3.2 Fires

A fire is a chemical oxidation process giving off energy, mostly in the form of heat. The generation of smoke and toxic gases is an important risk factor in a fire. Additional risks are caused by combination effects such as explosions or the leakage of contaminated water when extinguishing the fire.

The speed of the development of a fire varies greatly, depending on the material's combustibility and energy content, its physical form (solid, liquid or gas) and the availability of oxygen.

Fire hazards are caused by collections of substances which can be ignited when they are heated or come into contact with other substances. Some strong oxidizing agents or self-igniting substances also constitute fire hazards.

Firemen are repeatedly exposed to smoke containing a variety of harmful gases. When various different chemicals are present in smoke, they can interact to produce a smoke which is much more dangerous than the sum of the individual parts (synergy).

Carbon monoxide is usually the most dangerous gas produced by a fire. Hydrogen cyanide is an extremely toxic gas which is produced when material containing nitrogen burns. Chemical analysis has shown that varying quantities of hydrogen cyanide are present in smoke from synthetic products such as polyurethane, melamine and nylon. The proportion of hydrogen cyanide increases as the temperature of the fire rises. Products containing fluoride give off hydrogen fluoride at high temperatures. Many fluoride compounds are extremely poisonous, even in low concentrations. Products containing sulphur, eg rubber, give off sulphur dioxide when warmed. Care must be taken at fires involving pesticides or herbicides. These often contain arsenic and chrome. Some can even give off gases similar to nerve gas.

Gases from fires involving large concentrations of dangerous substances can spread over great distances. It is therefore vital to carry out a careful analysis of this kind of hazard. It is also important that there are instruments to detect the harmful substances most commonly produced in fires.

Consequences of fire in a factory, Melbourne, 1985.
Photo : F. BALKAU

3.2.1 Fire - Risk Objects and Threatened Objects:

Public buildings -
eg discotheque
department store
restaurant
sports arena
cinema
theatre
hotel
hostel
schools

Hospitals and other care homes

Industrial plants
eg saw mill
petroleum refinery/storage depot
chemical plant
plastic, rubber and paint factory
engineering plant
steel mill
cellulose production unit
explosives factory/storage depot
any plant handling liquified petroleum gas
papermill, paper store, tank farms,etc.

Nuclear power stations

Docks
eg oil terminals
ships with inflammable cargoes
warehouses with a high turnover of a variety of goods

Railway marshalling yards - wagons with inflammable loads

Natural gas facilities

Underground installations
eg mines
underground railways
military stores

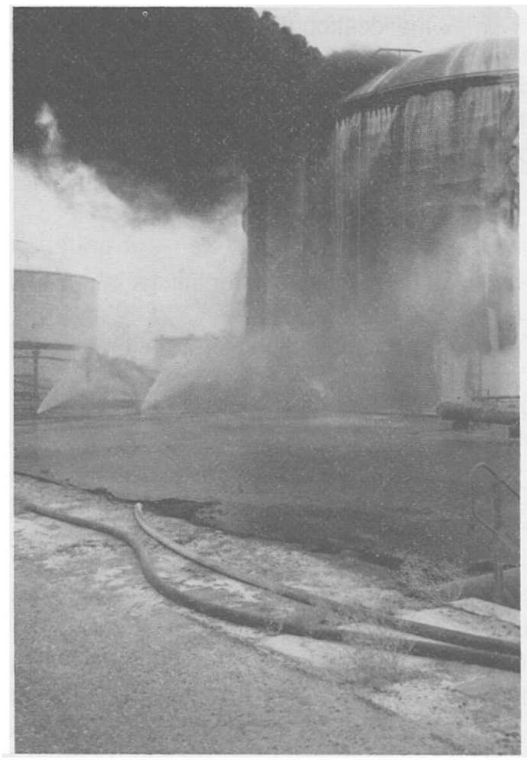
The use of liquified petroleum gas (LPG) and natural gas is increasing. They are transported by pipeline or in lorries, ships and trains. There is always the risk of a leakage leading to an explosion or fire when these gases are handled.

A crash involving a petrol tanker could have disastrous consequences in a built up area.

Large quantities of inflammable chemicals are handled in railway marshalling yards. These are often located in the middle of towns, which means that an accident could have serious consequences.

Large quantities of aviation fuel are handled at airports.

The loads of two lorries involved in a collision can come into contact with each other, leading to a very dangerous situation.



Fire in an LPG storage tank

3.2.2 Factors Raising the Risk Level:

- the increasing use of inflammable chemicals and dangerous industrial processes
- lightning
- electrical faults
- negligence and complacency when handling hazardous chemicals
- poorly marked or unmarked containers of hazardous chemicals
- arsonists, drug addicts and alcoholics who behave in a dangerous and unpredictable way
- sabotage
- large and complex installations with unknown contents, which make the work of firemen increasingly dangerous.

3.2.3 Factors Reducing the Risk Level:

- automatic systems to extinguish fires are becoming more reliable and effective
- automatic fire alarms are becoming more reliable and effective and fire alarms are being installed in homes
- smoke vents are becoming more reliable and effective - normal ventilation systems can spread harmful smoke in a building
- safer building techniques

- the location of fire stations near to risk objects
- pre-planning and regular exercises
- faster fire engines with effective equipment
- good access for fire engines
- strict regulations for fittings in public buildings
- good training and information for personnel in the rescue services
- less smoking
- information to the general public on television, radio and in newspapers
- information to schools and companies

risk level increases	**can be countered by**
• large/high buildings	dividing into sections, sprinklers
• complexity	smaller units, good overview
• combustible material	product development, information and education
• combustible fittings	inspection, technical improvements
• sabotage, terrorism	fire prevention to minimise the consequences

threat	**factors to consider**
• fire	intensity, speed at which fire spreads
• smoke	thickness, toxicity
• emergency exits	number, accessibility
• number of floors in building	evacuation of the building - especially if under ground
• building construction	strength, air-tightness, fire-resistance
• building material	combustibility, toxicity in a fire
• building's fire load	time for evacuation
• operation	fire risk, fire load, preventive measures
• number of occupants	possibility of evacuation
• handicapped/sick occupants	possibility of evacuation
• extinguishing systems	saving life and property
• fire alarm	possibility of evacuation, saving life and property
• rescue service's ability to save life and property	response time, manpower and equipment

There are examples from the second world war of large scale fires developing into fire storms. These intensive fires consume a large amount of oxygen. The suction from the fire can pull people and animals into the flames.

Sabotage and arson attacks can lead to serious fires and explosions

The need for methods to evaluate various risks has increased as industry and society

have developed Complex calculations are required to estimate the probability and consequences of a fire with some precision. There is no general method to estimate fire risk for any building and all operations Several different methods are available. Some of them can be used to show the effect of various preventive measures on the level of risk. Fire risk investigations are particularly important for industrial sites, depots, hospitals, schools, hotels and public buildings.

The method for evaluating fire risk which is used most frequently in Europe was developed in Switzerland by M. Gretener in the 1960s It is intended for industrial establishments but can also be applied to department stores, hotels, exhibition centres, blocks of flats and hospitals.

Gretener's method takes account of the architecture, construction and contents of the building in order to evaluate fire risk. Combustibility, fire load, smoke production and the corrosive effects of smoke are considered. (With a limited supply of oxygen, a fire in oil, plastic or rubber can produce large quantities of smoke although the intensity of the fire is low. Fires can also produce corrosive or toxic gases)

Around 1980 a new method for risk analysis was developed in the USA, providing a new approach to the problem. It attempts to take account of the effect of people's actions as well as that of automatic equipment. Various categories of people are considered - for example the old, sick and handicapped. The method is based upon balancing protective measures against the risks that different groups are exposed to. Protective measures are taken to include people's responses to the situation and their possibility of escape, as well as the physical features of the building.

3.2.4 Examples of Serious Fires:

The Sherwin - Williams Warehouse Fire

On 27th May 1987 an estimated 40 litres of inflammable liquid were accidentally spilled in a car paint distribution centre in Dayton, Ohio, USA.

Sparks from an electric fork-lift truck ignited the spilled liquid and the resulting fire destroyed the entire warehouse, consuming 5 million litres of inflammable liquids. The warehouse was situated in an area supplying drinking water. The fire fighters opted for a controlled burn-out because no adequate water retention devices were available. The fire lasted for six days but thanks to the burn-out decision major contamination to the ground-water was avoided.

Sandoz Warehouse Fire

During the night of the 31st October 1986 a fire broke out in a warehouse belonging to Sandoz at Schweitzerhalle, near Basel in Switzerland.

The fire spread rapidly Drums exploded and were thrown through the air, damaging nearby buildings where some 1000 tons of highly inflammable liquids were stored. To avoid a catastrophe the fire chief decided to extinguish the fire. Water used to extinguish the fire became contaminated. It flowed into the river Rhine (from which water was being pumped to fight the fire) This contaminated water contained pesticides and other toxic chemicals, which killed fish and other forms of life in the river. Drinking water supplies further downstream had to be shut off.

Chemical Factory, Tours

In June 1988 there was a fire in a chemical factory near Tours, France.

The fire spread very quickly because inflammable products were stocked close to each

other. About 600 tons of chemicals were destroyed, being dispersed into the atmosphere and a river flowing past the factory. A dense black cloud drifted towards the city of Tours. The drinking water for about 12,000 people had to be cut off for several days.

There are many examples of fires in public buildings, such as hotels and discotheques, which have claimed many lives. Fires, together with road accidents, are the most frequent events the rescue services have to deal with.

Fire resulting from chemical processes, Pemex, Mexico .