5 November 1979
ENGLISH ONLY

UNCTAD/UNDP/SIDA AFRO-ASIAN SEMINAR
ON LOSS PREVENTION IN FIRE AND MARINE CARGO INSURANCE
MADRAS, INDIA, 3-7 DECEMBER 1979

ABOUT FIRE LOSS PREVENTION IN GENERAL

by N.C. Strother Smith

Introduction

In most countries of the world with a fully developed industrial and commercial economy, fire is consuming about one quarter to one third of one per cent of the country's national product. The prevention and control of fire by the public fire brigades is consuming about an equal amount and a very rough estimate of the cost of in-built protection in the form of fire-resistance in the structure and of fire extinguishing equipment indicates that this is costing about the same amount again. To find out whether the expenditure on prevention and control is cost effective, it would be necessary to know what the cost of fire damage would have been without these preventive measures. An attempt to calculate this was made in the UK and it was seen that when the fire loss estimates were corrected for inflation, the ever-increasing growth of losses was checked in the middle 1960s at a time when insurance companies were demanding increased expenditure on fire precautions as an alternative to heavy increases in premium rates. Outstanding amongst all the precautions that were taken at that time, and increasingly ever since, was the installation of the automatic sprinkler system. Premium reductions of as much as 90% were obtainable in high risk premises, thus indicating the considerable faith attached to sprinklers by insurers, which was fully justified on the basis of a very long experience.

UNCTAD/INS/38
GE.79-55302

Restoring the damage done by fire is only part of the cost of a fire. A fire may have serious consequences for the productive capacity of a business and in the extreme the time taken to restore production may be such that the business is forced to close down altogether. The effect of a fire may not be confined to the business damaged by the fire. Businesses which are dependent on the fire victim's products may be seriously affected also, and the consequences may be such that even the economy of the country is adversely affected.

In this paper I have set out the basic principles of fire protection and loss prevention and the ways in which they can be implemented on a national basis by governments, by insurers collectively and individually, and by the managements of businesses. It is in the interests of the community at large that proper attention be paid to loss prevention since it is the community in the end which has to pay for the loss. Insurers may be paying for the damage done, but can only do so out of the premiums collected from the insured. If the losses exceed premiums then the insured will have to pay higher premiums.

The control of fire risks is a complex subject but it can be simplified if a preplanned system is developed. Without such a system, important matters may be overlooked. The final section of this paper outlines a system which can be adapted to any set of circumstances, any type of occupancy.

Principles of the Control of Fire

Fire has enormous potential for destruction. The combustion of fuel releases heat so that once it has started a fire will grow at an accelerating rate unless remedial measures are taken. Either the unburnt fuel must be separated from the heat or the supply of air cut off.

or the heat removed. The separation of combustible materials will limit the amount of fuel which can contribute to the growth of fire. The confinement of fuels within building compartments will limit the amount of air which can feed the fire as well as preventing the heat from the fire from reaching further combustible fuels.

However, for the ultimate extinguishing of the fire the combustible material must be cooled below its ignition temperature. Water, which has a high latent heat of vaporisation, is the most effective coolant. However, for it to be effective it must be applied in sufficient quantity and at such a rate that it will prevent the accelerating growth of the fire. A fire discovered within two or three minutes of its outbreak may be extinguished with less than 1,000 litres of water. If the water is not applied until five to ten minutes later, which is probably the shortest time in which a fire brigade may reach the scene of the fire, the fire will have grown to such proportions that between 50 and 100 times as much water may be needed for extinguishing the fire.

It can be seen, therefore, that if remedial measures are not taken in the very early stages following the outbreak of a fire, the limitation of the ultimate loss is going to depend on either a strict control of the amount of fuel exposed to any one fire or the provision of a well trained fire fighting force equipped with fire extinguishing appliances capable of delivering large quantities of water in a short space of time and, most essentially, large reserves of water. The amount of water required increases exponentially as the increase in the time taken for the fire fighting forces to reach the scene of the fire and start effective fire fighting operations.

An automatic sprinkler installation will, in the large majority of circumstances, control and extinguish a fire with less than 1,000 litres of water and may, therefore, be the most economic way of limiting the

loss in a fire, particularly in areas of limited water supplies. This does not mean to say that a well trained and well equipped fire fighting force is not necessary. The national financial resources available for loss prevention can, however, be more efficiently deployed if the automatic sprinkler installation is regarded as an important part of the overall national fire fighting resource.

Reliance placed on a public central fire brigade may be of doubtful value, whether in a town or a country district, since most towns and cities in developing countries are confronted with a rapidly deteriorating traffic problem. If the fire brigades are unable to reach the scene of the fire and apply water to the seat of the fire in adequate quantities within 15 minutes, or at the outside 30 minutes, it is probable that they will be confronted with a total loss. In a rural area not only is the fire brigade likely to be confronted by the need to travel long distances to the scene of the fire, but may well have to carry adequate water with them. Some provision, therefore, should be made for each business to be equipped with adequate fire fighting facilities and trained men on the premises. A compromise could, of course, be reached where several businesses are in close proximity with each other; in this case, a central brigade could be established to service all the businesses.

The planning of towns and cities and the siting of factories should be carried out with the needs for fire protection in mind and adequate natural water sources in the vicinity is the first consideration. In the absence of natural sources, provision should be made for the bulk storage of water for use for fire fighting purposes only. If reliance has to be placed on a central fire brigade then great care has to be taken in the town planning and in the siting of the fire brigade station to ensure that fire fighting vehicles are not impeded by traffic problems in their attempts to reach the scene of the fire.

The effectiveness of the fire brigade depends on its early arrival at the scene of the fire. Means must, therefore, be provided in every building of transmitting a call direct to the fire brigade control point. Manual means of transmitting the call should be supplemented by an automatic fire detector which when actuated by the fire automatically transmits a call to the control point.

The Part Played by the Building in Loss Control

The principal ingredient contributing to the size of the loss by fire is the amount of fuel exposed to any one fire. Control of this can be achieved by the sub-division of buildings into compartments of limited size by means of fire separating walls and floors, providing resistance to the passage of fire so that an outbreak of fire will be confined to the compartment where it starts. National building regulations should require a limit for the size of compartments and also for the size of the building itself.

Worldwide there is a growing tendency towards the construction of tall buildings. It could well be believed that the status of a city is sometimes judged by the number of skyscrapers. Tall buildings may be economically desirable where land is scarce but little jutification can be made for them where land is plentiful. Quite apart from the constructional problems presented by the need to build high, tall buildings present serious difficulties from the point of view of fire safety. Two fires which occurred in Sao Paulo, Brazil, within little more than a year of each other in 1973 and 1974, demonstrated the dangers to the occupants and the impossibility of fighting the fire and evacuating the occupants which confronted the fire brigades. However, those buildings lacked the fire resisting subdivision which would have confined the fire to one floor. (These fires are fully documented in the publications of the Fire Protection Association.) Only where the scarcity of land overrides all other

considerations should the development of tall buildings be countenanced.

The ideal maximum height for buildings from the fire protection and fire fighting point of view is 25 m. This is approximately the maximum effective reach of the longest fire brigade fire fighting ladders. This limitation has generally been accepted from the point of view of saving the lives of occupants of buildings who may be trapped. If a fire has developed to such an extent that rescues have to be effected through windows via fire brigade ladders, and the fire has to be fought from outside the building, serious damage must be done and a heavy loss suffered. From a loss prevention point of view single storey buildings, adequately sub-divided to limit the amount of goods exposed to one fire, provide the most satisfactory conditions.

Fire separating walls and floors must have sufficient resistance to the passage of fire to ensure that whatever the compartment may contain when it is on fire, it cannot destroy the separating elements. The size of the compartment and the degree of fire-resistance of the separating elements will need to be related to the nature of the contents and also to the time a fire is likely to burn before fire fighting or fire extinguishing intervention is possible. In the extreme the fire-resistance of the building elements may need to be such that they can withstand a complete burnout of the contents of the compartment without allowing it to spread.

The limitation of the size of compartments, and for that matter the size of the building, may be undesirable from a business point of view. If this should be the case, and compartments or buildings larger than the regulation size are required, then the installation of automatic sprinkler systems should be mandatory.

The fire resistance of walls and floors and other elements of building construction is measured in Europe and America by placing

sample forms of construction in furnaces designed specially for the purpose. The furnaces are designed to simulate the growth of a fire. Elements of structure which are intended to separate spaces, such as walls and floors, are required to provide resistance against collapse and against the passage of heat and flames. The fire resistance is measured by the time that the element survives the test. Load bearing elements such as beams and columns are tested until they collapse.

Openings in walls are needed for movement between compartments and from compartments to corridors and ultimately to staircases and liftshafts. It is the provision of these openings which is the weakness in the establishment of fire safety within a building. If doors are left open or if vertical shafts open directly onto the compartments on the different floors of the building, fire will quickly spread from compartment to compartment and from storey to storey.

Openings in fire separating walls and floors need to provide the same degree of resistance to the passage of fire as the wall or floor in which they have been made. To prevent the passage of fire from floor to floor, staircases, liftshafts and shafts for other purposes have to be encased in walls providing fire resistance and the openings onto the staircases or shafts have to be provided with doors providing the same degree of fire resistance. Building Regulations must, therefore also serve to control all openings in walls and floors for vertical and horizontal communications. Standard ways of achieving the control of fire spread by means of staircases and shafts are in general use in most countries of Europe and in America.

Safety of the Occupants

The safety from fire of staff and workpeople must be ensured. Provision must be made to ensure that in the event of fire, the

occupants of buildings can escape to a place of safety without having to go through the fire or through smoke. In most buildings the sub-division by fire separation can provide places of safety from fire since the fire can be confined to the place where it starts and the occupants can move to an unaffected part and thence to the outside. In buildings of more than one storey the escape of the occupants depends on the use of staircases. These, therefore, have to be planned in such a way that fire cannot affect more than one staircase. Thus, if one staircase is involved with fire or smoke, the occupants can move to another one. The design for the safety of occupants requires a thorough understanding of the behaviour of fire and guidance will need to be sought from recognised publications on the subject.

Building Materials

The materials used in the construction of buildings should as far as possible be such that they are not capable of making a contribution to the growth and development of a fire. Ideally, therefore, non-combustible materials only should be used in the construction of buildings. This, however, may be a severe restriction, particularly in countries where timber products are readily available. While timber and timber products can never be rendered wholly non-combustible they can, however, be treated in several ways to reduce the risk of ignition and to limit the contribution they may be able to make to the growth and development of a fire. Timber can be used for structural purposes as columns and beams and with a sufficient cross sectional area may be capable of withstanding the effects of a fire without collapse for sufficient periods for many purposes. There are, of course, strict limitations on the use of timber in this way and great care would need to be taken to ensure that its use was properly considered.

Timber and other combustible products of timber should not be used for separating spaces where fire resistance is required because

of the combustibility of the timber. However, it can be used in certain forms of construction where the timber is protected from the immediate attack of flame and heat by non-combustible forms of construction which will prevent the timber from reaching an ignition temperature. Timber is, in fact, used in certain sandwich construction as a core where it is protected from the heat of a fire and in which it provides a useful insulation to prevent the passage of heat through the panel.

Timber is, of course, widely used for doors, particularly in private houses and other residential accommodation. In sufficient thickness, a timber door will hold back fire for anything up to possibly even one hour, although in fact the maximum fire-resistance rating which has been achieved by doors in Europe and North America is half-an-hour.

Timber is often used in sheet form for decorative purposes and timber products and plastics material are often used in ceilings. Limitations should be placed on the use of combustible materials in these ways since once involved in a fire they may be capable of making a major contribution to the growth of the fire.

Non-combustible materials do not necessarily provide fire-resistance. Steelwork used for structural purposes loses its strength quite early in the development of a fire with the possible result of the collapse of the building. Concrete when subjected to high temperatures spalls, or chips, and the material falls away with a resultant loss of thickness. These are just two examples of non-combustible materials which need careful handling in the design of fire resistance in a building. Most European and North American countries can provide examples of the fire resistance achieved by varying forms of construction and examples of how building regulations have been developed to provide appropriate degrees of safety from fire.

When building regulations are being formulated, it is important that an approval system should be established by which the plans for buildings may be inspected before authority is given to commence building and by which the building may be inspected after completion, before authority is given for its occupation.

To facilitate the control of buildings, it is recommended that a system of approval be established to ensure that properly qualified architects and builders can be recognised by the public.

Building Services

Electricity and gas are the principal sources of energy for heat, power and light in any community be it industrial, commercial or residential. Both of them are major sources of ignition wherever they are used.

The passage of an electric current generates heat which may be used intentionally in plant process and space heating. The heat is also present in electrical illumination and anywhere electricity is transmitted along a cable. It is, in fact, the temperature rise in any electrical equipment which governs its capacity. All electrical equipment, therefore, must be carefully rated according to the work it is expected to do. If it is overloaded, excessive heat will be generated and a fire may ensue.

Fires are also caused by defects in electrical equipment and through damage to electric wiring insulation. They are also caused by allowing combustible materials to come too close to electrical equipment which is runnnng hot. A high standard of installation and maintenance, therefore, is necessary to ensure safety from fire which may be caused by the use of electrical equipment. Safety codes need to be established and they need to be enforced. Only qualified electrical contractors should be allowed to carry out electrical installations.

It is, therefore, desirable to establish the safety code and the system by which it will be enforced and this will mean a system for the approval of qualified electrical contractors. The inspection and approval system should embrace the standards for the manufacturer of electrical equipment or for the equipment which may be imported from overseas.

Similar practices to those recommended for electrical installations should be applied for gas installations. The gas likely to be used for energy sources will be either natural gas or liquified petroleum gas. In addition to the hazards of the installation and use, there are also the hazards of storage. A safety code should, therefore, be established for the storage of gas and this should embrace all forms of storage from bulk quantity tanks to small unit cylinders serving private dwellings. A similar form of inspection and approval system should also be established covering both the storage and the installation of gas equipment.

In buildings where a central air conditioning plant is installed for the transmission of conditioned air from the plant through ducting throughout the building, provision needs to be made to ensure that the ducting does not provide a means by which fire can be spread throughout the building. In the event of fire, the air conditioning plant should be shut down. This is most ideally achieved if the control of the plant is connected to the automatic fire detection system so that when a fire is detected, the plant is automatically shut down. In addition, the ducting should be provided with fire resisting shutters wherever the ducting traverses a fire separating wall or floor. The shutters should be arranged so that they close automatically when the plant is shut down.

Wherever any of the building services traverse fire separating walls or floors, the openings provided for them should not be allowed to diminish the fire resistance provided by the walls or floors.

Building Contents

Often it is the contents of building, rather than the structure itself, which burn. Careful attention, therefore, has to be paid to the layout of plant, process and storage, in particular the handling and storage of hazardous material. The materials which are controlled in this way in Europe and North America include explosives, certain chemicals and flammable liquids whose flashpoint is in the region of 23°C or lower. The most commonly used flammable liquids are derivatives of petroleum and the liquified petroleum gases. It should be a requirement that wherever they are used or stored in quantities exceeding, say, 10 litres, there should be a licence in force which establishes the method of storage and the precautions to be taken.

Implementation of the Principles of Loss Prevention

This, then, is the philosophy lying behind the control of loss by fire. Its implementation can be carried out by control through government regulations and by the insurers' financial pressures brought to bear through fire insurance premiums.

Firstly, government regulations are needed to control the design and construction of buildings, to control the transport, handling and storage of hazardous materials, and to control the use of hazardous sources of ignition such as electricity.

The level of control exercised by government through national regulations will depend on the standards of safety which are developed in the design and construction of plant, equipment and building services and on the standards of safety established by managements, workpeople and the public at large in relation to the handling and storage of hazardous materials and in the general management of plant and processes.

In Western Europe and in North America standards of fire safety have been evolved by the blending of government regulations which are principally concerned with public safety and the safety of work-people with the financial inducements of insurers and with codes of good practice developed by the national standards institutions, national fire protection associations and in many instances by individual trade and industry associations. In many countries, the national fire protection associations are continuously surveying the fire scene and acting as watchdogs on behalf of the public at large. Thus, trends in fire hazards come under the surveillance both of governments and fire protection associations so that corrective action can be taken as soon as possible.

National governments should, therefore, encourage the setting up of fire protection organizations whose function it will be to develop fire safety standards in equipment and codes of good practice for buildings, processes and installations. Encouragement should be given to conferences and the establishment of committees through which manufacturers, building developers and designers of buildings and equipment can learn of the fire safety features which they should be incorporating into their designs of buildings and products and users can learn of the fire safety standards which they should be adopting in their premises.

Fires are caused almost entirely by people, either through their actions which may be accidental or deliberate and malicious or through their failure to take appropriate precautions such as, for example, the regular inspection, maintenance and repair of defective equipment. The prevention of fire, therefore, depends almost entirely on people. If people have an understanding of the nature and behaviour of fire, they will be in a better position to recognise fire hazards and to take preventive measures. National governments should, therefore, give encouragement to schools and colleges to integrate the teaching of fire loss prevention into their curricula. Children at all ages,

university students, engineers, designers, architects and management should all receive some instruction in fire and its control.

Insurers' Role

Fire may be the quickest way of bringing a business to a halt. Not only will the whole process of manufacture and production be interrupted, but the buildings and plant will be in ruins. Before they can be replaced and production restored, much work in clearing up the site will be necessary. It will also be necessary to determine what has been lost and damaged. Even if only a small part of the plant has been involved in fire, staff from other work will need to be diverted to clear up the mess and to plan the rebuilding and restoration of production.

The successful prevention of fire loss depends almost entirely on the management of the business. Fire creates total waste. Such waste would not be tolerated by efficient management if it resulted from inefficient operation. No management should, therefore, tolerate the creation of waste by fire. To control the loss through fire, the management must survey the total operation of the business to determine where the loss potential lies.

Insurers can do much to assist managements in setting up the necessary systems in addition to ensuring their maintenance and the maintenance of high standards of fire protection.

Insurance premiums must be related on the one hand to the fire hazard presented by the insured and, on the other hand, to the protection that the insured provides to control the hazard. Where there is a high degree of fire risk or where a fire will so disrupt the operation of the business that it may have to close down for a long period, the insurer should require an adequate level of protection

that will obviate this risk before he accepts the insurance. Since fire loss prevention is vital to the national economy of a developing country, the national government should give every support to insurers in demanding a high level of protection. It is also of importance to the national economy that insurance premiums should be pitched at an economic level and the insured should always be given as much encouragement financially to improve his own fire risk.

There are three principal areas of risk improvement on which insurers should concentrate

(a) Immediate and preferably automatic extinguishing of fires.

(b) The segregation of hazardous materials and processes and the fire resisting sub-division of the building to limit the potential loss.

(c) The supervision of the management of the business. For this purpose insurers should require that every business has a fire loss prevention plan which is supervised by regular inspections and reporting of defects.

To implement these roles in risk improvement and loss prevention, insurers need the services of qualified staff who are fully conversant with the nature and behaviour of fire and its control and with the nature of the businesses which are being insured. Individual insurers may find it an excessive burden each to supply and finance such staffs and, therefore, they may find it preferable to co-operate with each other in financing a central organization able to provide a variety of services.

The services which have to be provided are -

the inspection of the insured's premises and the drawing up of a

plan and a report with recommendations as to the fire precautions that should be taken and recommendations to the insurer on all matters affecting the risk and the insurance. This plan and report would constitute the contract between the insured and the insurers and there must naturally be an understanding that any alterations that are made by the insured are reported to the insurer who would then call for a further inspection and report on any changes necessary in the fire precautions. Periodical inspections should also be carried out to ensure that the precautions are being observed.

The preparation of standards and codes. The establishment of standards and codes of practice for the manufacture and installation of, on the one hand, equipment designed to control and extinguish fires, such as automatic sprinkler installations, automatic detection equipment and fixed and portable fire extinguishing apparatus, and on the other hand, installations, equipment and plant which may constitute a fire hazard, for example electrical installations, air conditioning services, fuel systems, oil burning equipment, and many others. Examples of standards and codes of practice which are in use in Western Europe and in the United States of America may serve as useful guides although they may need to be adapted to suit local conditions.

Additional services which insurers would need to provide are:-

investigating staff for the purposes of determining the cause of a loss and agreeing on the settlement with the claimant.

The investigation and research into all fire hazards and mehtods of protection and control and the preparation of guidance, educational material and publicity material based on the results so as to give the widest spread of knowledge to the community at large.

The study of the experience of fires so as to determine those aspects of fire which have the greatest effect in terms of direct loss and of consequential loss, so as to assist insurers in, on the one hand, the guidance they should be giving to the insured, and, on the other, the levels of premium and the extent of insurance cover which they should be establishing.

Insurers may wish to establish research laboratory facilities in order to establish the correct levels of protection and to determine the standards of construction or equipment which they are prepared to accept and approve. However, insurers should bear in mind that extensive laboratory facilities have been established in several European countries and in North America and it might only be necessary to provide staff to appraise the results of their work and to apply them on a national basis.

Salvage

Provision should be made by insurers for the mitigation of damage done during and after fire fighting. In some parts of the world, in the United Kingdom in particular, insurers have established salvage corps whose function it is to collaborate with the fire brigades in protecting the premises, in particular from the effects of water used in fire fighting. It is sometimes calculated that approaching 50% of the loss in a fire is due to the damage done by water. Insurers should, therefore, consider the training of men in salvage operations. They should also give encouragement to their insureds to provide training of salvage crews who are on the normal payroll of the insured.

Provision should also be made for the training of factory and office staff in the handling of first-aid fire extinguishing appliances as well as in salvage operations.

The Management Plan for Loss Prevention

Insurers should insist on supervision of loss prevention by the management of every business.

The first step insurers and management together should take in this plan is to identify the fire risks. This is best done by using a plan of the premises and identifying on that plan all the potential sources of ignition and the materials which will burn and the ways in which fire can spread.. On the plan there should also be some indication of the relative importance of the various areas and plant to the continuity of business operations, together with an indication of the susceptibility to damage of those areas and plant. By means of this plan, it should be possible to identify the relative loss potential of the various areas of the business which, in turn, will indicate where the greatest needs for protection lie.

For businesses which are not yet built, the same process of identifying the fire risks and loss potential areas should be carried out before the plans are finalised. In this way, it may be possible to plan the layout of the business to present the minimum loss potential from the outset and thus reduce the needs for protection.

The layout of the buildings will need to be studied to determine the ways in which fire can spread and the possible extent of the damage with a view to providing means of controlling spread by sub-division. The materials with which the building is constructed will need to be studied to determine whether they make a contribution to the spread of the fire and whether they provide the necessary level of fire resistance for sub-division purposes. The building services will also need to be studied to consider whether the standard of installation conforms with the best practice.

The fire risk presented by each item of plant and equipment must be considered. The risk may arise by virtue of the plant's potential

for initiating a fire or for its susceptibility to damage in a fire or by virtue of the fact that it is a key item in the maintenance of the business operation. Plant which is processing flammable liquids, gases or dusts presents much greater risks than much other plant.

Consideration will need to be given to the raw materials and the finished goods in respect of their ease of ignition and of the likelihood of them being damaged by fire, smoke and water. Attention should be given to the bulk storage in the open or in warehouses and to the storage and handling of materials in day to day use. Attention should also be given to the handling and the disposal of waste products.

Fires do not start only in manufacturing or storage areas. They may start in the offices or the canteens and kitchens. Fires starting in these places can be prevented from spreading to the manufacturing and storage areas by means of adequate fire separation.

Fires may also start in the open and spread to the buildings and can be prevented from spreading to the buildings by keeping an area around all buildings free from combustible materials such as storage of finished goods, cartons, stacking pallets and waste and of all combustible vegetation such as grass and scrub.

Fire Precautions

The fire risks which have been identified should then be evaluated in terms of the actual potential loss which may be suffered and the long term effects which this loss may have on the business. An attempt should be made to determine the time which may be required to restore full production following a fire. This will naturally depend on the time required to replace the materials or plant which have been destroyed. Therefore, it is advisable to keep a schedule of all materials and plant and their availability for delivery in the event of their loss.

It would be a very serious fire if the whole of the manufacturing capacity and all the storage was destroyed at once. This, of course, can be avoided by sub-dividing the manufacturing capacity by fire separating construction and by segregating the storage of raw materials and of finished products from each other and from the manufacturing plant. Sub-division of the storage will also ensure that in the event of fire, not all the storage is destroyed. In this way the continuity of the business can be maintained even though it be at a reduced level.

In many manufacturing operations, it is not feasible to sub-divide the manufacturing capacity so that there are two or three separate lines of production. Where the output depends on one line of production, then the whole factory is susceptible to shut down in the event of fire affecting any one part of that production line. To some extent, the disruption of business can be deferred yb means of having sufficient storage of finished products from which to supply customers. It is then in these circumstances that the schedule of delivery times for the materials and plant will be of importance in determining the time taken to get back into full production and supplying customers. These are factors which will govern the potential consequential loss from a fire.

The following are some of the factors which might cause delays in restoring full production -

specialised raw materials or specialised machines which may have to be made to special orders may well take many weeks or months in manufacture and if they need to be imported may take many weeks for delivery.

any form of complex operation which is dependent on extensive electrical, hydraulic or pneumatic controls may require many weeks of extensive skilled labour to rebuild.

plant or products which work to a high level of quality control may require long commissioning periods.

Where factors of this sort, which may cause long delays, exist special precautions will need to be taken to control the outbreak and the spread of fire.

It has already been seen that one of the principal means of controlling the extent of fire loss is to limit the amount of material which may be exposed to any one fire. This is achieved by sub-division with the use of fire resisting separating walls and floors. A measure of control can also be achieved within compartments by maintaining safe distances between stacks of materials and plant so that in the event of an outbreak of fire, fire extinguishing equipment can be brought to bear so that the fire is confined to the smallest practicable area.

An important element in the prevention of outbreaks of fire and in their control is the training of the workpeople. As has been said earlier in this paper, it is people who cause fires and it is, therefore, people who can be instrumental in preventing and controlling them. By training all workpeople in the operations which they perform, most fire hazards can be avoided. This applies particularly to workpeople engaged in operations involving hazardous materials, but it also applies to the everyday operation of plant and equipment and to the day to day behaviour of everybody employed in the business.

Fire Extinguishment

In the last resort, when a fire breaks out there must be the means of controlling and extinguishing it. Water is vital for this and storage must be provided on each plant for fire fighting purposes only. Portable fire extinguishers and hosereels need to be provided for the use of the workpeople, who must naturally be trained in the operation of this equipment. In the first p rt of this paper, the possibility of each business providing its own fire brigade has been discussed. In a small business, it may be possible for all the workpeople to be adequately taained to tackle the majority of fires which may break out. In a larger business, it is probably necessary to have

a small number of men who may be employed on normal company's business but who have been specially trained. However, in due course fire will occur which will get out of hand and will need the attention of skilled fire fighting crews equipped with major fire fighting apparatus. Only a very large business could afford to maintain and to have trained such crews. Therefore, consideration should be given to collaboration with other businesses to provide a central communal fire fighting force which would need to be available throughout the 24 hours of the day, every day of the year.

It is quite possible that an automatic sprinkler system which provides protection for 24 hours of the day throughout the year may be more economical than either a communal fire brigade or a brigade for each business. The automatic sprinkler system automatically detects the fire, delivers water to the seat of the fire and sounds an alarm. The experience gained throughout the world with automatic sprinkler systems is that some 95% of fires are controlled and extinguished with insignificant losses and a very high percentage of these fires are extinguished with the operation of one sprinkler head only.

Water is the most effective extinguishing agent for the general protection of the premises, but there are certain fire risks such as live electrical equipment and flammable liquids where the use of water may be dangerous. Other extinguishing agents have to be used. The equipment has, therefore, to be chosen with care and suited to the specific risks to be found on the premises.

Provision also has to be made for the detection of the fire and for the sounding of the alarm. Automatic detection systems are the best, since they eliminate the human factor. Even where an automatic sprinkler system is installed, it may be desirable to have an automatic detection system as well. Whichever system is in use, however, it is important that an alarm is sounded at a continuously manned station, such as the telephone switchboard, so that action can

be taken at once to investigate the circumstances and to set in motion the appropriate extinguishing action..

Security

Throughout the world, security has become a vital part of all business management. The integrity of a business depends on the prevention of unauthorised persons entering the premises. Planned, deliberate sabotage is difficult to combat, but there are many measures which can be taken which will make incendiarism and sabotage difficult. Points which need attention are inadequate or damaged fences, broken windows, inadequate security locks on windows and doors, and the clearing away of all combustible waste and rubbish, so that it is inaccessible to the incendiarist. Outside storage is, of course, particularly vulnerable and special care has to be taken. The stacking of packing materials, storage pallets and combustible waste adjacent to the outside of a building provides a very good starting point for a fire which may spread to the building itself. This should on no account be allowed.

Fire Protection Manual

Having designed the buildings, selected the plant and planned the layout of a plant and storage to minimise the fire risk, the management will need to produce a manual setting out the ways in which the business will be run in order to ensure the minimum loss from fire.

The first part of the manual will comprise a report which will be based on the survey and the plan of the business referred to earlier in which the fire risks of the various operations will have been identified and evaluated in terms of their importance to the maintenace of the business operation. The report will also indicate the ways in which the risk has been minimised and the protection in terms of subdivision and the provision of extinguishing equipment. This report will give managements at all levels of the business a understanding of

the risk with which they are confronted and it will explain the reasons for the protection provided.

The second part of the manual will set out the operating procedures for the maintenance of the standard of fire protection which has been established and for the action to be taken by workstaff in the avoidance of fire risks and on the action to take in the event of fire. Job specifications and operating instructions should indicate the fire hazards and the ways of avoiding them and they should indicate the action which should be taken in the event of a mishap. The job specification should cover every level of management and all workpeople throughout the business, including the cleaners. They will include responsibility for inspections, repairs and maintanance. Special instructions will be needed for plant engineers and maintenance staff, for those people responsible for building services, and for those involved in the collection, removal and disposal of all waste.

A third part of the manual should be devoted to the training of the staff and workpeople. Provision has to be made for the training of new staff and for the training of all staff at periodic intervals and, in particular, where operations are in any way altered.

The fourth part of the manual will comprise check lists which will set out the routine inspection and checking procedures to ensure that the standards of fire protection, once established, are maintained on a permanent basis. Special staff should be allocated to the duty of inspection and servicing fire protection equipment and for the inspection and checking of all fire precautions laid down in the manual. The check lists should be sub-divided into those items which need to be checked at the beginning and end of every working day and periodically as part of the regular fire protection audit. The check lists will be devised from the fire protection plan and from the operating procedures which have been set out in parts 1 and 2 of the manual.

Here, then, is a loss prevention system on which the safety from fire of all premises will depend. I strongly urge you to ensure that every business adopts it.