal temperature condition 27+2°C, the foam solution shall be expelled in the form a jet which Fill maintain the throw of not less than 6m for the minium period of time given below, also provided that minimum of 95% of expelled foam shall be discharged from tile extinguisher within maximum period specified below :-

(a) Minimum period during which the jet shall be maintained as a length not less than 6m.- 30sec.

(b) Maximum period ; for complete discharge of 95% of Expelled foam-90 secs.

(c) Plunger type the inner compartment is sealed by means of a mica disc and strike knob mechanism sealed thus allowing the extinguisher to breath with variation of temperature.

Testing : At quarterly inspection, check vent holes in the cap nozzle, sniffer valve (where fitted) and must be kept clean of metal polish or dust. Check level for scaling devices and when replacing cap check washer and screw the cap fight.

2. Each extinguisher should be tested by discharge once a year this period to date from last occasion when it was used at a fire or for test purpose.

3. A hydraulic pressure test of 25kg./cm2 should be carried out every fourth year.

Advantages :

1. Foam costs the burning surface of the substance and excludes oxygen :

2. Foam bas considerable heat resisting qualities as an insulator and prevents reignition ;

3. Foam is not effected by draught;

4. Foam floats in the most liquids and quenches many types of liquid fires.

Disadvantages :

1. Foam mixes with certain types of liquids and renders them unmovable.
2. When used in conjunction with dry powder, it may break down the foam unless the powder is compatible with the foam.
3. Chemical foam and mechanical foam have detritus effect on each other.

D. Carbon Dioxide or CO_2 Extinguisher :

1. Carbon dioxide as an extinguishing medium is widely used in portable extinguishers.

At ordinary temperature, it is a gas but liquefied when compressed for storage in cylinders. It produces chilling effect when released and part of the gas is solidified in fine particles in the form of dry ice. It rapidly vaporises and its expansion ratio is 1:450. The cooling effect is likely to play some part in extinguishing the fire but it is exclusion of oxygen which is of primary importance. The contents of the cylinder are held under a pressure of 744 lbs. Per sq. inch at 60°F.

Hysical Properties : CO_2 is a colourless, odourless gas and is a non-supporter of combustion. It has no poisonous effects but if inhaled in large quantities may lead to suffocation. It has also the physiological act of stimulating the respiratory action.

Physical Data : Specific gravity : 0.8. Boiling point 109° F, vapour density-1.5, specific heat and latent heat 0.2 and 345 B. TH.UT respectively ; gas generation 8 off/lb, inhibitory-factor W-29% and normal pressure in extinguisher 734. Ibs/sq. inch.

Sizes : The extinguishers are available in cylinder sizes of 2kg. to 6.7kg. of liquefied gas. Larger capacities are obtainable in the form of trolly units.

Constructional features : Tile CO_2 extinguisher essentially consists of steel cylinders of seamless construction and contains the liquefied gas filled to approximately 2/3 weight of its total water capacity and fitted at the top with sealing disc and a piercing mechanism or valve mechanism, it is also fitted with a discharge horn by high pressure flexible tube to larger sizes. For smaller models the discharge horn is rigidly connected to the valve mechanism.

The gas may be released by piercing the disc by means of either plunger or level or by opening the valve. The cylinder of the extinguisher is fitted internally with a discharge tube so that liquid CO_2 as released through the valve, without freezing.

Discharge Performance : (IS : 2878-1976)

Nominal size	DISCHARGE PERIOD	
	Maximum	Minimum
2 kg.	8 secs.	18 secs.
3 kg.	10 secs.	20 secs.
5 kg.	10 secs.	24 secs.
6 to 7 kg.	10 secs.	30 secs.

Notes :

1. The above rates are specified when the extinguishers is operated at an angle of 45 and ambient temperature at 27+2°C and that is expels 95% of the content.

2. In the case of extinguishers designed for intermittent, discharge t>pes they should be capable of operating satisfactory with an interrupted discharge cycle of 4 sec. Open and 4 sec's hut, and discharge the same proportion of the contents

Discharge Horn : The function of the discharge horn is not only to direct the gas on to the fire but also to reduce the velocity of the discharging gas and to prevent crtertainment of air without this the gas; will discharged in the form of below torch and will entrain air to intensify the fire.

Advantages :

1. It is extremely rapid in action and is independent of atmospheric temperature ;

2. It is clean and non-residual;

3. The gas is a non-conductor of electricity and can safety be used on live-electrical equipment;

4. It may be used in highly inflammable liquid like methyl-alcohol, other carbon-disulphide etc., which it does not contaminate as would foam ;

5. It can penetrate into other wise inaccessible position, being a gas.

Disadvantages :

1. The comparative weight of the extinguisher with the weight of the gas is considerable.

2. There is no visible check on the contents. Extinguisher must be accurately weighted at regular intervals to ensure that no leakage his taken place.

3. It has to be sent out for recharging.

4. It is to be used at a short range ;

5. Not effective on fires in materials which contains its own supply of oxygen.

Testing :

1. CO_2 extinguisher should be tested once in six months by weighting, there is a loss of 10% of they contents, they should be returned for recharging :

2. All CO_2 extinguishers should be hydraulically pressure tested to withstand pressure of 3360 lbs./sq. in (235 kg./cm^2).

3. In case of any evidence of external corrosion, it should be repeated every 5 years otherwise at interval of 10 years on first two occasions and subsequently every 5 years.

4. In addition to checking by weighting every 6 months, check hose, horn and valve assembly, check squeze grip control.

E. Dry Power Extinguisher

Try power extinguisher using patented dry powder (or dry chemical) are available in sizes containing between 1 kg. and 13.5 kg. also as large units and fixed installations. The method of expelling the powder from the container is by a charge of compressed air or gas, which, when released 'fluidifies' the powder and ejects if via a discharge tube to the nozzle.

Types : There are two types of portable dry powder extinguishers

(i) Gas cartridge type (ii) Stores pressure Type (This is relative new type and not discussed here.) Constructional Features

(i) Gas cartridge typical Motael

In this type the expellent, usually carbondioxide is contained in a sealed gas cartridge, which is normally screwed the bottom of the operating read having a piercing mechanism in the form of a spring loaded plunger.

The container of the extinguisher which holds the dry powder charge is cylindrical in shape and made of solid eawn steel fitted internally with a tube. The carbon-dioxide gas cartridge is held in position inside the extinguisher in a sealed inner container Shell having gas parts protected by this rubber sealing ring.

A length of delivery tubing is tightly secured to the ports connection on the body of the container and is fitted a squeeze grip control for controlling the flow of powder after the plunger has been depressed.

A fully charge extinguishers normally contains only approximate half its volume as powder.

Methods of Operation :

1. Remove Safety clips ;
2. Depress the plunger;
3. Withdraw the nozzle from the rubber cap and press the squeeze grip ;
4. Direct the dry powder to the base of the flames with a fast sweeping motion.

Recharge :

1. After use before recharging, care should be taken to ensure that the powder remaining in the discharge tube, hose and nozzle is fully cleared.
2. When refilling once the new powder container is opened, the powder should immediately be transferred into the extinguisher and the appliance, should be sealed.
3. Personnel, handling of very fine powder particularly where the ingredients are poisonous as with some chlorides employed, should wear dust mask.

Types of Dry Powder : The composition of powder varies with different proprietary mixture. The main constituent of the powder in general use is Sodium Bicarbonate with which is mixed a water profine agent such as metallic stearate. (Although other agents are used). The action of the stearate is to prevent moisture absorption and subsequent caking of the powder and also to prevent corrosion of the container. When a finally divided dust of sodium-bicarbonate is blown into the gases and flames of a fire, rapid decomposition takes place and the flames are extinguished quickly by smothering effect.

Uses : Chiefly used for extinguishing fires in highly inflammable liquids, and live electric equipment. It should not be used with foam which is not compatible to it as otherwise the foam will break down quickly.

Other Types of Powders : Recent developments have produced the following main constituent of dry powders -

1. Borax :	Capable of dealing with
2. Ammonium Phosphate :	Carbonaceous fires,
3. T.E.C. (Ter nary Eucteetic chloride):	For dealing with metal fires,
4. Potassium Sulphate	(Magnesium, Aluminium, Uramum, titanium etc.). These are capable of controlling/or extinguishing these fire whether it, be drippings swart or bulk.. This is a foam compatibles type of dry powder.

Constituents of some Proprietory Mistures

(i)	1. Sodium Bicarbonate	97%
	2. Magnesium + Stearate	11/2% 1.5%
	3. Magnesium Carbonate:	1%
	4. Tiicalcium Phosphate :	*V2V0* 0.5%
(ii)	1. Bitumen :	45%
	2. Slate powder:	45%
	3. Aluminium + Stearate	10%
(iii)	T.E.C. Powder	
	1. Sodium Chloride :	20 wt. %
	2. Potassium Chloride :	29 wt. %
	3. Burium Chloride :	51 wt. %

Optium size of Particles (20 to 30 micron)

Discharge performance (IS : 2171-1976)

The extinguisher shall be capable of discharging 25% of total mass when operated at 45° at 27 + 2°C, the discharge performance shall be :

Cap. of Ext.	Minimum period of Which jet shall be maintained	Maximum period of discharge of 85% of contents.	Ranges of throw
1 to 2 kgs.	8 to 10 Secs.	10 Secs.	not less than 2 mt.
5 kgs.	15 Secs.	20 Secs.	not less than 4 mt.
10 kgs.	23 Secs.	30 Secs.	not less than 6 mt.

FIRE EXTINGUISHMENT

- **CLASS A (PAPER, WOOD ETC) - WATER, FOAM, DCP**
- **CLASS B (OIL) - FOAM, DCP, WATER, CO_2 .**
- **CLASS C (GASES) - DCP, CO_2, WATER**
- **CLASS D (METALS)-SPECIAL POWDERS**

FIRE EXTINGUISHMENT

METHODS O EXTINGUISHMENT :

- o STARVATION—CUTTING OFF FUEL SUPPLY
- o SMOTHERING—REDUCING 02% TO BELOW 15%
- o COOLING—REMOVING HEAT
- o CHEMICAL FLAME INHIBITION :
- o BREAKING COBUSTION REACTION.

FIRE EXTINGUISHMENT

STARVATION : CUTTING OFF FUEL SUPPLY

- o FIRE EXTINCTION BY STARVATION IS CARRIED OUT IN ANY ONE OF THE FOLLOWING WAYS
- o REMOVING COMBUSTIBLE MATERIAL SUCH AS THE TRANSFER OF FUEL FROM BURNING OIL TANKS, CLOSING THE VALVES ON THE GAS/FUEL LINE ETC. BY REMOVING MATERIAL ON FIRE NEAR TO THE COMBUSTIBLE MATERIAL SUCH AS PULLING APSRT A BURNING HAYSTACK OR A THATCHED ROOF.
- o BY SUB-DIVIDING THE BURNING MATERIAL TO SMALL SIZED ISOLATED FIRES TO BREAK CONTINUITY SUCH AS REMOVING ONE HUT FROM THE ROW OF HUTS ON FIRE.

FIRE EXTINGUISHMENT

SMOTHERING : REDUCING OXYGEN(02% TO BELOW 15%)

COMBUSTION WILL CEASE IF THE OXYGEN CONTENT OF THE ATOMOSPHERE IN THE IMMEDIATE VICINITY OF BURNING MATERIAL CAN BE SUFFICIENTLY REDUCED, WHERE IT WILL NOT SUPPORT THE COMBUSTON PROCESS.

IN THE REFINERIES FOAM IS EFFECTIVELY USED AS A SMOTHERING AGENT FO FIGHTING OIL FIRES, SNIFFING A CANDLE AND CAPPING A BURNING OIL WELL. EMPLOY PRINCIPLE OF SMOTHERING ONLY.

FIRE EXTINGUISHMENT

COOLING : REMOVING HEAT

IF THE RATE AT WHICH HEAT GENERATED DURING COMBUSTION IS LESS THAN THE RATE AT WHICH IT IS DISSIPATED. THE COMBUSTION CAN NOT CONTINUE LONG. THUS IF THE SURFACE OF THE BURNING MATERIAL IS COOLED BELOW THE TEMPERATURE AT WHICH WILL GIVE OFF SUFFICIENT VAPOURS TO SUPPORT COMBUSTION, THE FIRE WILL BE EXTINGUISHED.

CONTINUOUS THE APPLICATION OF WATER IN JET OR SPRAY TO EXTINGUISH FIRE IS BASED ON THE ABOVE PRINCIPLE.

FIRE EXTINGUISHMENT

CHEMICAL FLAME INHIBITION OR CHAIN BREAKING COMBUSTION REACTION

THE CHAIN REACTION THEORY OF COMBUSTON ASSUMES THAT FREE RADICALS ARE PRESENT IN THE COMBUSTION ZONE AND THE REACTIONS OF THESE PARTICLES WITH EACH OTHER ARE NECESSARY FOR CONTINUED BURNING.

THE MOST ACTIVE FREE SPECIES HYDROCARBON COMBUSTON ARE OXYGEN & HYDROGEN ATOMS AND HYDROXYLRADICALS IE. O*, H* AND OH*. FIRE EXTINGUISHMENT BY DCP AND HALONS IS BASED ON THE ABOVE PRINCIPLE.

FIRE EXTINGUISHMENT

GENERATION OF CHAIN REACTION :

$H_2 + E \rightarrow 2H^*$ $\quad\quad$ $H^* + O_2 \rightarrow OH^* + O^*$

$OH^* + H_2 \rightarrow H_2O + H^*$ $\quad\quad$ $O^* + H_2 \rightarrow H^* + OH^*$

EXTINGUISHMENT WITH I) CP

$2NaHCO_3 \rightarrow Na_2CO_3 + H_2O + CO_2$ $\quad$ $Na_2CO_3 \rightarrow Na_2O + CO_2$

$Na_2O + H^* + OH^* \rightarrow 2NaOH$

WE CAN SEE THAT DISCHARGE OR DRY CHEMICAL POWDER INTO THE FLAMES PREVENTS REACTIVE PARTICLES FROM COMING TOGETHER AND CONTINUING THE COMBUSTION CHAIN REACTION.

FIRE EXTINGUISHMENT

FIRE EXTINGUISHING MEDIAS

WATER

DRY CHEMICAL POWDER

FOAM

CO_2

FIRE EXTINGUISHMENT

WATER :

- O SMOTHERING : BY REDUCING O_2 PERCENTAGE
- O COOLING : BY BRINGING DOWN THE TEMPERATURE
  - ❖ PROPERTIES OF WATER AS AN EXTINGUISHING MEDIA
  - ❖ ADVANTAGES OF WATER AS AN EXTINGUISHING MEDIA.
  - ❖ DIS - ADVANTAGES OF WATER AS AN EXTINGUISHING MEDIA

FIRE EXTINGUISHMENT

FOAM :

- ❑ BLANKETING : BY CUTTING OF AIR
- ❑ COOLING : BY BRINGING DOWN THE TEMPERATURE
  - ❖ TYPES OF FOAM COMPOUND
  - ❖ DESIRABLE PROPERTIES OF FOAM FOR OIL FIRES
  - ❖ ADVANTAGES OF FOAM AS AN EXTINGUISHING MEDIA.
  - ❖ DIS-ADVANTAGES OF FOAM AS AN EXTINGUISHING MEDIA

FIRE EXTINGUISHMENT

DRY CHEMICAL POWDER.:

- O INHIBITION : BY BREAKING COMBUSTION CHAIN REACTION
- O SMOTHERING : BY REDUCING 02 PERCENTAGE
  - ❖ PROPERTIES OF DCP AS AN EXTINGUISHING MEDIA
  - ❖ ADVANTAGES OF DCP AS AN EXTINGUISHING MEDIA
  - ❖ DIS-ADVANTAGES OF DCP AS AN

EXTINGUISHERS

DCP EXTINGUISHER

	DETAILS EXT'R	**DCP 10 KGS**
1.	DESIGN CODE	IS : 2171
2.	CYLINDER TYPE	WELDED
3.	TYPE OF POWDER	NaHC03 : MAP
4.	CO_2 CARTRIDGE	IS : 4947 ; 200 gms
5.	OPERATING PRESSURE	10 KG/CM2
6.	HYDRO TEST PRESSURE	30 KG/CM2
7.	FREQUENCY OF H.T	ONCE IN 3 YEAR
8.	PERFORMANCE REQUIRMENT	85% DISCHARGE IN 30 SEC.
9.	THROW	6 METERS

EXTINGUISHERS

CO_2 EXTINGUISHER

SL. NO.	**DETAILS OF EXT'R**	**CO_2 4.5/22.5 KGS**
1.	DESIGN CODE	IS : 2878-1976
2.	CYLINDER TYPE	SEAMLESS
3.	C02 FILLING PRESSURE	30-35 KG/CM^2
4.	OPERATING PRESSURE	10 KGS/CM^2
5.	HYDRO TEST PRESSURE	210 KGS/CM^2
6.	FREQUENCY OF H.T	ONCE IN 5 YEAR OR AT THE TIME OF REFILING
7.	PERFORMANCE REQUIREMENT	95% DISCHARGE IN 10 SEC.

EXTINGUISHERS

MAINTENANCE OF DCP EXTINGUISHERS IS:2190 MONTHLY

- o EXTERNAL CLEANING
- o CHECKING OF THE FOLLOWING
- o NOZZLE, CAP, HOSE
- o PIERCING MECHANISM
- o CONDITION OF EXT'R

EXTINGUISHERS

MAINTENANCE OF DCP EXTINGUISHERS IS:2190

ANNUAL:

- o CHECKING OF THE FOLLOWING
- o SEALING DISC OF CARTRIDGE
- o WEIGHT OF THE CARTRIDGE

- o INTERNAL PARTS
- o POWDER
- o BODY (INTERNAL & EXTERNAL)
- o CLEANING OF EXT'R WITH DRY AIR
- o FILLING AND FIXING ALL PARTS

EXTINGUISHERS

MAINTENANCE OF CO_2 EXTINGUISHERS

- o CHECKING OF THE FOLLOWING
  - ◗ WEIGHT OF THE EXT'R
  - ◗ VALVE ASSEMBLY
  - ◗ DISCHARGE HOSE, HORN
  - ◗ BODY (EXTERNAL)

EXTINGUISHERS

MAINTENANCE OF DCP EXTINGUISHERS IS:2190 HYDROTESTING

- o DCP EXTINGUISHER : ONCE IN 3 YEARS AT 30 KG/CM^2
- o CO_2 EXTINGUISHER : ONCE IN 5 YEARS AT 210 KG/CM^2 OR AT THE TIME OF REFILING
- o **MAINTENANCE / INSPECTION AT VR**
  - ◗ ALL THE CHECKS LISTED IN STANDARD ARE CARRIED OUT ON MONTHLY BASIS
  - ◗ RANDOM OPERATION OF DCP EXT'R IS CARRIED OUT (ONE EXTINGUISHER PER UNIT EVERY DAY)
  - ◗ ALL THE DCP EXTINGUISHERS ARE NUMBERED
  - ◗ DATA-BASE MAINTAINED IN PC

1.6 Smoke Management

Preamble : Smoke is always associated with fire. Smoke propagates in many directions and is more dangerous than fire. Most of fire case study reveals that a large number of fire deaths have been caused due to inhalation of toxic gases.

The propagation of smoke to various areas is uncontrollable as being lighter than air. It travels to various nooks and comers and especially during night-time fires its presence is undetected and this causes many sleeping people to succumb due to smoke.

Combust, on product contain gases, vapors and solid particles. The cellulose materials evolve less dense in presence of oxygen and high temperature. On the other hand, the synthetic materials release dense smoke from very initial stage of fire.

Effect of Smoke :

VISIBILITY - Poor visibility and asphyxiation due to irrespirable atmosphere created by smoke

TOXICITY - All smoke from fires contain gases which are toxic and if exposure to smoke is prolonged its effect may be lethal.

Area of Dangers :

The smoke filled in a compartment hampers fire fighting and rescue operations.

Toxic gases produced at fires lead to an environment that is inhabitable or even lethal after short exposure ; The potential danger from these toxic products in a fire has been increasing because of the increasing use of new and more complex materials in our daily life.

The toxic gases evolved in fire have significantly contributed to fire injuries and fatalities and therefore assessment and evaluation of toxicity of these gases have drawn considerable attention of those working in fire safety and allied areas. More and more new toxic products are being encountered in fires because of the increasing use of new and complex synthetic materials in daily life.

The plastics like PVC, polyurethane foam, Acrylics etc. have found an unavoidable place in our society and they are used for upholstery and decoration purposes and also as main building construction materials. Under fire conditions the CO and HCN produced from the above materials travel from one part of the building to the other part in no time and lay a death trap.

1.6.1 Role of Oxygen in Human Body

On breathing in a normal and unpolluted atmosphere, air is filled in the lungs of a person. The oxygen from air joins with the haemoglobin (Hb) of the blood and forms HbO.

$$O_2 + 2Hb = 2HbO$$

This oxidized haemoglobin (HbO) flows with the blood to al parts and cells of the body. The blood acts as a carrier of oxygen to all the cells of the body. Further HbO, on reaching the cells of the body, reacts with them and oxidizes them.

$$HbO + Cell \rightarrow Oxidized\ cell + Hb$$

Thus Hb becomes free and flowing with the blood through heat again reaches in the lungs and repeats the process. All the tissues and muscles of each part of the body et oxidized and generate energy in this process. Infect oxygen itself can he called as energy needed by the body

Under all situations (sleeping or awakened) the heart and brain of a person function continuously after getting energy (O_2) through blood circulation. In case blood does not reach the brain or heart they will become idle.

1.6.2 The Toxic Products Evolved on Combustion

Sl. No.	Material involve in Fire	Toxic Gas or Vapour Generate
1.	All combustible materials containing carbon, celluloid, polyurethanes	co, co2 Nitrogen oxides
2.	Wool, silk, leather, plastics containing nitrogen, wood, paper	Hydrogen Cyanide Acrolein
3.	Poly-vinyl chloride, fire retardant plastics, fluorinated plastics.	Halogen acids, phosgene Amonia
4.	Nylon, Urea formaldehyde resins. Phenol formaldehyde Polyurethane foams Fire retardant treated polyurethane foams.	Phenol Iso-cynates Sulphur-di-oxide Bicylic phosphate

1.6.3 Carbon Monoxide

Carbon Monoxide spreads very fast in air

The vapour density of air 14.4 and vapour density of CO is 14.0 obviously, the vapour densities of air and CO both are approximately same so CO mixes with air instantaneously and spreads very fast in air.

When a person breaths in a polluted atmosphere containing carbon monoxide, the CO gas goes inside along with other gases i.e., oxygen, nitrogen, oxygen etc. in the lungs. Carbon monoxide has 210 times more affinity to react with the Haemoglobin of blood than oxygen and forms stable compound after reacting with the haemoglobin of blood.

$$CO + Hb = COHb$$

Carboxyhaemoglobin

Carboxyhaemoglobin is very stable compound and forms a very strong layer around Hb and leaves no chance for Hb and Oxygen to form HbO and reach to the cells, tissues and other parts of the body.

At this stage, Hb is totally incapable to carry oxygen to different parts of the body like brain, heart etc. in the initial stages, due to non-availability of oxygen, the natural functioning of the brains gets retorted and the brain becomes idle. As CO enter in the body, the body is further deprived of oxygen, then chocking of the breath starts, man gets deeply fainted and finally, dies.

Carbon monoxide is the main toxic gas in smoke generated from burning of all type of combustible materials, which produces the most deaths in real fire situation.

1.6.4 Carbon Dioxide

Biologically Carbon-di-oxide is an important constituent of the human body and photosynthesis proces .' CO: is not considered as toxic agent at concentration observed in fire. Inhalation of CO2 causes rap c breathing to take more oxygen which in turn will accelerate uptake of possible toxic components from fire environment. It is not correct to assume that signs and symptoms of CO: toxicity will not occur in man. Inhalation of CO2 concentration above 10% has caused headache, narcosis in most of the people.

1.6.5 Hydrogen Sulphide

Hydrogen sulphide, H_2S, is a gas under normal atmospheric conditions it is also

extremely poisonous, much more so than hydrogen cylinder, but since it is incredibly foul smelling we can normally detect its presence long before the levels become toxic.

It occurs naturally in crude petroleum, natural gases, sour gases, in salt mines, in volcanic gases, hot sulphur springs, lakes, salt water ponds, undersea vents, marine sediments, swamps, stagnant bodies of water. It is also by-product or many industrial operations, such as petroleum refineries, petrochemicals plants, natural gas plants, Kraft paper mills, iron smelters, coke ovens, food processing plants and tanneries.

1.6.6 Characteristics & Properties of H_2S

H_2S gas is toxic, irritant and asphyxiates. It is colourless, which, at low concentration, is accompanied by rotten egg dour.

It is more toxic than carbon monoxide and almost as toxic as Hydrogen Cyanide gas.

Heavier than air, specific gravity 1.189. Vapors may travel considerable distance to a source of ignition and flash back.

Burns with blue flame to evolve SO_2 which also is very toxic.

Threshold limit values-short term Exposure limit; 15 ppm Soluble in water, Alcohol, petroleum solvents and crude petroleum.

Hazards associated with H_2S

- Headache
- Dizziness
- Excitement
- Nausea
- Coughing
- Drowsiness
- Dryness & sensation of pain in nose, throat and chest.

1.6.7 Hydrogen Cyanide

The role of HCN in fire fatalities is less clear than that of CO. The extreme toxicity of cyanide most likely is due to the cyanide ion complexion with metals in enzymes and haemoglobin in the body and thus preventing nonnal metabolism. HCN is more toxic than HCL because of cyanide ion often bring out the maximum co-ordination number of a metal. It has been observed that the HCN is produced rapidly in the fire well before CO involve

materials those contain nitrogen in their structure. The concentration above 20 or— in the environment are considered as dangerous to Health. Higher concentration above 270 ppm. may bring immediate death.

Nitrogen in a polymer structure forms a very wide range of oxides. Nitrous oxide is used as an anaesthetic. Nitric oxide is unusually stable. It reacts with oxygen and gives nitrogen-di-oxide red brown poisonous gas. These oxides cause various degree of toxicity when they are inhaled. The lethal effects will occur when the atmosphere level reaches 250 ppm. and above in a relatively short period of time.

Gas/Vapor	Maximum Allowable concentration for prolonged Exposure (ppm)	Concentration dangerous for short period exposure (ppm)
Carbon-di-oxide	5000	100000
Carbon monoxide	100	4000
Hydrocyanic acid	10	300
Hydrochloric acid	10	1500
Sulphar-di-oxide	5	500
Nitrogen-di-oxide	5	120
Hydrofluoric acid	3	100

1.7 Control & Prevention

Smoke production can be controlled to some extent by using fire retardant materials or materials using fire resistant paints. This helps in acting as fire stops and regards the growth or fire as well as produces less smoke.

Compartmentation, pressurizing of staircase, pressurizing of Means of escape, pressurizing of Lift lobby, Installation of Fire & Smoke check Door at entry & exit point to create smoke free atmosphere.

Additionally, the early release of partially burnt gases which will accumulate at high level restricts the effects of explosions and flashover commonly associated with late venting after the fire is well established.

Smoke and heat ventilation systems can therefore be designed for both the protection of life and property in special structures, particularly large areas with large individual spaces such as factories, warehouses, shopping complexes, sports halls, basement areas and atria.

If a person is exposed to lethal concentrations of carbon monoxide and hydrogen cyanide, the chances of his survival are almost negligible. This is the reason that the use of polyurethane foam for upholstery and decorating purpose is discharged.

Installation of Fire & Gas Detection System. Installation of Sprinkler System.

Use of Mask, Breathing Apparatus during fire fighting inside toxic environment.

Use of Personal Protective Equipment etc.

Unit - 2 ❑ Building Fire Safety System

Structure

2.1 Fire Prevention of Resort Complex

Stipulation of National Building Code

1. **Fixed fire fighting installation/requirement as per National Building Code**

A. Wet Riser

One wet riser-cum down per 1000 m^2 floor area. The riser shall be fully charged with adequate pressure all times, and shall be automatic in operation.

Capacity of underground static tank - 1,00,000 litres.

Capacity of Terrace tank - 20,000 litres.

Capacity of Pump

i. Near Underground tank

2400 litres per minute giving a pressure not less than 35 kg/cm^2 at the top most hydrant.

ii. At the Terrace Level

900 litres per minute giving a pressure not less than 35 kg/cm^2 at the top most hydrant.

Note :

1. Where more than one is required because of large floor area, the quantity of water recommended in this table shall be proportionately increased.
2. Any of the above categories may incorporate an automatics sprinkler, irenchar system, if the risk is such that it requires installation of such protective methods. Where sprinkler/dire char system is installed water requirements for such installation shall be in addition to those indicated in this table.
3. A minimum of two hydrants shall be provided within the courtyard.
4. Wet riser cum down comer is an arrangement for fire fighting within the building by means of vertical rising mains not less than 100 mm internal dia with hydrant outles and hose reel on eadh floor/landing connected to terrace tank for fire fighting purpose, through a booster pump, check valve and non return valve near the tank end and a fire pump, gate and non return valve, over the underground static tank. A fire service inlet at ground level fitted with a non return valve shall also be provided to the rising main for charging it by fire services pump in case of failure of static fire pump over the underground static tanks.

5. The performance of pumps specified above shall be at revolutions per minute nor exceeding 3000.
6. The terrace tank and pump need not be provided at the automatic pump at ground level can be maintained to the satisfaction of the local fire brigade.
7. The above quantities of water shall be exclusively for fire fighting and shall not be utilised for domestic or other use.
8. A facility to boost up water pressure in the riser directly from the mobile pump shall also be provided on the wet riser system with a suitable fire service inlets (collecting head with 2 Nos of 63 mm inlets for 100 mm rising main and 4 Nos of 63 mm inlets with check valves for 150 mm diarising main) with check valve and a gate valve.
9. Internal diameter of rubber hose for hose reel shall be minimum 12 mm. A shutoff branch with nozzle of 5 mm size shall be provided.
10. All arrangement of alternative source of power supply shall be provided to drive pumps, etc, in case of failure of normal power supply.

In addition to wet riser/wet riser cum down commer, first-aid hose reels shall be installed or all the floors of building.

B. Automatic Sprinkler System :

Automatic sprinkler shall be installed in

a) Housing essential services

b) Any room or other compartment of building exceeding 500 m2

c) All non-domestic floors of mixed occupancy which censtitute a hazard and are not provided with staircase independent of the remainder of the building.

C. Automatic High Velocity Water Spray :

Automatic high velocity water spray system shall be provided for protection of indoor transformer.

D. Fixed Foam Installation :

Fixed foam generating system shall be provided for protection of boiler room with its a ciliary storage of furnace oils.

E. Carbon dioxide Fire Extinguishing System :

Fixed carbon dioxide fire extinguishing installation shall be provided on premises where water or foam can not be used for fire extinguishing because of the special nature of the contents of the building/areas to be protected.

F. First-aid fire fighting appliances shall be provided & installed on all floors.

G. The building shall equipped with manually operated electrical fire alarm system and automatic fire alarm system.

FIRE FIGHTING EQUIPMENT SHALL BE SUITABLY LOCATED AND CLEARLY MARKED BY ILLUMINATED SIGNS

2.2 General Requirements for Fire Prevention

Access to Fire Appliances :

The building shall about upon a street or streets/or upon open space to give satisfactory access and working space for Fire Brigade appliances. The width of the street or approach road on which the building about shall not be less than 9.20 metres wide in case there are no bends and if there are bends or curves a sufficient width shall be provided at the curve to enable the fire engines to turn at least 8.70 m. The approach road to the building shall be hard surfaced and must be able to take the weight of a fire engine weighing 12000 kg.

Entrance to the site and archways, if any, leading to internal courts shall have a clear passageway of not less than 4.6 m width and height clearance of not less than 4.00 m. Access gates shall be open able from either side.

At least two sides of the building must have courty ards of minimum width of 9.20 m while the other two sides shall have courty ards of minimum of

In case of averaging of width 9.20 m, 6.10 m shall always the maintained free from car parking. The minimum widths of the a foreside courtyards shall be clear of any structure and also of projection such as chajjas, and balcomes to a height of not less than 4 mts from the ground level.

The courtyards must be hard surfaced so as to take the load of the fire engine (about 12000 kg).

Car Parking Area :

Car parking shall be permitted in basements, on ground floors on stilts and at upper levels provided the parking area is completely segregated from the dwelling occupancy by an adequate fire separation.

Car parking may also be permitted on courtyards of 9.20 m width and shall be along the periphery of the courtyard keeping at least 5 metre wide clear space free from any projections for the movements of fire appliances.

Constructional Features :

The building shall be of R.C.C or structural steel construction The structural R.C.C members and the structural steel members encased in fire-resisting materials, shall have a fire resistance of not less than two hours.

Stair Cases:

The minimum number of staircase to be provided and the travel distances shall be as given in requirement for each class of occupancy.

All staircases shall be of enclosed type throughout their height and shall have a fire resistance of not less than two hours.

Access to main staircases shall be gained through at least half an hour fire resisting swing door placed in the enclosed walls of the staircases. The swing type door shall open in the direction of the escape.

There shall be no glazing or glass bricks in any nearest or closing wall of a staircases.

No dwelling store or other fire risk shall open directly into the main staircase.

External exit door of staircase enclosure at the ground level shall open directly to the courtyard or may be reached without passing through any door other than a door provided in front drought lobby.

Main staircases width shall be 150 cms. Treads shall not be less than 23 cms wide measuring from riser to riser and riser shall not be more than 20 cms high and shall not be more than 16 riser in a flight.

Staircase enclosure:

The enclosing walls of staircase shall be of brick or R.C.C construction having a fire resistance of not less than two hours. Access to staircase shall be gained through self closing doors of at least half-hour fire resistance. There shall be swing doors opening in the direction of the escape.

The enclosed staircase shall be on the external wall in the building and shall be ventilated to atmosphere at each landing. No staircase shall be arranged around the lift shaft.

Permanent vent at the top equal to 21 per cent of the cross sectional area of such enclosure (enclosed staircase) and open able sashes at each floor area equal to 15 per

cent of the cross sectional area of enclosed staircase on the external wall shall be provided. The roof of the shaft shall be at least 1 mtr above the surrounding roof. There shall be no glazing or glass bricks in any internal enclosing wall of a staircase.

The mechanism for pressurizing the staircase shaft shall be so installed that the same shaft operate automatically, what the fire alarm and sprinklers (wherever provided) operate. The mechanism shall be also have facilities to be operated manually.

The floor number shall be indicated on the staircase lending.

Staircase and Corridor Lighting :

The staircase and corridor lighting shall be on separate circuit and shall be independently connected with inverter so that it could be operated by one switch installed on the ground floor easily accessible to fire fighting staff at any time irrespective of the position of the individual control of the light points if any.

Suitable arrangements shall be made by installing double throw switches to ensure that the case and the corridor do not get connected to two so.

Suitable arrangements shall be made by installing double throw switches to ensure that the installments to the staircase and the corridor do not get connected to two sources of supply simultaneously. Double throw switch shall be installed in the service room for terminating the stand-by supply.

The licenses sub-station shall be located in a separate independent building or any suitable place as approved y the licenses.

Fire Lift:

To enable Fire Brigade personnel to get to the upper floors with the minimum delay, one of the lifts shall be so designed as to be available for the exclusive use of firemen in an emergency and be directly accessible to every dwelling on every floor.

The lift shall have a floor area of not less than 1.4 Sq.m. It shall have loading capacity of not less than 545 Kgs (8 persons lift), with automatic closing doors.

The speed of he fire lift shall be such that it can reach the top floor from the ground level within one minute or 91.5 m per min. whichever is less.

The electric supply shall be on a separate circuit and the cables shall run in a route safe from free i.e. within the lift shaft.

The operation of the fire lift shall be by a simple toggle or two button switch situated in a glass fronted box adjacent to the lift at the entrance level when the switch is on

handling call-points shall become inoperative and the lift shall be on the car control only. When the switch is off, the lift will return to normal working. This lift may be used by the occupants in normal times.

Lifts and Lift enclosures :

The walls enclosing lift shafts shall have a fire resistance of not less than two hours. Shafts shall have permanent vents immediately under the Machine Room not less than 0.2 Sq.mt. in clear area. Lift motor rooms preferably be sited at the top of the shaft and shall be separated from lift shafts by the enclosing wall of the shaft or by the Machine Rooms.

Landing :

Landing doors of lift enclosures shall open in the ventilated lobby or pressurized corridor and shall have a fire resistance of not less than one hour.

Lift car doors shall have a fire resistance of one hour.

Shaft for fire lift in a lift bank shall be separated from each other by a brick masonry or R.C.C. wall of a fire resistance of not less than two hours.

If the lift shaft and lift lobby are in the core of the building, a positive pressure of 5 mm w.g. and not less than 2.5 mm w.g. and not more than 3 mm w.g. in the lift shaft and lift lobby created by an electrically operated blower shall be maintained. The mechanism for pressuring the lift shaft and lift lobby shall be so installed that the same shall operate automatically when the automatic fire alarm and sprinkler installation (wherever provided) operate.

The mechanism shall also have facilities to operate manually.

Exit from the lift lobby shall be through a self closing stop door of half-hour fire resistance.

The lift machine room shall be separate and no other machinery shall be installed therein.

Grounding switch at the ground floor level to enable the fire service to ground the lift cars in emergency shall be provided.

Service Ducts :

Service ducts shall be enclosed by wall having a fire resistance of not less than two hours. Doors for inspection or shall also have a fire resistance not less than two hours.

If the cross sectional area exceeds 1 sq. mt it shall be where it passes a floor by

carrying the floor through the duct. The floor within the duct shall be pierced for any service pipe or ventilation trunk and shall fit as closely as possible around any such pipe or trunk.

A permanent vent shall be provided at the top of the service shaft or cross sectional area not less than 460 sq. cm or 6.25 sq. cm for each 900 sq. cm of the area of the shaft whichever is more.

Refuse chutes and refuse Chambers :

Hoppers to refuse chutes shall be situated in well ventilated positions and the chutes shall be continued upwards with an outlet above roof level and with an enclosure wall of non combustible material with a fire resistance of not less than two hours. The hoppers shall not e located within the staircase enclosure.

Inspection panel and hopper (charging station) opening shall be fitted with tight fitting metal doors, covers having a fire resistance of not less than one hour.

Refuse chambers shall have walls and floors or routs constructed of non-combustible and unpervious material and shall have a fire resistance of not lss than two hours. They shall be located at a safe distance from exit routes.

Electrical Services :

The electric distribution cables wiring shall be laid on separate shaft. The shaft shall be sealed at every alternate floor with non-combustible materials having the same fire resistance as that of the shaft.

The inspection panel doors and any other opening in the shaft shall be provided with air tight fire doors having a fire resistance of not less than one hour.

Water mains, telephone lines inter-com liner, gas pipes or any other service lines shall not be laid in the shaft for electric cables. If the licenses agree to provide meters on upper floors, the licenses cables shall be segregated from the consumer's cables by providing a portion in the shaft.

Separate circuits for water pumps, lifts, staircase and corridor lighting and blowers for pressuring system shall be provided directly from the main switch gear panel and these circuits shall be laid in separate conduct pipes so that in one circuit will not affect the others.

Medium and low voltage wiring running in shafts, and within false celling shall run in metal conduct till such time fireproof cables are provided.

An independent and well ventilated service rooms shall be provided on the ground

floor with direct access from outside or from the corridor for the purpose of termination of electric supply from the licenses service and alternate supply cables. The doors provided for the service room shall have a fire resistance of not less than two hours.

Air Conditioning:

Escape routes like staircases, common corridors, lift lobbies etc. shall not be used as return air passage.

The ducting shall be constructed of substantial gauge metal in accordance with IS 665 (latest revision).

Wherever the ducts pass through fire walls or floors the opening around the ducts shall be sealed with fire resisting materials.

As far as possible metalhe ducts shall be used even for the return air instead of space above the false celling.

The materials used for insulating the duct system (inside or outside) shall have surfaces of very low flare spread.

The air handling unit room shall not be used for storage of any combustible materials.

Hazardous or Inflammable Materials :

No hazardous materials shall be allowed to be stored or kept in any aprt of the building either as storage or for handling processing or manufacturing etc.

Use of inflammable solvents for clearing carpets etc shall not be allowed inside the building.

No refuse dumps or storage places shall be permitted in the staircase wells .

Liquefied petroleum gas shall not be stored or used in basement.

Wooden or any other combustible material shall not be used in staircases, lift lobby and such other places which connect one floor to the other.

If the floor space on a floor exceeds 700 sq. mtrs it shall be separated by means of fire walls of not less than two hours fire resistance.

Kitchens shall be in a separate room situated away from staircase and other escape routes.

Smoke Venting:

Smoke venting facilities, where required for safe use of exits in windowless buildings,

underground structures, large area shall be automatic in action.

Natural draft smoke venting shall utilize roof vents or vents in walls at or near the ceiling level; such vents shall be normally open, or, if closed, shall be designed for automatic opening in case of fire, by release of heat sensitive elements, such as fusible links ; breakage of glass, or melting of plastic under the influence of heat; or by other approved means.

Where smoke venting facilities are installed for purpose of exit safety in accordance with the requirements of the code, these shall be adequate to prevent dangerous accumulation of smoke during the period of time necessary to evacuate the area served, using available exit facilities with a margin of safety to allow for unforeseen contingencies. It is recommended that smoke exhaust equipment should have a capacity of approximately a 5 air change. Where mechanical venting is employed, it shall be firesafe.

Exit Requirements :

An exit may be a doorway ; corridor, passageway(s) to an internal staircase, or external staircase, or to a verandah or terrace(s), which have access to the street, or to the roof of a building or a refuge area. An exit may also include a horizontal exit leading to an adjoining building at the same level.

House Keeping:

To eliminate fire hazards, good house keeping, both inside and outside the building, shall be strictly maintained by the occupants and / or the owner of the building.

Control Room :

For all buildings over 15 M in height and apartment buildings with a height of 30 M and above, there shall be a control room on the entrance floor of the building with communication system (suitable public address system) to all floors and facilities for receiving the message from different floors. Details of all floor plans along with details of fire fighting equipment and installations shall be maintained in the control room. The control room shall also have facilities to detect the fire on any floor through indicator boards connecting fire detecting and alann system on all floors. The staff in charge of the control room shall be responsible for the maintenance of the various services and fire fighting equipment and installations.

Generator:

A Generator shall be installed to supply power to staircase, corridor and compound

lighting circuits, fire lift/s, pressurisation blowers, smoke extraction and damper systems in case of failure of electricity supply. The generator shall be capable of taking starting current of all the machines and circuits stated above simultaneously. Where paralleled LT/HT supply is provided with appropriate emergency services a stand-by generator need not be provided.

Kitchenette or Canteen Kitchen :

Kitchenette or canteen kitchen, if provided on any floor, shall be in an enclosure having two hours fire resistance and shall be a located at the perimeter of the floor away from the exit route.

The entrance door of kitchenette/kitehen shall be self-closing type and shall have a fire resistance of not less than one hour.

In case of L.P. Gas cylinders are used, the requirements for its safe use shall conform to the requirements for "Handling of L.P. Gas cylinders prescribed by the Bombay Fire Brigade.

Caretaker:

A qualified Fire Officer with experience of not less than 3 years in the city fire brigade shall be appointed as a Caretaker who will be available on the premises at all times.

The Fire Officer shall:

i) Maintain the fire-fighting equipment in good working condition at all times.

ii) Lay out fire orders and fire operational plans,

iii) Impart training to the occupants of the buildings in the use of fire fighting equipment provided on the premises and keep them informed about the fire emergency evacuation plan.

iv) Keep proper liaison with the city fire brigade.

The role of passive fire protection

Passive fire protection can be defined as :

1. Providing compartmentation to a given building type in order to minimise the spread of fire and smoke.
2. Ensuring the integrity of compartments in case of fire by fire stopping any gap penetrating through those building sections.
3. Offering heat insulated solutions to eliminate possible self-ignition of combustible materials by the transfer of heat through building elements.

4. Protecting structural elements from deformation and collapse or minimising heavy repair costs of spalled concrete in the case of underground spaces such as tunnels.

Consequently, the implementation of passive fire protection principles can achieve the following results :

1. Contain smoke and flame in a safe cell for a given fire resistance period.
2. Safe evacuation of building occupants without being obstructed by smoke and flames.
3. Sufficient time for fire fighters to reach the site (this is not to be neglected especially during peak traffic hours in busy cities).
4. Allow fire fighters to operate quickly and safely in smoke-free zones.
5. Minimise the cost of property damages for the developer.

   Passive measures will ensure higher safety standards and offer cost effective solutions whenever active protection has reached its limits. For example, smoke will activate smoke detectors and will trigger a signal at the safety control room. This active form of fire protection is incomplete without the support of property designed smoke extraction system. This would in volve passive fire protection methods such

2.3 Fire Safety Management for your Organization

Fire safety strategy for any Industry is made up of three essential elements

A) Passive fire safety measures

B) Active fire safety measures

C) Management fire safety measures

Passive Fire Safety Measures

Passive Fire safety measures are features which are built into the structure of the **building/plant** and is called as structural **Fire** Protection.

Active Fire Safety Measures

Active Fire Precaution measures are systems which normally active or are required to be activated in the event of an outbreak of fire

2.4 Management Fire Safety Measures

a) Management Fire safety measures relate to the day to day management of fire safety in a plant.

b) There is a legal responsibility on persons having control over the Plant to take reasonable measures to prevent the occurrence of a fire and to protect the lives and safety of occupants & minimize the loss of property in the event of fire.

2.41 Emergency Procedures

All occupants must be capable of responding correctly in the event of fire. Accordingly, a plan should be prepared outlining the procedures to be followed. This predetermined plan can be further subdivided into a number of sections :

a) a procedure for raising the alarm ;

b) a procedure for calling the fire brigade ;

c) an evacuation procedure ;

d) an assembly point and roll call procedure ;

e) a procedure for fighting the fire ;

f) a procedure for assisting the fire brigade.

2.4.2 Evacuation Procedure

Evacuation procedure shall be initiated once the fire alarm has been sounded

2.4.3 Procedure for Fighting the Fire

1. In the early stages of a fire it may be possible to successfully contain it or extinguish it with first aid fire fighting equipment.
2. To accomplish this, staff members should be instructed in the use of hand held extinguishers and hose reels.
3. Certain members of staff may be designated as a fire fighting team as part of the emergency procedures & their function would be to assess and “if safe to do so” tackle the fire with the available equipment until the Fire Brigade arrive.

2.5 Procedure for Assisting the fire Brigade

When the Fire Brigade arrive they need to be given as much information as possible in order to take the best course of action. The type of information required includes :

1. Exact location of the fire ;
2. Type of materials involved in fire ;
3. Details of missing persons ;
4. Location of nearest fire hydrants ;
5. Location of all access doors to the building.
6. Location of any special risks adjoining to the fire location ;
7. Keys for access into any locked areas.

2.6 Fire Evacuation Drills

Drills should be carried out at regular intervals to test the effectiveness of the predetermined arrangements which will ultimately will play a key role for life safety.

2.7 Staff Instruction and Training

To ensure fire safety programme to be effective,

1. Staff must be familiar with the parts of the fire safety programme which relate to them.
2. Comprehensive instruction and training should be given to staff to enable them to carry out their functions under the programme.
3. All staff should receive instruction in :
   a) Everyday fire prevention measures
   b) Emergency procedures
   c) First aid fire fighting

2.8 Fire Safety Register

1. The 'Fire Safety Manager' is responsible for the implementation and oversight of the fire safety programme should keep a Fire Safety Register as a complete record of all fire safety matters on the plant.

a) Details of all Tire incidents and false alarms that occur and the actions taken as a result

b) The register will serve as a record and also as a checklist for the Fire Safety-Manager to ensure that checks and training which are required are being carried out on an ongoing basis.

2.9 Safety of Buildings against Fire

Introduction : The recent fire in India's historic trading hub Barra bazaar where several buildings packed with tarpaulin and textile material were gutted shows the needto implement fire safety norms especially in crowded market areas where different categories of buildings with respect to occupancy type coexist. The fire safety should include demarcation fire Zones classification of buildings based on occupancy with respect to fire probability, type of building construction according to fire resistance, restrictions and regulations to ensure minimizing fire break out, smoke, flame and panic. Although absolute safety against fire is difficult to achieve in practice, measure that ensure construction, occupancy and protection features that are necessary to minimize danger to life and property from fire must be implemented as per the current NBC 2005 code

2.10 Components of Implementation Strategy

The safety measures should be implemented under the following three categories.

1. **Fire prevention** : This covers aspects pertaining to design and construction of buildings on passive fire protection measures considering various types of building material and their fire rating based on the ability to resist fire,
2. **Life Safety** : This covers life safety measures in the event of fire addressing construction and occupancy features that are necessary to minimize danger to life from fire smoke, flames or panic (to avoid stampede etc)
3. **Fire Protection** : This covers correct type of equipment and their installation meant for fire protection of buildings depending on classification and type of building.

2.11 Fire Prevention

All buildings are classified according to use as residential, educational and storage etc. The city area is demarcated into distinct zones based on fire hazard inherent in the building

known as “Fire Zones” The design of any building and type of material used are important factors in making a building fire resistant either against complete burnout or spread of fire. The fire resistance in hours of resistance against specified fire load in kcal/sq.m against a certain intensity of fire. The fire resistance rating required for various components such as walls etc. of buildings are given in NBC code.

The thickness/dimensions required for various materials of construction for achieving this rating is also codified and given in NBC 2005, Hence, we can get the designs satisfying a specified fire rating.

2.12 Life Safety

Every buildings should be constructed equipped and maintained so as to avoid undue danger to life and property of occupants from fire, smoke, fumes and panic. This is achieved by the provision of proper location number size and access of openings. The provision of exits should be such that the total occupants for Type 1 construction and 1.5 minutes for (4 hour fire rating) Type 2 construction (2 hour fire rating). Is this possible in certain of our cinema halls and multiplex commercial market places storing combustible materials. Lifts and escalators should not be considered as exits because they will not function during fire. The number of exits and their location and passage way should satisfy the total capacity of exit requirements, If the buildings is a multistory high rise structure a proper external fire staircase is desirable.

2.13 Material design and fire loads

The design of any building and the type of materials used in its construction are important factors in making the building resistant to fire. Fire load is the measure of the maximum heat that will be released if all the combustibles in a fire area burned, including wall linings, material stored, wooden or combustible partitions, linings/coverings on floors and ceilings. The fire resistance of a building or its structural and non- structural elements is expressed in hours against a specified fire load (kcal/m2), and against a certain intensity of fire. The usual fire resistance ratings for structural assemblies, members, doors etc. are expressed in hours. For buildings 15 m in height or above, noncombustible materials should be used for construction and the internal walls of staircase enclosures should be of brick work or reinforced concrete or any other material of construction with minimum of 2h fire rating.

2.14 Multiple or Special Occupancy

A typical example of a mixed occupancy is a covered mall or super market building, which is a single building enclosing a number of tenants such as mercantile units, restaurants, entertainments and amusement facilities, offices, clinical laboratories etc. A recent development is the growth of multi-level building complex, botel/restaurants, and may be a few other ancillary occupancies. The unusually high fire and life hazards in such 'multiplexes' can well be imagined. Consequently, the design and construction of the building, as well as the fire protection and life safety measures becomes most important.

Fire Protection and Life Safety requirements as stipulated in National Building Code as well as IS 14435 : 1997 "Fire Safety in Educational Institutions-Code of Practice" gives guidance for measures to be complied with for all special buildings.

2.15 Fire Protection

All buildings depending upon occupancy use and height should be protected by fire extinguishers, wet riser, down comer automatic sprinkle installation etc. A satisfactory supply of water for the purpose of fire fighting should always be available in the form of underground or over head level static storage tank with adequate capacity to supply water at the rate of 10001/min for the period required.

2.16 Proper Exit

Every building shall be constructed, equipped, maintained and operated as to avoid imdue danger to life and safety of the occupants from fire, smoke, fumes or panic during the survival time available for escape. Safe exit for the occupants in a building on fire requires a safe path of escape from the fire in the shortest possible time. This path, which should be as short as possible, and easily negotiable, should be ready for use in case of emergency. Provision of two separate means of exits for every floor including basements is a fundamental requirement. In case of failure of electricity, lifts and escalators tend to suddenly stop in between floors trapping the occupants of the lift. Hence, Lifts and Escalators shall not be considered as exits. Building Codes advocate the traditional evacuation by stairs in fire affected buildings for up to 3 or 4 storeys. All buildings, which are 15 m in height or above, and all buildings used as educational, assembly, institutional, industrial, and occupancies having area more than 500 sq. m on each floor shall have a

minimum of two staircases. They shall be of enclosed type ; at least one of them shall be on external wall of building and shall open directly to place of safety. In taller buildings Fire lifts should be provided with emergency power supplies.

Following minimum width shall be provided for staircases:

a)	Residential buildings (dwellings)	1.0 m
b)	Assembly buildings like auditorium shopping malls theatres and cinemas	2.0 m
c)	Educational buildings up to 30 m in height	1.5 m

2.17 Structural Considerations

A structure or structural element should be designed to possess an appropriate degree of resistance to flame penetration ; heat transmission and failure. The fire resistance of a structural element is expressed in terms of time in hours it can withstand a fire of specified temperature. General requirements for fire protection are given in IS 1642. Minimum requirements of concrete cover and member dimensions for normal-weight aggregate concrete members so as to have the required fire resistance should be in accordance with IS 456 : 2000.

The reinforcement detailing should reflect the changing pattern of the structural section and ensure that both individual elements and the structure as a whole contain adequate support, ties, bonds and anchorages for the required fire resistance. Additional measures such as application of fire resistant finishes, provision of fire resistant false ceilings and sacrificial steel in tensile zone, should be adopted in case the nominal cover required exceeds 40 mm for beams and 35 mm for slabs, to give protection against spalling.

2.18 Building Code, safety, economy and the role or community

Safety is often reckoned as the opposite of risk. Greater safety means less risk at a slightly increased cost. A Building Code is a recommendation that sets forth minimum requirements for design and construction of buildings and structures. These minimum requirements are established to protect the health and safety and economic feasibility. Although builders and owners often establish their own requirements, the minimum Code requirements must be met. Features covered in these codes include structural design, fire protection, and means of egress, light, sanitation, and interior finish. The different parties involved in the construction of a building like architects, structural engineers, construction

engineers, promoters, contractors, owners and statutory authorities have all a roll to play ensuring fire protection measures in buildings.

2.19 Guidelines for Fire Drill and Evacuation Procedures for High Rise Buildings

In case of fire in a high rise building safe evacuation of its occupants may present serious problems unless a plan for orderly and systematic evacuation is prepared in advance and all occupants are well drilled in the operation of such plan. These guidelines are intended to assist them in this task.

Alarm :

Any person discovering fire, hear or smoke shall immediately report such condition to the Fire Brigade, unless he has personal knowledge that such a report has been made. No person shall make, issue, post or maintain any regulation or order, written or verbal, that would require any person to take any unnecessary delaying action prior to reporting such condition to the Fire Brigade,

Drills :

1. Fire Drill shall be conducted, in accordance with the Fire Safety Plan, at least once every three months for existing buildings during the first two years. Thereafter, fire drills shall be conducted at least once every six months.
2. All occupants of the building shall participate in the fire drill. However, occupants of the building, other than building service employees are not required to leave the floor or use the exits during the drill.
3. A written record of such drills shall be kept on the premises for a three years period and shall be readily available for Fire Brigade inspection.

Signs and Plans :

1. Signs at Lift Landing.
2. Floor Numbering Signs
3. Stair and Elevator Identification Signs
4. Stair Re-entry Signs
5. Fire Command Station shall be provided with floor plan of the building and other pertinent information relative to the service equipment of the building.

Fire Safety Plan :

1. Building Address
2. Purpose and Objective

   To establish method of systematic safe and orderly evacuation of an area or building by its occupants in case of fire or other emergency, in the least possible time, to a safe area by the nearest safe means of egress; also the use of such available fire appliances as may have been provided for controlling or extinguishing fire and safeguarding of human life.

   To provide proper education as a part of continuing employee indoctrination and through a continuing written program for all occupants, to ensure prompt reporting of fire, the response of fire alarm as designated, and the immediate initiation of fire safety procedures to safeguard life and contain fire until the arrival of the Fire Brigade.
3. Fire Safety Director
4. Deputy Fire Safety Director
5. Fire Wardens and Deputy Fire Wardens
6. Building Evacuation Supervisor
7. Fire Party

Occupants Instruction :

1. Evacuation Drills
2. Fire Command Station ,3. Signs
4. Fire Prevention and Protection Program
5. Building Information Form.
6. Representative Floor Plan
7. Fire Safety Plan Prepared
   - Date when prepared
   - Date when revised

Duties :

1. Fire Safety Doctor's Duties
2. Deputy Fire Safety Doctor's Duties
3. Fire Safety Warden's and Deputy Fire Safety Warden's Duties

4. Building Evacuation Supervisor's Duties
5. Fire Party's Duties
   - ❖ Organization Chart for Fire Drill and Evacuation Assignment.
   - ❖ Representative Floor Plan
   - ❖ Fire Safety Plan
   - ❖ Personal Fire Instruction Card

For your own safety you should know :

1. Two push button fire alarm boxes are provided per floor. You should read the operating instruction.
2. You should read the operating instructions on the body of the fire extinguishers provided on your floor.
3. The nearest exit from your table.
4. Your assembly point on ground floor.
5. FOR YOUR OWN PROTECTION YOU SHOULD REPORT TO YOUR FIRE WARDEN/ DEPUTY FIRE WARDEN.

If you discover a fire :

1. Break the glass of the nearest push button fire alarm and push the button
2. Attack the fire with extinguishers provided on your floor. Take guidance from your wardens.
3. Evacuate if your Warden asks you to do so.

If you hear evacuation instruction :

1. Leave the floor immediately by the South/ North staircase.
2. Report to your warden, at your predetermined assembly point outside the building.
3. Do not try to use lifts.
4. Do not go to cloakroom.
5. Do not run or shout.
6. Do not stop to collect personal belongings
7. Keep the lift lobby and staircase doors shut.

A Few Section of Fire Prevention Act 1986

West Bengal Fire Services Act, 1950

Section : 11. **Power to withdraw or suspend license.**—A licence granted under section 9 may, without prejudice to any other action that may be taken against the licensee, be suspended or withdrawn by the Collector after giving the licensee an opportunity of being heard, if in the opinion of the Collector it is necessary to do so in the public interest or in the case of a license to sell fire-works, if ther&has been a breach of any prescribed condition.

11A. General public to take preventive measures for safety from fire etc.— Subject to the provisions of the relevant municipal law, a local authority may require the general public residing in an area within its jurisdiction to take such preventive measures as may be required for safety from fire and other similar hazards.

11B. Owner or occupier of building to make or carry out arrangements necessary for fire prevention etc.—Subject to the provisions of the relevant municipal law and the building rules in force and in consultation with the Director, a local authority may, by general or special order, require the owner or occupier of any building of any or all categories to make or carry out such arrangements be necessary for fire prevention and fire safety in that area.

11C. Owner or occupier of high-risk building to provide fire prevention safety measures.—(1) The owner or, where the owner is not tradeable, the occupier of a high-risk building or part thereof shall provide fire prevention and fire safety measures in such building or part thereof and the occupier shall maintain the fire prevention and fire safety measures in good repair and in efficient condition at all times in accordance with the provisions of this Chapter or the rules made thereunder:

Provided that in the case of such building or part thereof, the construction of which has been completed on any date before the date on which this Chapter comes into force, the occupier and, in the case of such building or part thereof which is under construction on the date immediately before the date on which this Chapter comes into force, the owner shall undertake and carry out such additional fire prevention and fire safety measures as are specified in the notice served on him under section 35.

(2) The owner or occupier of a high-risk building, as the case may be,[1][shall obtain from the Director-General] or the nominated authority a 'Fire Safety Certificate' in the prescribed

form issued by a licensed agency in the manner prescribed.

(3) The State Government may require compulsory endorsement of 'Fire Safety Certificate' by the Director or by a superior nominated authority in respect of any class or classes of high-risk buildings as may be notified by the State Government from time to time :

Provided that the Director or a superior nominated authority shall not endorse any 'Fire Safety Certificate' unless he or it is satisfied about the fire prevention and fire safety measures including safety of electrical installations [2][, structural means of escape from where owner or occupier can evacuate the buildings or place to a place of safety at the time of fire emergency] and provision of supply of adequate quantity of water for fighting purposes made by the owner or occupier of such building.

(4) The occupiers of all high-risk buildings shall carry out a mock fire drill involving the watch and ward staff of such buildings every year under intimation to the Director or the nominated authority in such manner as may be prescribed and a certificate of performance of such drill shall be furnished to the Director or the nominated authority, as the case may be.

(5) No person shall tamper with, or alter, or remove, or cause any injury or damage to, any fire prevention or fire safety equipment installed in any such building or part thereof or instigate any other person to do so.

11D. 'No objection' required under any other law.—A fire safety certificate duly endorsed under sub-section (3) of section 11C shall be the 'no objection' regarding fire prevention and fire safety measures for a building or installation under the Indian Explosives Act, 1884 (4 of 1884), or the Explosive Substances Act, 1908 (6 of 1908), or the Petroleum Act, 1934 (30 of 1934), or the Inflammable Substances Act, 1952 (20 of 1952), or the Cinematograph Act, 1952 (37 of 1952), or the rules made thereunder, or under any other law for the time being in force, as required from the Director.

11E. Special fee—(1) With effect from such date as the State Government mayroy notification, appoint in this behalf, there shall be levied a special fee for the purposes of this Act on the owners of such class or classes of high- risk buildings within a local area in which this Act is in force as may be prescribed :

Provided that no special fee shall be levied on any such building or part' thereof, which by virtue of its being used for any of the purposes referred to in section 12, requires a licence under that section.

(2) (a) The State Government shall prescribe by rules the rate of special fee for different classes of high-risk buildings on the basis of the total floor area of all the floors of a building as shown in the approved building plan :

Provided that the rate of such special fee may be different for different local areas.

(b) The manner of imposition, assessment and collection of such special fee shall be such as may be prescribed.

11F. Grant of license to act as licensed agency.—(1) The Director may, from time to tifne and in accordance with such qualifications, experience or other matter in this behalf as may be prescribed in respect of such classes of buildings as may be prescribed, grant any person or association of persons, a license to act as licensed agency for the purposes of this Act.

(2) Every such license shall be renewed every three years.

(3) The State Government may, from time to time, prescribe a scale of fee for licensed agencies in respect of any class of building, if there is no written contract in this behalf to the contrary.

(4) Where the Director has reason to believe that any person to whom a license has been granted under sub-section (1) has contravened any provisions of this Act or the rules made thereunder or has failed to comply with the conditions of the license oris unfit to hold the license by reason of incompetence, misconduct or any other reasons, the Director may, after giving the person a reasonable opportunity to show cause, suspend or cancel the license, after recording the reasons in writing.

11G. Bar to carry out work of providing fire prevention etc.—No person, othefthan a licensed agency, shall carry out, in the manner prescribed, the work of providing fire prevention and fire safety measures or performing such other related activities required to be_carried out in any high-risk building or part thereof under this Act.

11H. Bar to compromise fire safety.—Where the wilful default on the part oil licensed agency in respect of fire safety of any building or premises is compromised, such licensed agency shall be liable to criminal prosecution and, in the event of any fire accident in such building or premises, shall make good all damages on account of such fire accident. .

11I. Appeal against order of Director.—(1) Any person aggrieved by an orderof the Director under this Chapter may, within thirty days of the service of the order, prefer an appeal to such authority as may be prescribed.

(2) The manner in which an appeal shall be filed and the manner of deciding the appeal shall be such as may be prescribed.

11J. Penalty for contravention of provisions of Chapter IIIA—Whoever contravenes any provision of Chapter IIIA or the rules made thereunder or fails to comply with any requisition lawfully made to him under any provision of Chapter IIIA or the rules made thereunder shall, without prejudice to any other action that may be taken against him under section 36 or section 37, be punishable with imprisonment for a term of-three years which may extend to five years or with fine of twenty thousand rupees which may extend to five lakh rupees or with both and, where the offence is a continuing one, with a further fine of one thousand rupees which may extend to ten thousand rupees for every day during which such offence continues after the conviction for the first such offence.

11K. Penalty for furnishing false 'Fire Safety Certificate'.—Any person associated with a licensed agency for any of the purposes of Chapter IIIA, who knowingly furnishes a false 'Fire Safety Certificate', 1[or false recommendation and misleading information in respect of such certificate,] shall be punishable with imprisonment for a term of three years which may extend to five years or with fine of twenty thousand rupees which may extend to five lakh rupees oryyith both.]

[2]**[11L. Offences cognizable and non-bailable** — All offences punishable under this Chapter shall be cognizable and non-bailable.]

[3]**[License for storing hazardous substances]**

[4]**[12. Bar to use of premises for storing or processing hazardous substances without license**—No premises in any area where this Act is in force shall be used for the purpose of storing or processing at any material point of time hazardous substances beyond such quantity as may be prescribed unless the owner or occupier thereof shall have previously been granted a license by the Collector.]

[1]**[13. Premises to conform to prescribed conditions.**—No license to use any premises for the purpose referred to in section 12 shall be granted unless such premises conforms to such conditions as may be prescribed.]

[2]**[14. Issue of license.**—An application for license referred to in section 12 made to the Collector in the prescribed form along with an authenticated the requisition for fire safety issued by a licensed agency and duly endorsed, in such manner as may be prescribed, by the Director or superior nominated authority, and such other documents as may be prescribed. The Collector shall, on scrutiny of the application, the requisition for fire safety and other documents, compute the annual fee payable by the applicant and shall, on payment of such fee in advance, issue the licence to the applicant on such terms and

conditions as may be prescribed :

Provided that any owner or occupier of any premises which requires a license under section 12 and who holds a valid license under this Act on the day immediately before the date of coming into force of the West Bengal Fire Services (Amendment) Act, 1996, shall not be required to apply for a license but shall, at the time of renewal, make an application for a fresh license under this Act :

Provided further that where any owner or occupier of any premises which requires a license under section 12 has made an application for a license under this Act before the coming into force of the West Bengal Fire Services (Amendment) Act, 1996, but has not been granted a license till the date immediately before the date of coming into force of that Act, such owner or occupier shall be required to make an application for such license in accordance- with the provisions of this Act.]

15 [1][Conditions of grant of license].—[2][(1) Non-fulfilment of any fire prevention and fire safety measures as may be referred to in the 'Fire Safety Certificate' shall be a breach of a condition of license.]

[3][(2) Every license granted under section 12 shall be required to be renewed annually; application for renewal of license along with duly endorsed 'Fire Safety to the Collector, who snail renew the license on such scrutiny as he may consider necessary and on payment of the prescribed annual fees :

Provided that if an applicant so desires, he may renew the license for three years at a time on payment of the prescribed fees.]

[1][(3) The annual fee shall be payable in advance in respect of the period commencing from the date from which the premises is used for the purpose referred to in section 12 in the case of new license, and from the date following the date of expiry of the license in the case of the renewal of license.]

(3a) When a license is granted under this section or on application under section 14 accompanied by a plan in duplicate of such building or place or when a license is renewed on application submitted with a plan in duplicate under proviso (b) to section 14, a copy of the plan authenticated by the Collector in the manner prescribed shall be returned to the licensee. Such authenticated copy shall be preserved in good condition by the licensee and he shall produce it before an inspecting officer for scrutiny whenever demanded.

(3b) Every license granted under sub-section (2) shall have effect from the date on which the license is granted and the renewal of every license renewed under sub-section

(3) shall have effect from the date following the date of expiry of the license which is renewed :

Provided that where for any reason no order either granting or refusing a license is made under sub-section (2) within a period of [2][sixty] days from the date of receipt by the Collector of the application for the license, the applicant may, on the expiry of such period and for so long as the license is not refused, use the building or place concerned for the purpose for which the license is applied for, and if the license is subsequently granted, the license shall have effect, from the date following the date of expiry of such period.

(4) A license or renewal of a license, for which an application has been duly made under [3][section 14,] shall not be granted if the Collector is satisfied that the area in which the [4][premises] proposed to be used or continued to be [5][used for the purpose referred to in section 12 is] unsuitable for the purpose. Where any such license (or renewal of license) is refused, the Collector shall record in writing the reason for such refusal and shall communicate his order of refusal to the applicant.

(5) An appeal shall lie to [1][any officer not below the rank of a Joint Secretary] [2][against] an order refusing a license or the renewal of a license. The period of limitation for presenting such appeal shall be thirty days from the date of receipt of the communication referred to in sub-section (4) :

Provided that no appeal shall be entertained unless the memorandum of appeal bears [3][such court-fee stamp as may be prescribed].

16. Period for disposal of application for license.—Every application for a license under section 14 [4][* * *] shall be disposed of within [5][sixty] days from the date of its receipt by the Collector and if it is not disposed of within that period, the applicant shall not be liable to any penalties under this Act, [6][for the use of the premises for the purposes referred to in section 12], after the said period of [5][sixty] days, so long as such application is not refused by the Collector.

[7][***]

[8][18. Annual fee.—(1) The annual fee for any premises, which requires license under section 12, shall be such as may be prescribed :

(2) A rebate in annual fee at such rate as may be determined by the State Government shall be allowed in the prescribed manner in respect of the premises where the owner or occupier maintains his own fire services, employing qualified and full-time fire personnel supported by adequate fire-fighting appliances :

Provided that a monthly return of the fire-fighting appliances, fire personnel and such other details as may be prescribed shall be furnished to the Director or the superior nominated authority and such fire services shall be subject to inspection by the Director or the superior nominated authority :

Provided further that in case the fire cover provided is found to be inadequate, such rebate may be withdrawn and the annual fee for the period commencing from the date on which the fire cover became inadequate, may be required to be paid.]

19. Change in occupation of warehouse or workshop to be notified.—Whenever [1][* * *] a change in the occupation of any [2][premises requiring a license under section 12] occurs, the person entering into occupation of the same shall, within two weeks of his so entering into occupation, give notice in writing to the Collector of such change of occupation, and shall thereupon pay [3][such fee as may be prescribed;] and his name shall accordingly be substituted in the license in respect of the [2][premises requiring a license under section, 12] [4][in lieu of the name of the previous occupier],

[5][**20. Suspension or withdrawal of license.**—A license issued under section 14 may, without prejudice to any other action that may be taken against the licensee, be suspended or withdrawn by the Collector after giving the licensee an opportunity of being heard, if, in the opinion of the Collector, it is necessary to do so in the public interest or if there has been a breach of any prescribed condition,]

"21. Magistrate may cancel or suspend license.—The Magistrate, before whom the case instituted under the last preceding section is brought on for disposal," may, if he be 'satisfied after taking the evidence that there exists reasonable and proper grounds for cancelling or suspending the license, cancel such license or may suspend the same, for such time as he may think fit and may impose such conditions as to the reversal of such order of cancelment or suspension as may be consistent with the provisions under this Act for the grant of a license for a warehouse or workshop."

2. The words", not below the rank of Sub-Divisional Officer", omitted by s. 11 of the West Bengal Fire Services (Amendment) Act, 2002 (West Ben. Act XXVIH of 2002) w.e.f. 1.5.2003 which were earlier ins. by s. 29 of the West Bengal Fire Services (Amendment) Act, 1996 (West Ben. Act VII of 1996).

3. Subs, by s. 30(a) of the West Bengal Fire Services (Amendment) Act, 1996 (West Ben. Act VII of 1996) for 'performed also by—

4. Clauses (a) to (d) omitted by s. 30(b), *ibid.* Earlier these were as under :

"(a) the Director or such other officer as the State Government may specify in the order, or

(b) in Calcutta, the Commissioner of the Corporation of Calcutta, or

(c) in any other municipality, the Commissioner of the Municipality, or

(d) in Chandernagore, 'the Chief Executive Officer of the Municipal Corporation of Chandemagore."

5. Sub-sections (2) and (3) omitted by s.30(c). Before omission these were as under:

"(2) Where the State Government makes an order under sub-section (1) directing the Commissioner of the Corporation of Calcutta or the Chairman of the Commissioners of a Municipality or the Chief Executive Officer of the Municipal Corporation of Chandemagore to exercise or perform any powers, duties or functions of the Collector under this Act, such Commissioner, Chairman or Chief Executive Officer, may by order authorise any officer of the Corporation of Calcutta or of the Commissioners of the Municipality or of the Municipal Corporation of Chandemagore, as the case may be, to exercise or perform, subject to his control and supervision, any or ail such powers, duties and functions.

(3) Where the Commissioner of the Corporation of Calcutta or the Chairman of the Commissioners of a Municipality or the Chief Executive Officer of the Municipal Corporation of Chandernagore or any other officer acting in pursuance of an order • under sub-section (1) or sub-section (2) realises any fee under this Act, such fee shall be paid to the State Government at such times and after making such deduction for the cost of collection and other incidental expenses therefore as may be prescribed."

22. Delegation of power by Collector.—The Collector may delegate any of his powers, duties and functions under this Chapter to any officer or officers [2][* * *] subordinate to him.

23. Powers of State Government to direct delegation of powers—(1) The State Government may, by general or special order published in the Official Gazette, direct that such of the powers, duties and functions of the Collector under this Act as may be specified in the order, shall be exercised and

[3][performed also by such other officer or officers as may be specified therein.]

Temporary Structures and Pandals

23A. Erection of temporary structures or pandals.—(1) A person who intends to erect **a** temporary structure or pandal with roof or walls made of straw, hay, *ulu grass, golpata, hogla, darma,* mat, canvas or other like material [1][in an area where this Act is

in force] for use as a place where members of the public may assemble, shall apply to the Director [2][or the superior nominated authority along with the prescribed fees] for permission to erect such structure or pandal and such permission shall not be refused if the structure or pandal conforms to the conditions that may be prescribed in this behalf.

[3][Provided that the State Government may prescribe by rules the essential requirements of a 'Fire Safety Certificate' in respect of any class or classes of temporary structures or pandals.]

(2) No structure or pandal referred to in sub-section (1) shall be erected—

(a) unless it conforms to the conditions referred to in sub-section (1); and

(b) unless permission of the Director [4][or the superior nominated authority] has been granted under sub-section (1) :

Provided that where no order granting or refusing the permission is made within such period as may be prescribed in this behalf, the structure or pandal may be erected if it conforms to the conditions referred to in sub-section (1).

Explanation.—For the purpose of the above proviso, different periods may be prescribed for different kinds of structures and pandals.

Penalties

[5]**[23B. Dismantling of temporary structure or pandal,**—The Director or the superior nominated authority with the assistance of the local authority and under police protection shall dismantle a temporary structure or pandal erected in contravention of the provisions of sub-section (1), and the cost of such dismantling shall be charged to the person who so erects the temporary structure or pandal, as the case may be.]

23C. Penalty for not giving way to fire brigade vehicles.—Any person who, being in charge of a vehicle, contravenes the provisions of section 5C shall be punishable, on conviction [1][* * *], with fine which may extend to [2][two thousand] rupees.

[3]**[24. Penalty for selling fire-works.**—Any person who sells fire-works without obtaining a license, or were a license to sell fire-works has been granted breaks any of the conditions specified in the license, shall be punishable on conviction, with fine of one thousand rupees which may extend to five thousand rupees.]

25. Penalty on house-holders for allowing rockets, etc. to let off without license.—If any rockets are let off or fire-balloons sent up from within the precincts of any private premises or compound without a license, the owner or occupier or person under whose immediate control the premises or compound is, shall unless he can prove that the offence

was committed without his knowledge, be punishable, on conviction [4][* * *] [5][with fine of one thousand rupees, which may exceed to five thousand rupees.]

26. Penalty for not taking out a license for a warehouse or workshop—Any person who without a license uses any [6][premises tor tne purpose referred to in section 12] shall be punishable, on conviction [7][* * *] [8][with fine of one thousand rupees which may extend to five thousand rupees] or with imprisonment for a term which may extend to two months or with both, and with [9][furtherfine not exceeding five hundred rupees] for each day during which he may continue to so use such [10][premises].

27. Penalty fot using warehouse or workshop after refusal, etc., of license.— Any person who [1][for the purpose referred to in section 12, uses any premises] in respect of which a license has been refused, or after the license in respect thereof has been cancelled or during the time for which such license has been suspended, shall be punishable, on conviction [2][* * *] [3][, with fine of one thousand rupees which may extend to five thousand rupees] or with imprisonment for a term which may extend to two monthsor with both, and with [4][furtherfine not exceeding five hundred rupees] for each day during which he may continue to so use such [5][premises].

28. Penalty for breach of conditions.—Any holder of a license who breaks any of the conditions under which a license is held in respect of any [6][premises] shall be punishable, on conviction [7][* * *] [8][with a fine of one thousand rupees] or with imprisonment for a term which may extend to one month or with both for any on such offence.

29. Penalty for failing to notify change in occupation of warehouse or workshop.— If [9][* * *] there by a change in the occupation of [10][any premises referred to infection 12,] the person entering into occupation fails to give a notice and to pay the fees required by section 19 such person shall be punishable, on conviction [11][* * *] [12][with fine of one thousand rupees which may extend to five thousand rupees] for each during which he may so use or continue to use [13][such premises].

"30. Penalty for giving false information to Collector responding license.—Any person who gives false information to the Collector or to any person performing or exercising powers duties and function of the Collector under this Act, with tne object of inducting him to take action under section 209 shall be punishable, on conviction before a Magistrate, with fine not exceeding one hundred rupees or with imprisonment for a term which may extend to one month or with both.".

"31. Penalty for using as residence of warehouse used for pressing jute or cotton.—Any person who uses as a residence any portion of a warehouse used for

pressing or screwing of jute or cotton if jute or cotton be then stored therein shall be punishable on conviction before a Magistrate, with fine not exceeding one hundred rupees and with further fine not exceeding twenty rupees for each day during which he may continue to so use it.".

2. Section 32 subs, by s. 42, ibid (with effect from 1.11.1996). Earlier it was as under:

"32. Penalty for using matchboxes, etc., in warehouse—Any person who brings into a warehouse used for the pressing or screwing of jute or cotton (if jute or cotton) be then stored or used therein, any match-boxes, match-sticks or any artificial light not duly and thoroughly protected, shall be punishable, on conviction before a Magistrate, with fine not exceeding one hundred rupees for any such offence.".

3. Section 33 subs, by s. 43, *ibid* (with effect from 1.11.1996). Earlier it was as under:

"33. Penalty for smoking within warehouse.—Any person who smokes within a warehouse used for the pressing or screwing of jute or cotton (if jute or cotton) be then stored or used therein shall be punishable, on conviction before a Magistrate, with fine not exceeding one hundred rupees for any one such offence,".

[2]**[32. Owner or occupier of building or premises to compensate person affected by fire.—**Whenever on enquiry into an incident of fire by the District Magistrate or by the committee specially constituted by the State Government - under sub-section (1A) of section 8 it is established that the incident of fire was due to wilful default or negligence on the part of the owner or occupier of any building or premises, such owner or occupier shall be liable to compensate every person affected by such fire for the loss sustained by him in addition to his being liable to criminal prosecution.]

[3]**[33. Offences by companies.—**(1) Where an offence under this Act has been comitted by a company, every person who, at the time the offence was committed, was in charge of, and was responsible to, the company for the conduct of the business of the company, as well as the company, shall be deemed to be guilty of the offence and shall be liable to be proceeded against .; and punished accordingly :

Provided that nothing contained in this sub-section shall render any such person liable to any punishment, if he proves that the offence was committed without his knowledge or that he had exercised all due diligence to prevent the commission of such offence.

(2) Notwithstanding anything contained in sub-section (1), where any offence under this Act has been committed by a company and it is proved that the offence has been committed with the consent or connivance of, or is attributable to any neglect on the part of, any

director, manager, secretary or other officer of the company, such director, manager, secretary' or other officer shall be deemed to be guilty of that offence and shall be liable to be proceeded against and punished accordingly.

Explanation.—For the purposes of this section,—

(a) "company" means a body corporate and includes a firm or other association of individuals; and

(b) "director", in relation to a firm, means a partner in the firm.]

33A. Penalty for erecting structure, etc., in contravention of section 23A.—Any person who erects any structure or *pandal* in contravention of the provisions of sub-section (2) of section 23A, shall be punishable, on conviction [1][* * *] [2][with fine of ten thousand rupees which may extend to fifty thousand rupees] or with imprisonment for a term which may extend to one month or with both, and with further fine not exceeding [3][three thousand] rupees for each day during which such contravention continues.

33B. Penalty for obstructing persons exercising powers under section 37A.—Any person who wilfully obstructs, or offers any resistence to, or impedes or otherwise interferes with the Director or any officer exercising powers under section 37A or any assistant accompanying the Director or such officer while exercising such powers, shall be punishable, on conviction [4][* * *] [5][with fine of one thousand rupees which may extend to five thousand rupees.]

33C. Offences-bailable and cognizable.—All offences punishable under this Chapter shall be bailable and shall, [6][* * *] be cognizable.

Miscellaneous

[7]**[34. Inspection of building or premises.—**(1) The Director or the nominated authority may enter and inspect any building or part thereof or any premises at any time between sunrise and sunset where such inspection appears necessary for ascertaining the contravention, if any, of fire prevention and fire satety measures referred to in section 11C and of the conditions referred to in section 13:

Provided that the Director or the nominated authority may enter into and inspect any such building or part thereof or premises at any time if it appears to him or it to be expedient and necessary to do so in order to ensure safety of life and property.

(2) The Director or the nominated authority, as the case may be, shall be provided with all possible assistance by the owner or occupier, as the case may be, of such building or

part thereof or premises for carrying out the inspection under sub-section (1).

(3) When any such building or part thereof or premises used as a human dwelling is entered under sub-section (1), due regard shall be paid to' the social and religious sentiments of the occupiers; and before any flat or part of such building or premises in the actual occupancy of any woman who, according to the custom, does not appear in public, is entered under sub-section (1), notice shall be given to her that she is at liberty to withdraw, and every reasonable facility shall be afforded to her for withdrawing.

(4) Where the inspection is carried out by the nominated authority under the foregoing provisions of this section, it shall give a report of any such inspection to the Director or the superior nominated authority.

Explanation.—For the purposes of this section, "flat" shall have the meaning assigned to it in the West Bengal (Regulation of Promotion of Construction and Transfer by Promoters) Act, 1993.]

[1][**35. Issue of notice to owner or occupier to undertake fire prevention and fire safety measures.—**(1) The Director orthe suDerior nominated authority.

as the case may be, shall, after completion of the inspection of the building or part thereof or the premises referred to in section 34, record his or its views on the deviations from, or contravention of, the requirements with regard to the fire prevention and fire safety measures orthe inadequacy of, or non-compliance with, such measures provided or to be provided therein with reference to the structure of the building orthe premises orthe nature of activities carried on in such building or part thereof or premises and issue a notice to the owner or occupier of such building or part thereof or premises directing him to undertake such measures, and within such time, as may be specified in the notice. Where the owner is not available, the occupier shall undertake such measures in the interest of public safety, notwithstanding anything contained in any other law for the time being in force.

"35. Police officer may arrest offenders under section 24.—(1) Any person committing an offence under section 24 may, if his name and address be unknown, be arrested by any officer of police and forthwith conveyed before a Magistrate having jurisdiction in the place in which such offence has been committed, or shall be taken to the nearest police-station within the said jurisdiction, in order that such person may be detained until he can be brought before a Magistrate or until he shall enter into a recognizance with or without sureties for his appearance before a Magistrate.

(2) Whenever such person shall be taken to a police-station, the officer in charge of such station shall, as soon as possible, but in every case within twenty-four hours, cause

him to be conveyed before a Magistrate having jurisdiction in the matter.".

[1][**36. Compliance with notice issued under section 35.**—(1) The Director may, in the event of non-compliance with any notice issued under section 35, take such steps as may be necessary for the compliance with such notice.

(2) All expenses incurred by the Director in relation to any steps taken by him under sub-section (1) shall be payable, on demand, by the owner or occupier on whom such notice is served, and shall, if not paid within 30 days of such demand, be recoverable under the Bengal Public Demands Recovery Act, 1913.]

[2][**37. Recovery of fees.**—(1) The fees payable under this Act, if not paid within the time provided in this Act or the rules made thereunder, shall be recoverable as a public demand under the Bengal Public Demands Recovery Act, 1913.

(2) The State Government may remit payment of fees in such cases as may be recommended by the Collector.]

[3][**37A. Director or superior nominated authority to seal building.**—(1) If the Director or the superior nominated authority is satisfied that owing to inadequacy of fire prevention and fire safety measures, the condition of any high- risk building or part thereof is in imminent danger to person or property, then, notwithstanding anything contained in this Act or in any other law for the time., being in force, he or it shall, by order to be recorded in writing, require the persons in possession or occupation of such building or part thereof to remove themselves forthwith from such building or part thereof.

(2) If an order made by the Director or the superior nominated authority under sub-section (1) is not complied with, the Director orthe superior nominated authority, as the case may be, may direct any police officer having jurisdiction to remove such persons from such building or part thereof and such police officer shall comply with such direction.

(3) After the removal of the persons under sub-section (1) or sub-section (2), as the case may be, the Director or the superior nominated authority, as the case may be, shall seal such building or part thereof.

(4) No person shall remove such seal except under a written order made by the Director or the superior nominated authority *suo motu* or on application by the owner or occupier.

(5) Any person who contravenes the provisions of sub-section (4) shall be punishable with imprisonment for a term of three years which may extend to five years or with fine of twenty thousand rupees which may extend to five lakh rupees or with both.]