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Concepts of Fire Prevention Technology and their Evaluation from the Point of View of the Industrial Insurer

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As an introduction to my subject, I should like to familiarise you with a few data showing the course of fire and explosion losses in Germany. According to the figures collected by the Association of Property Insurers (VdS), the amounts of the annual losses in Industrial Fire Insurance rose from approx. DM 2,000 million in 1980 to approx. DM 4,400 million in 1991. These figures are evidence in particular of the trend towards major losses, i.e. claims of DM 1 million and more per event. Whereas in 1980 approx. 280 events resulted in losses totalling approx. DM 1,260 million, there were as many as 346 major fires in 1991, which shook the Fire Insurance industry to the tune of DM 3,200 million. These statistics do not include those fire losses which are covered by Motor Own Damage, Marine, Aviation, Erection All Risks and Builder's Risk Insurance or by Machinery Breakdown and Electronic Equipment Insurance. These data likewise do not take into account the actual amounts of the losses in the event of under-insurance or if a stop-loss was exceeded.

Let me give you an example:

About 3 years ago, as a result of welding work, the flue-gas purification unit in a refuse-incineration plant burnt down during the **construction phase.** This loss, amounting to approx. DM 30 to 40 million, is not therefore included in the statistics of the **fire insurers.** It is therefore likely that the assets actually destroyed by fire or explosion in the Federal Republic of Germany substantially exceed the amounts of the losses established by VdS. Exact figures are unfortunately not known, however.

This trend is not restricted to Germany alone, but is an international phenomenon. I would remind you, for example, of the explosions and fires in an ethylene oxide plant in Antwerp, the Piper Alpha drilling rig in the North Sea, and the polyethylene plant in Pasadena, USA, which resulted in property and loss of profits claims ranging from several hundred million dollars to more than $ 1,000 million.

Fire and/or explosion risks exist in companies of all kinds and sizes. Also from the point of view of environmental protection, these risks must be combated with appropriate fire prevention systems and equipment. In almost every case, property losses resulting from fires or explosions involve the emission of pollutants to a greater or lesser extent, with pollutants entering the soil, water and air. The duration and extent of the fire are decisive for the environmental impact in this respect. Every time an incipient fire is extinguished, and every time a full-scale conflagration is contained, this therefore means automatically that the harm done to the environment will be limited. This leads us to the formula:

Fire Prevention = Environmental Protection.

Environmental protection, environmental compatibility, and environmental friendliness are buzzwords today, and we find them used to an increasing extent in product advertising - indeed, advertisers could hardly manage without them, and, what is more, they are effective with the consumer. A company's image, and thus its success, are dependent on this possibility of linking its production processes and products with environmentally relevant themes, which explains the importance of quality assurance. Here, too, a company's fire prevention efforts offer PR support which should not be underestimated.

Fires and explosions do not always need to result in the total loss of a production and storage complex. When damage is done to bottleneck machinery and equipment, to supplies which are difficult to obtain, or to means of production that can only be repaired in the long term and on which a substantial part of the production - or indeed the entire output - depends, this can reduce a company's earnings power considerably; in some cases, an incident of this kind can force the owner to call in the receivers. This leads us to another important formula:

Fire Prevention = Securing Earnings Power.

Property protection, environmental protection and the need to secure earnings power mean that we must analyse and evaluate risks conceptually and holistically, and then, on the basis of our conclusions, develop protective measures in the context of the managerial approach to the question of tackling risks.

It is our experience that the average policy holder is often convinced that insurance protection alone is sufficient. Physical and organisational security and safety measures are only complied with when it is necessary to meet conditions imposed by the authorities. Protective measures above and beyond that are seldom adopted, and then only if the corresponding investments are economically worthwhile because they lead to a premium discount.

Safety conditions imposed by the authorities are, however, concerned primarily with the **protection of life and limb, neighbourhood security, and warding off dangers threatening the public interest.** In a democratic, constitutional state, the implementation of **fire-prevention measures to preserve material assets and to avoid losses of profits because of business interruptions** is not a matter for the legislative or executive powers.

This is where the insurer comes in, as the partner of industry: higher premiums alone are no solution if we are to bring the rising losses under control. Rather, industry and the insurers need to cooperate even more closely and intensively than before in the field of loss prevention. A partnership is the obvious move, simply because the specialist knowledge of industrial enterprises complements the varied, global experience of the insurer. This safety concept, including all the technical details, must be coordinated at the very earliest stage of planning a new building, after a detailed risk analysis with all concerned, such as the owner, the architect, the safety officer, the authorities and the insurer. Only in this way is it possible to achieve inexpensive protection against fires and explosions.

The classic fire prevention concept for an industrial risk consists of the following components:

o Structural fire prevention

  This is determined by the **inflammability and fire propagation properties** of the building materials. The range extends from building materials of normal inflammability to those which are hardly inflammable or completely non-combustible .

  In addition, the fire-resistance properties of the building components are of considerable importance, because they describe the possibility of repairing a building after a fire or the likelihood that it will collapse after being subjected to fire for a defined time. The fire resistance of building components ranges from 0 to 30, 90 and even 180 minutes.

o Structural and physical subdivision of a risk by means of:

- spacing
- complex dividing walls
- fire walls
- fire-resistant walls

o Fire detection and alarm

- manual fire alarm systems
- automatic fire alarm systems
- monitoring by a security service

o Fitting out with manually operated extinguishing equipment

o Provision of water for fire fighting

o Fires fought by

- public fire brigade
- works fire brigade
- automatic fire-extinguishing equipment
- smoke and heat venting facilities

o Explosion prevention measures

o Lightning protection

o Organisational security measures

o Protection against arson

The nature and number of the fire prevention components necessary are determined, inter alia, by a company's size and location (area covered with buildings, number and size of buildings), the concentration of assets, the nature and size of the fire load, the ignitability and fire-propagation speed of the raw materials, semi-finished and finished products, the toxicity and corrosiveness of the combustion gases formed in the event of a fire, the sensitivity of the production facilities and products to water, smoke and heat, the risk of explosion resulting from dust/air or gas/air mixtures, the production processes (pressures, temperatures, sources of ignition), and the risk of spontaneous ignition of the products.

Let me give you a few broad examples to illustrate this point:

Irrespective of the factors of influence just mentioned, some basic equipment is needed <u>in every case</u>. This consists in general of:

- fire extinguishers
- means of calling the public fire brigade, e.g. telephone
- provision of water for fire fighting by means of a network of hydrants on the road in front of the works premises
- fire walls between production facilities and storage areas.

The question of whether an automatic fire alarm system contributes to an increase in safety needs to be studied in more detail. The decisive factor in reaching a decision is the time between the automatic sounding of the alarm and the beginning of fire fighting. If the public fire brigade, for example, takes 30 minutes or more to reach the location of the fire, or if the premises are not guarded, an investment in automatic fire alarm systems is a waste of money. In this case, it would make more sense to discuss whether an automatic extinguishing system would not be more effective - where the level of the fire load, the concentration of assets, the business interruption and other major operational factors are considerable.

On the other hand, it certainly makes sense to install an automatic fire alarm system if it can be guaranteed that fire fighting by a professional public brigade or a works fire brigade will begin without delay, or if the plant works round the clock. Installing sprinkler equipment is a *conditio sine qua non* - even when there is a qualitatively and quantitatively well equipped professional works fire brigade available - whenever it is a question of protecting large-area and/or multi-storey production facilities and warehouses with a high fire load where there is no subdivision by fire walls or high-rack stores.

Insurers favour automatic fire prevention technology, and in some cases offer not inconsiderable discounts on fire insurance premiums. Automatic fire prevention technology has grown progressively in importance as the increasing automation of production processes and intra-plant logistics have meant that there are fewer and fewer people working in a plant who might discover and be able to fight an incipient fire.

Stationary fire-extinguishing equipment that is triggered automatically is generally divided into two groups, viz.

- **total-flooding fire extinguishing equipment**, e.g. sprinkler equipment that protects entire building complexes and their contents against fire, **covering entire areas and rooms**, irrespective of the place of origin of the fire, and

- **local-application fire extinguishing equipment**, e.g. using CO_2 as the extinguishing agent. This equipment is used **in individual locations** to protect operating facilities exposed to a fire hazard. Classic example: paint-spraying rigs.

Among local-application facilities, sprinkler systems have been most widely used throughout the world for the last 100 years or so, because of water's almost universal extinguishing capacity. The great advantage over automatic extinguishing systems using other extinguishing agents, such as CO_2, foam or powder, consists in the fact that the extinguishing nozzles react selectively to heat and only take effect at the place where the fire actually begins.

Sprinkler systems are the *ultima ratio* when it comes to avoiding major fires if the following conditions apply, since they involve technical and tactical problems for a fire brigade in action:

- high fire loads
- rapid fire propagation speed
- considerable generation of smoke
- extra-large sections of fire, ranging from several thousand to tens of thousands of square metres
- multi-storey buildings
- extensive underground storeys and facilities.

Sprinkler systems can therefore be used in almost all branches of industry, from car manufacturing, wood and plastic-processing plants, the textile and paper industry, the electrical and electronics industry, heavy engineering, and the food industry, including flour mills.

Sprinkler systems protect cable cellars and ducts in power plant areas, extensive stores and automatically operated high-rack stores. They are used to protect human beings and tangible assets in underground car parks, theatres, meeting places, department stores, hotels and office blocks and on passenger ships and car ferries. They can be used in underground railways and in railways that frequently have to pass through lengthy sections of tunnel.

Local application has the advantage that it can take effect automatically at the source of the fire or explosion, so that it constitutes a necessary complement to the overall safety concept. In many cases, local application is the only intelligent solution from the point of view of fire prevention technology: e.g. when total-flooding systems, such as sprinkler systems, would tackle the actual source of the fire too late or would be unable to fight it at all, e.g. in encapsulated machinery and operating facilities. In cases like this, by the way, the fire brigade is also faced with a difficult situation as far as its extinguishing tactics are concerned.

The use of local-application systems is also particularly appropriate when a company wishes subsequently to improve fire prevention standards in an existing plant. In many cases, cost factors rule out the possibility of subdividing the building with fire walls, i.e. by means of extensive structural measures, and by installing total-flooding systems. Furthermore, complex subsequent alteration and installation measures of this kind disturb the entire production operation over a lengthy period of time, which in turn involves increased costs. In this case, it is no doubt the better solution to fit local-application systems to operating facilities that are essential to production and are exposed to particular hazards.

As with total-flooding systems, all extinguishing agents can also be used in local-application fire fighting systems, such as water, foam, CO_2, powder, halons and, in certain cases, steam. The choice of extinguishing agent depends on the fire behaviour and the nature of the object to be protected and its sensitivity to the extinguishing agent. (Halon, the extinguishing agent used to an increasing extent, particularly in the EDP sector, in the past 15 years, has lost its importance for reasons of environmental protection, and is only mentioned for the sake of completeness.)

The following examples of applications illustrate the wide range of uses of automatically triggered local-application fire extinguishing systems.

- filter plants
- film-shrinking plants
- air compressors
- cleansing baths
- barrel-heating plants
- barrel-cleaning plants
- EDP machinery
- electronic and electrical switching equipment
- process control engineering equipment
- painting equipment
- quenching oil baths
- drying facilities
- filling racks for combustible liquids and gases
- electrical discharge machinery
- test chambers for electromagnetic compatibility
- shaft bearings between turbines and generators
- stirring systems
- tank farms
- oil hydraulics systems
- rolling mills
- rotogravure machines
- tenter driers (textile industry)
- pumps for combustible liquids
- plastic-coating plants
- oil transformers
- dry ends of paper machines
- thermo-oil plants
- fibre-depositing equipment (textile industry)
- refuse-compaction containers
- continuous tinning plants

- o baking conveyors in the food industry
- o cooking equipment in restaurants and large-scale catering establishments

To these examples we can add explosion-suppression equipment to protect facilities where explosive dust/air mixtures arise in the course of operations, e.g. in powder-coating plants, spray-drying towers, pneumatic dust-conveyor plants, and the like. Safety valves and pressure-relief equipment are other major components in avoiding or minimising damage caused by explosions.

In open-air facilities, automatic extinguishing equipment is limited in its application, e.g. to protect oil transformers. Here, especially in the petrochemical industry, spray equipment that is triggered either automatically or via remote switching has become the standard means of protection against thermal radiation.

Such systems are fitted to dephlegmators and distillation towers, since their height, which can reach 80 m (260 ft) and more, and the risk of explosion posed by mobile equipment, such as monitors, mean that they cannot be protected ideally by the fire brigade. In addition, tanks containing combustible liquids or pressurised or liquid gases are protected against thermal radiation by spray equipment.

The use of spray equipment of this kind is not just restricted to industrial applications. In the Old Town of Montreal, the façades of the historic buildings are equipped with this kind of equipment in order to prevent a flash-over from one building to those opposite.

In connection with automation and process control in production plants and building engineering (electrical equipment, air conditioning and ventilation equipment, heating equipment, lifts, conveyors and so on) and the need to monitor them from central control rooms, growing importance is being attached to automatic fire alarm technology, in addition to the automatic fire extinguishing equipment.

Apart from detecting and reporting fires at an early stage, automatic fire alarm systems can be linked to a building's technical equipment, so that it can, for example, automatically close fire-proof doors, switch off air conditioning and ventilation equipment, prevent smoke from spreading, switch off production and transport facilities, etc.

However, it only makes sense to monitor a hazard by using automatic fire alarms if it can be ensured that people will react quickly in order to fight the fire.

Technological progress and social changes affect the insurer directly as new risks and hazards arise. One of these risks is deliberate arson, a phenomenon that can be observed in the industrialised nations throughout the world. The fire insurers in Germany estimate that some 40 - 50 % of the total amounts of losses are due to deliberate arson. The arsonists have a variety of motives.

Apart from insurance fraud, the main motives include political blackmail and extortion by organised crime, sabotage, vandalism, psychological problems, drug and alcohol addiction, and burglary - a large number of cases of arson can be linked to break-ins. This means that we can certainly think of some organisational and technical protective measures, even if they will not be effective against all culprits, such as those committing insurance fraud, e.g.:

- controlled access for members of staff, outside firms, suppliers, etc., by having watchmen constantly monitoring gates and entrances

- surrounding the premises with a safety fence

- putting toughened glass or bars on windows facing directly on to the road, in order to make it difficult for burglars to enter

- surveying and monitoring buildings with burglar alarm systems, with the alarm transmitted to a permanently manned location

- securing doors and gates with safety locks

- providing sufficient lighting and illumination for the premises

- guarding the site with a security service and guard dog, and/or television monitoring system.

All fire prevention systems and measures, such as structural fire prevention, fire alarm systems, extinguishing systems, works fire brigades, etc., are reactive, i.e. they do not prevent a fire, but merely limit its scope.

An essential component of a safety concept - and this refers not only to avoiding and reducing damage from fires and explosions - therefore consists in the security organisation and in repairing and maintaining production facilities, stores, buildings and safety engineering equipment.

Research into the causes has shown that approx. 70 - 80 % of all incidents and loss events are not due to technical defects, but ultimately to human error. The constant changes in the legal, technical, social and competitive environment lead to growing imponderabilities for a company. New risks therefore require new management concepts. Safety can thus no longer be a task merely for individual specialists, because safety problems are often of strategic importance. Safety is therefore a management task.

A major contribution can be made to this by deciding on the fundamental and systematic organisation of the right conduct and rapid reaction in raising the alarm, warding off the danger and fighting fires in the context of safety management. Experience has shown that simply issuing instructions for the staff is not sufficient. At the time a loss event occurs, a brief summary of the necessary activities must be available in writing in order to ensure that everyone reacts to the situation in an appropriate and orderly way.

Components of an effective fire prevention organisation in the context of safety management are:

- o Appointing a fire prevention officer, who should report directly to the company management and should possess the necessary competences.

- o Fire instructions informing the staff how to behave in the event of fire.

- o Plans for raising the alarm and warding off risks, in which organisational and technical competences to prevent or limit the effects of a fire are laid down, and which establish the procedure for raising the alarm.

- o Fire brigade plan listing all the relevant objects, the use of the buildings, technical fire prevention equipment, fire fighting and escape routes, the provision of water for fire fighting, special hazards, etc.

It is only the meaningful interaction between man and safety engineering that offers any guarantee of keeping the damage within limits by means of a synergy effect.

Throughout the world, there has been an increase in activities for the protection of the environment, and these are exerting a growing influence on existing philosophies concerning fire prevention concepts and fire prevention techniques. The discussion began after the Seveso incident, which was admittedly not caused by a fire, with the familiar dioxin problems. The "new way of thinking" in fire prevention then finally began in the early 80s, after the skyscraper fire in Bighampton/ New York, which made people throughout the world sit up and take notice. The fire affected transformers operated with polychlorinated biphenyls (PCB) as the liquid dielectrics and coolant. In the course of the fire, the PCB decomposed into the highly toxic products dibenzofuranes and dibenzodioxins, which were deposited throughout the building by the air conditioning system, together with the fumes. The building had to be closed down and sealed up.

As a result of this and other fires, the manufacture of PCBs was abandoned, at least in Germany, and they were no longer used in new transformers, capacitors, etc. Electrical operating facilities filled with PCB have had to be disposed of since then.

Because of its low combustibility, PCB was recommended by fire prevention specialists for decades for use in transformers, hydraulics and thermal oil equipment. Substitute substances had to be developed, or alternatively fire prevention had to be ensured by means of automatic extinguishing and alarm systems.

Another key word: asbestos. In the past decades, statically important steel constructions have been protected against the effects of fire by means of an asbestos cement cladding. Today, because of the asbestos hazard, millions are having to be spent in some cases on reconstructing or tearing down the buildings affected.

A further incentive to rethink the subject of fire prevention was provided by the fire in the chemical and pesticide store at Sandoz in 1986. Fires in stores containing dangerous substances constitute a particular environmental risk to the ground water and soil, and also to the air. The Sandoz case, together with other spectacular warehouse fires, forced industry, the authorities and insurers to produce specific guidelines, also on an international level, for fire prevention in stores containing dangerous substances.

Another example is that of chlorinated hydrocarbons, which are used for cleaning purposes, for example. These materials, which may not be problematic from the point of view of fire prevention, nevertheless constitute a danger to the environment and human beings, and so substitutes are being used today, some of them on an aqueous basis, which is an advantage from the point of view of fire prevention, but some of them - and this is the case to a growing extent - based on inflammable solvents and detergents, such as benzines. This means that the fire and explosion hazards in the risks concerned are rising again (e.g. cleansing and degreasing baths in the metal and electrical industries).

In the last few years, the non-combustible propellants, fluorinated hydrocarbons, have been replaced to a growing extent throughout the world by a propellant mixture of butane and propane. Here too, experts are concerned that the risk of fire and accident will increase, both in firms filling spray cans, and in warehouses and when the spray cans are being used by the consumer.

In conventional power plants, the installation of flue-gas purification equipment has led to considerable changes in the risks for the insurers. In order to provide corrosion protection, large amounts of plastic are used in this equipment, in the form of cladding, filter materials, containers and pipes, which constitute a considerable fire load. The compact and fine structure of these plants means that the fire brigade only has a limited chance of bringing a fire under control in the initial phase. This has been confirmed by a number of major fires in the last 4 - 5 years:

Four fires which took place during the construction phase or in the course of maintenance work, caused losses amounting to approx. DM 200 million.

However, it is not only in flue-gas purification equipment, but in all branches of industry that, as experience has shown, there are substantial fire hazards during the shell-construction and maintenance phases. It is in the nature of things that the potential hazard is increased by large quantities of combustible packaging material and components, temporary constructions and wood scaffolding, inadequate housekeeping, an increased use of outside and temporary staff who are not aware of the risks, the erection of light-weight structures made of wood (accommodation for building workers), an increased amount of welding and abrasive cutting work, a general hectic and disorganised atmosphere, the pressure of deadlines and other factors. Safety facilities, such as the water supply system for fire fighting, the provision of fire extinguishers and the like, are not installed parallel to the progress of the construction work. Safety regulations are not observed in this rough operating climate.

The insurer's fire prevention experts must therefore cooperate more intensively with the plant operator and the firms doing the work during the construction, maintenance and repair phases, in order to increase safety standards where fire and explosion hazards are concerned.

One factor that has a not inconsiderable influence on the protection concept of an industrial risk is the Probable Maximum Loss (PML) evaluation. Nowadays, simply implementing what has been learnt from claims experience is no longer sufficient when it comes to producing protection concepts and operating a safe plant. In the last few years, more and more importance has therefore been attached to using models for the quantitative assessment of the hazard potential and the possible extent of losses as a result of accidents, because changes and restructuring measures are taking place in industry at ever shorter intervals. In addition, because of the increasing environmental awareness and in order to ward off disasters, there is a growing need for quantitative estimates of accidents.

The following models are internationally recognised and in use:

- The TNT-equivalent model to estimate the consequences of explosions.

- Heat balance models to determine the effects of fires in enclosed spaces.

- Pollutant-propagation models in order to calculate the propagation of heavy and light gases in the atmosphere.

Summary:

Technological progress, social change, ecological considerations, growing concentrations of assets, mutual dependence and interaction are exerting an increased influence on the development of losses and thus on the importance of safety concepts for fire and explosion risks in industry.