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Fire protection in hotels

Detection, alarming, evacuation, extinguishing

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1. Introduction

Hotel fires represent a major risk to people's safety, the hotel property and business continuity. Statistics from the U.S. show that a structure fire is reported by one of twelve hotels or motels every year. Between 2006 and 2010 the fire departments responded to an estimated average of 3,700 structure fires per year at hotel and motel properties, causing annual average losses of 12 civilian deaths, 143 civilian injuries and $127 million in direct property damage[1].

It is the hotel owner's primary concern that guests enjoy their stay: but besides offering first-rate service, this also includes ensuring maximum safety. Fire incidents not only result in financial losses, they can also severely damage a hotel's reputation.

To guarantee adequate fire safety standards, national and regional directives have been established in the vast majority of countries. Personal safety is generally regulated by laws and official requirements, while the protection of material assets is mainly determined by the guidelines and directives drawn up by insurance companies.

Depending on the size, shape and furnishings of a hotel – as well as the national and regional directives of a country – different solutions are appropriate. Special attention should be given to critical areas where many people are present and areas with significant deceptive phenomena, heat sources and large fire loads such as guest rooms, kitchens, laundries, plant rooms, etc.

For maximum protection, a comprehensive fire safety system is needed to ensure personal safety and damage mitigation in case of fire. The cornerstone of such a system is a fire detection system that guarantees earliest and most reliable fire detection and activates the alarm devices and the relevant fire safety controls.

The goal is to protect people and property as effectively as possible and to minimize any operational interruptions and loss of customer base. Fire safety is therefore a long-term investment that must be carefully planned to ensure the continued success of the hotel.

1.1. Fire hazards in hotels

Hotels are more than simply utility buildings. Large hotel complexes with their heating and air conditioning systems, ancillary buildings, workshops, IT infrastructure and employee living quarters can, however, easily be compared to modern industrial facilities, as the surrounding infrastructure has many similarities.

The 'population' of a hotel cannot only be considered in terms of guests and employees, but must include people in conference rooms and function rooms, visitors and patrons of bars, discos and restaurants. The hotel management carries a very high responsibility for the safety of all.

The risk for human lives and property are high in hotel buildings, due to the heavy concentration of people and valuables, and to the often combustible interior furnishings and fittings. These risks, however, can be drastically reduced by taking appropriate fire protection measures.

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[1] NFPA, U.S. Hotel and Motels Structure Fires

1.1.1. Fire load

Fire risks are largely determined by the fire load of a room, an area, or a building. This term describes the latent energy which can be released by the combustion of materials in fixtures, fittings, furniture and furnishings during an outbreak of fire.

The typical fire load in hotels can be classified as 'low' to 'medium'. Due to their construction and decoration, older buildings usually have a larger fire load than newer ones.

It must also be considered that refurnishing (new carpets, curtains, bedding, etc. which differ in fabric composition from the old furnishings) can drastically alter the fire load in a hotel, as can temporary exhibitions, seminars and other functions.

If not already required by local codes and regulations, the chief engineer of the hotel or a similarly qualified person should be permanently on the look-out for changes in the fire load, and should initiate appropriate measures to reduce fire risks as much as possible.

1.1.2. Fire risks

Fire risks result basically from the probability of occurrence and the effect caused by fire. In hotels, fire dangers are found almost everywhere.

Risk = probability of occurrence x effect

The main causes of fire outbreaks in general areas are the following:

- Malfunctions in electrical equipment (e.g. electrical distribution systems, motors, transformers, ventilators, electrical heaters and lighting systems) leading to short circuits, overloads, discharges, etc.
- Maintenance work such as welding or soldering.
- Carelessness such as negligence in turning off electrical equipment, use of combustible materials and liquids (cleaning, painting, etc.), and smoking.
- Temporary decorations for festivities and functions.
- Spontaneous combustion of cleaning rags, cotton waste, etc.
- Arson and sabotage acts also remain a very serious fire risk.

The main causes of fire outbreaks in guest rooms are the following:

- Smoking, especially in bed and under the influence of alcohol and/or drugs.
- Use of faulty electrical equipment, such as electric blankets, kettles, cookers, irons, razors, heaters, hair driers and radios, which are possibly not suited to the hotel`s outlets and voltage.
- Carelessness with electrical equipment, especially negligence in turning off equipment at night or when leaving the room.

1.1.3. Potential danger to human life

Over and above any codes and regulations, it is the moral responsibility of the hotel management to protect guests and staff from fire hazards. The reputation of a hotel is directly related to successful fire prevention. Even one incidence of fire where the prevention measures prove insufficient can damage a hotel's otherwise good reputation, which is then extremely difficult to re-establish.

People staying at a hotel as guests are usually not familiar with the hotel layout, the location of fire exits, fire escapes or even the alarm signals. Hotel guests also vary greatly in physical condition, age and mental awareness. One can assume that guests are asleep most of the time they spend in a hotel. It is a safe assumption that the printed warning notices (customarily provided in guest rooms) are not being read. Each of these factors can be dramatically intensified during the stress situation created by an emergency event such as a fire alarm or hotel evacuation.

1.2. Fire protection in hotels

The goals of fire protection are to efficiently protect people, assets and the environment from the dangers and effects of fire, and to minimize material damages, operational interruptions and the consequent loss of business.

Personal safety is generally regulated by national and regional regulations, while the protection of material assets is mainly determined by the guidelines and directives issued by insurance companies. Many hotel associations and other interest groups have also developed their own guidelines on fire safety for hotels. These generally give advice to owners, managers and staff on good fire safety management and actions to be taken in the event of a fire.

Effective fire protection is based on the coordination of the appropriate structural, technical and organizational fire protection measures.

1.2.1. Fire protection objectives

The primary goal of fire protection is to avoid personal injury and material damage. In a hotel, the safety of guests and personnel is of paramount importance. All persons working and staying in the hotel are reliant on the security of the hotel – this is especially true for fire protection.

If a damaging fire can no longer be prevented, the effects of the fire must be limited as efficiently as possible.

Typical protection objectives are:

- Personal injury must be prevented.
- Asset damage must be kept to an absolute minimum.
- Environmental damage due to extinguishing water must be avoided.

1.2.2. Fire protection concept

A fire protection concept is the result of a methodical approach; making use of an array of measures to minimize the fire risk and achieve the specified protection objectives.

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The fire protection concept describes all protection measures which help:

- Reduce the risk of fire breaking out.
- Prevent the spread of flames and smoke.
- Ensure that all occupants are evacuated safely.
- Enable the emergency services to take action.

1.2.3. Fire protection measures

Fire protection measures can be divided into passive measures and active measures.

Generally speaking, passive (structural) measures define a building's resistance and endurance after a fire has developed, while active measures are aimed at preventing the outbreak and spread of fire and smoke.

1.2.3.1. Passive measures

Although passive protection measures are not the subject of this document, they are extremely important. The majority of passive protection measures are related to the building structure, construction methods, and materials used to make a building as fire resistant as local circumstances demand.

The main elements of passive (structural) fire protection measures include:

- Fire compartmentalization of a building.
- Use of materials to prevent building collapse.
- Fire-resistant construction elements to limit spread.
- Provision of fire-resistant escape routes/exits/staircases/elevators.
- Selection of materials to reduce fire load.
- Selection of materials to prevent toxic vapors.

For buildings under construction, most of these measures are defined by national or local codes, especially for metropolitan and high-rise type hotels with complex escape routes. However, one must bear in mind that in the case of many older buildings, it is extremely difficult to improve effective passive protection, without first undertaking drastic reconstruction. Many of these existing hotels are built largely of wood, the interior decoration including heavy carpeting and furnishings, often enhanced by wood paneling, wall hangings and paintings etc. As a result, these buildings have a high fire load.

1.2.3.2. Active measures

Having included passive protection methods in a building's construction does not mean that the active measures can be neglected, reduced, or omitted. Active protection can be divided into organizational, detection and alerting, evacuation and firefighting measures:

Organizational measures   The advantage of many hotels is that they are able to summon professional help relatively quickly in emergency situations. Despite this fact, all hotels should aim at achieving a high level of competence in dealing with emergencies and in recognizing potential sources of danger, independent of outside assistance. Organizational measures include:

- Staff training (prevention and intervention).
- Provision of alarm and emergency plans.
- Periodic maintenance and checking of fire-fighting equipment.

- Keeping escape routes accessible and unobstructed.
- Use of fire resistant decorations, furniture and furnishings.

Detection measures

The main tasks of an automated fire protection system are to detect (an incipient stage) fire, sound an acoustic alarm, notify the fire service and activate the pre-programmed control functions. Such a system consists of a control unit with peripheral input devices (such as manual call points and automatic fire detectors), output devices (such as sounders and beacons) and output contacts to control other systems (such as smoke control systems, HVAC systems, elevators, automated extinguishing systems, etc.).

To minimize the danger to life and the damage to property, it is important to detect a fire as early as possible. Optimal product selection combined with the appropriate knowledge make it possible to design a fire detection system capable of detecting a fire extremely early and virtually eliminate any danger of false alarms.

Chapter 2 describes the measures needed to ensure that a fire is detected reliably and at the earliest possible stage.

Alarm and evacuation measures

When a fire breaks out prompt warning is essential and buildings must be evacuated within minutes to protect people's lives. Buildings with large numbers of occupants, such as hotels, therefore have special requirements with regard to alarming and evacuation.

The purpose of a (acoustic) fire alarm is to warn people of the potential hazard. In the case of a hotel three distinct target groups are addressed:

- Hotel guests for whom a hazardous situation has been detected.
- Hotel staff who should coordinate the evacuation.
- The people who should deal with the fire.

In a basic installation the fire detection system must activate the installed alarm devices and transmit the alarm signal to the fire department.

More sophisticated installations may include a dedicated voice alarm system, which can be instrumental in preventing panic by providing clear information about the danger and any required evacuation procedures through calm and concise announcements.

In addition to the type of alarm and evacuation system provided, evacuation plans, escape route identifications, emergency lighting systems and smoke venting systems are essential to ensure a fast and safe evacuation of all persons.

Each hotel must have a detailed evacuation plan with detailed procedures for the systematic, safe, and orderly evacuation of the building in case of fire or other emergencies. Fire drills should be carried out on a regular basis to ensure that all members of staff are familiar with all aspects of this plan.

If an evacuation of the building becomes necessary hotel guests, who will normally have little knowledge of the building, must be able to rely on the escape route identification notices to find their way out of the building.

To enable a safe evacuation, the emergency lighting must be turned on in all relevant areas.

Air handling systems remove smoke from a building allowing the escape routes to be kept clear of smoke which is essential to enable people to leave the hotel in a quick and safe manner.

Chapter 3 describes the measures needed to alert staff, hotel guests and the intervention forces, and how to ensure a fast and safe evacuation of the hotel.

Intervention measures   To limit the danger to human life and the extent of the damage, it is extremely important to start intervention and firefighting measures as soon as possible after the outbreak of fire. All firefighting equipment must always be kept in perfect working order: this is a prerequisite for any successful intervention.

Intervention measures activated by the fire control panel include:

- Automatic closing of fire doors etc.
- Activation of smoke handling systems.
- Automatic alarm transmission to the fire department.

Important firefighting systems include:

- Portable fire extinguishing equipment.
- Hose reel equipment.
- Self-actuated sprinkler systems.
- Dedicated extinguishing systems for high-risk areas.

Chapter 4 describes the available firefighting equipment in more detail.

1.3.   Purpose of this document

This short introduction shows how complex the problems of fire protection in hotels are, especially if one considers the great variety of hotel buildings which exist. It becomes clear that each hotel has to be considered on an individual basis. As a result, the establishment of universal guidelines is quite complicated.

This document provides an overview of the most important topics in technical fire protection for hotel applications. These include:

- Fire detection (chapter 2).
- Alarming, smoke control and evacuation (chapter 3).
- Extinguishing (chapter 4).

Detailed information regarding the planning and execution of fire protection measures in critical rooms or areas is provided in associated documents.

2. Fire detection

The earlier a fire is detected, the more time there is for evacuation and firefighting, and the less damage can occur. Earliest possible detection is thus the key to minimizing damage and gaining precious intervention time.

2.1. Fire basics

To ensure reliable, early detection of fire, it is important to be familiar with the different fire phenomena, fire propagation and possible deceptive phenomena.

2.1.1. Fire phenomena

Fire phenomena are physical values that are subject to measurable change in the development of a fire (e.g. smoke, heat, radiation, gas).

Large volumes of volatile fire aerosols are produced with almost all hostile fires. Smoke has thus become the most important fire phenomenon for the early detection of fire.

Liquid fires directly develop flames which immediately create a temperature increase and heat radiation.

2.1.2. Fire propagation

The fire phenomena generated by fire propagate differently, depending on the room size and the room conditions such as a high air circulation. This must be taken into account when planning a fire detection system.
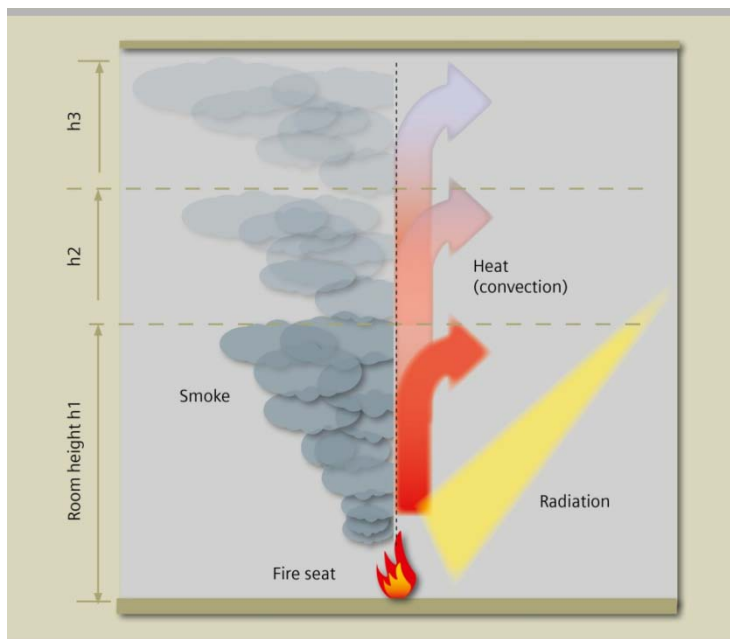
Figure 2.1.2-1 Propagation characteristics of fire phenomena

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In general, the higher the room, the greater the distance between the seat of fire and the fire detectors on the ceiling. This is why the intensity of the fire phenomenon to be detected (e.g. smoke density, temperature increase or radiation intensity) decreases with increasing ceiling height. It must be taken into consideration that with an increasing ceiling height (and consequent larger room volume) an incipient stage fire can become larger without necessarily increasing the danger of rapid fire propagation.

High air circulation, as is the case, for example, in computer rooms, significantly dilutes the concentration of smoke. This is why very sensitive smoke detection systems are often used for this type of application.

2.1.3. Deceptive phenomena

The fire detector has the task of detecting fire from fire aerosols, heat and radiation at an early stage and to trigger an alarm. Aerosols, heat and radiation, however, are also generated by production processes, by electrical equipment such as motors, or by environmental factors such as sunlight. If these deceptive phenomena are sufficiently intense and exist over a certain period of time, they may influence fire detectors enough to trigger an unwanted alarm.

State-of-the-art fire detectors are largely capable of distinguishing between deceptive phenomena and genuine fires. If, however, massive deceptive phenomena are to be expected, it is often needed to combine different fire detectors to provide a more suitable detection principle for the application.

2.2. Fire detection system

2.2.1. Tasks

The task of an automated fire detection system is to detect fire as early as possible, to sound the alarm and to activate the preprogrammed control functions.

State-of-the-art fire detection systems are capable of detecting fire very early and as a consequence minimizing any damage that may be caused. By optimal product selection and appropriate knowledge it is possible to build systems that virtually rule out unwanted alarms.

The principal requirement on a fire detection system is early and reliable alarming in the event of fire. As a consequence of this:

- All persons in the danger zone should be able to save themselves.
- Fire control systems can be activated to prevent the fire from spreading to more than one fire sector.
- Firefighting can be initiated as early as possible, so that damage to property and operational interruptions can be reduced to a minimum.

2.2.2. Elements
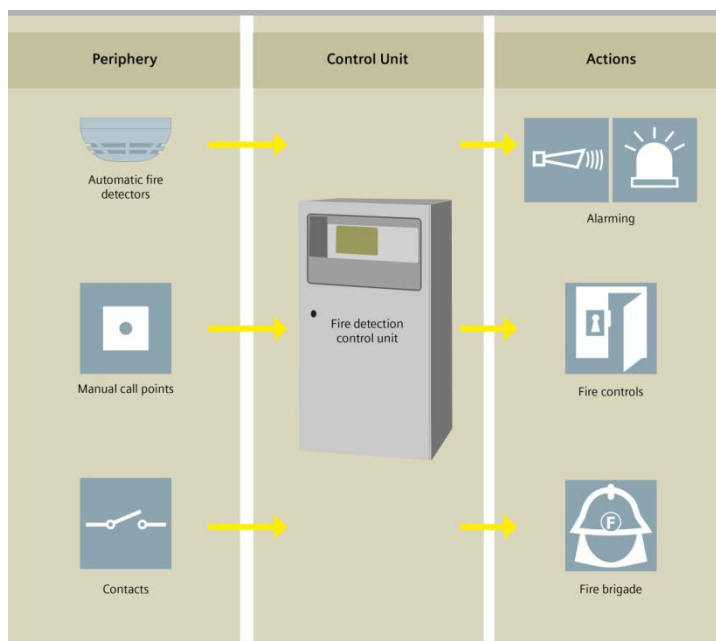
Figure 2.2.2-1 Setup of a fire detection system

Periphery

Fire-related information is collected from all parts of the building by the input periphery (automatic detectors, manual call points and input contacts) and transmitted to the control unit.

The intelligent, automatic fire detectors detect and analyze the different fire phenomena and automatically report the current hazard levels to the control unit. When selecting the correct fire detector for each location (together with its settings and placement), it is also crucial to consider the type of fire to be expected, the room height, ambient conditions such as air changes and possible deceptive phenomena.

Manual call points enable direct alarm activation by people who recognize an incipient stage fire or smoke in their vicinity.

Contacts (e.g. from the activation of a sprinkler extinguishing system) report a fire alarm indirectly.

Control unit

The system is monitored, controlled and operated by the fire detection control unit, which evaluates the hazard messages from the peripheral devices and activates audible alarm warnings and fire control installations.

Actions

The actions initiated by the control unit include alarming, activating the fire controls and alerting the fire brigade. Optical and acoustic alarm devices warn the people in the building. The activation of the preprogrammed fire controls causes fire doors to be closed, and smoke and heat extraction systems to be activated, in certain cases extinguishing systems may also be activated.

2.3.   Fire detection in hotels

A total surveillance concept is most applicable for fire detection systems in hotels, ensuring that the entire building is monitored. This includes not only all rooms, corridors, staircases and anterooms, but also all air conditioning and cable ducts, supply shafts, false ceilings, raised floors, and similar structures which permit smoke and fire to spread.

Most hotel fires are started by heat generated by overheating or malfunctions in electrical equipment, or electrical arcing. Another important category of ignition source is heat or open flames from candles, cigarettes, lighters, and matches. Hot embers or ashes, molten, hot material, and heat generated by friction are further fire sources.

Special attention should be given to critical areas where many people may be present, areas with numerous heat sources, large fire loads or significant deception phenomena.

Critical areas include the following:

- Guest rooms
- Kitchens
- Laundries
- Restaurants
- Stairways
- Parking garages
- Plant rooms

2.3.1. Guest rooms

Typically the greatest proportion of a hotel's floor area is occupied by the guest rooms themselves. These are also the least controllable areas since guests cannot be included in the organizational fire protection measures. The large variety of ignition sources, such as overheated electrical devices (fridge, TV) or careless handling of smoking products or candles put hotel guests in great danger, especially when fire starts during the night.

The fire detection system needs to warn people in the guest rooms before a dangerous situation has time to develop due to hazardous smoke. In addition, unnecessary alarming, triggered by steam or cigarette smoke, must be prevented. Depending on the room dimensions a smoke detector or a multi-sensor fire detector with the combination smoke/heat is recommended for monitoring guest rooms.

More detailed information regarding fire detection in guest rooms is given in the document "fire detection in guest rooms".

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2.3.2. Kitchens

Large cooking vessels, frying pans and especially deep fryers, present a very serious fire hazard in hotel kitchens. This is mainly due to the strong possibility of fire breaking out due to overheating as well as the local high fire load.

Multi-sensor fire detector with the combination smoke/heat and a sophisticated signal processing are recommended for monitoring these areas. Avoiding unwanted alarms due to the inevitable presence of deceptive phenomena, such as fumes or steam, requires in-depth knowledge and experience in positioning the detectors in such applications.

More detailed information regarding fire detection in kitchens is given in the document "fire detection in kitchens".

2.3.3. Laundries

These areas must be considered as relatively critical zones in a hotel. Firstly, they may have a very high fire load (e.g. amount of dirty linen) and secondly they provide a high risk due to the possibility of overheated electrical installations.

Due to the many deceptive phenomena in such an environment, like steam or dust, fire detectors are recommended which guarantee an early alarm in case of fire and at the same time offer a high robustness against deceptive phenomena.

More detailed information regarding fire detection in a laundries is given in the document "fire detection in laundries".

2.3.4. Restaurants

These areas must be considered as relatively critical zones in a hotel, due to the variety of ignition sources such as candles or cooking and frying at the table and the number of guests in the room.

Depending on the room dimensions and the expected deceptive phenomena smoke detectors or multi-sensor fire detectors with the combination smoke/heat are recommended for monitoring restaurant areas.

More detailed information regarding fire detection in restaurants is given in the document "fire detection in restaurants".

2.3.5. Stairways

Because elevators must not be used in case of fire, staircases play an important role as the primary escape routes in hotel buildings.

As a general rule, a single smoke detector should not monitor more than three floors on a staircase and one detector is required on the top floor ceiling. In addition a number of manual call points must be placed throughout the escape route.

More detailed information regarding fire detection in staircases is given in the document "fire detection in stairways".

2.3.6. Parking garages

A fire in an enclosed garage can very quickly create a dangerous situation for all people in that area. Due to the significant fire load of the parked cars, a fire which is not detected and suppressed early can develop into a fire that will be very difficult to extinguish and may threaten the stability of the building.

Deceptive phenomena such as exhaust emissions and the harsh environmental conditions not only affect early and reliable fire detection but also affect the service life of ordinary fire detectors. For this reason only fire detectors which respond appropriately to such deceptive phenomena and which were developed especially for harsh environments are installed in parking garages.

More detailed information regarding fire detection in parking garages is given in the document "fire detection in parking garages".

2.3.7. Plant rooms

Plant rooms, in which power supply, control systems, security systems and IT infrastructure are accommodated, are risk areas that need to be especially protected. This applies particularly to fire safety in these areas.

Aspirating smoke detection systems (ASD) are able to detect even the smallest aerosol concentrations. They can detect extremely low smoke concentrations which may be caused, for example, by a malfunction of an electrical or electronic component. It is possible to prevent fire developing simply by removing the power from the particular unit.

More detailed information regarding fire protection in plant rooms is given in the document "fire protection in plant rooms".

3. Alarming, smoke control and evacuation

3.1. Introduction

Once a fire has been detected by an automatic detector, by sprinkler flow monitoring, or by a person activating a manual call point, the fire detection system will generate the preprogrammed control and alarm signals.

A major factor that can affect the success of building evacuation is that many people do not take the sounding of fire alarm sufficiently seriously or do not understand the meaning of the acoustic signal. Such doubts lead to unnecessary delays in people's reaction to the warning and may mean the difference between life and death. The more clearly the information can be conveyed to the public, the better the situation will be understood and the more quickly the necessary actions will be taken.

A fast and efficient evacuation procedure is essential. This not only saves lives, but once the evacuation of the building has been completed, the fire services can concentrate on minimizing the damage to property.

3.2. Alarming

3.2.1. Objectives

The purpose of a fire alarm is to warn people about the presence of a fire within the premises. In a hotel context these people may be divided into 3 target groups:

- Hotel guests
- Members of staff
- The municipal fire service

For each of these target groups various technical solutions are available, which can alert the people concerned in the most appropriate and efficient manner.

3.2.2. Alerting members of staff

Alarms to the in-house staff are always generated without delay to allow the cause of the alarm to be investigated. Time is of the essence: investigation must begin immediately. It is still possible that the fire is small enough to be dealt with by local means. The aim is to prevent any unnecessary disruption to guests or normal business functions until absolutely necessary.

Without activating the main alarm, members of staff may be alerted in one (or more) of the following ways:

Pager   Alarm activation via an in-house pager system, causing the pagers carried by all members of staff to vibrate.

Mobile/Cell phone (SMS)   Transmission of a preprogrammed text message.

Local acoustic   Activation of buzzers or speakers in staff areas only: e.g. front desk, manager's office, engineer's office, laundry, kitchens, plant room, security control room.

Silent/coded alarm	Broadcasting of a "silent" alarm in the form of a coded message transmitted via the hotel PA system e.g. "Will Mr. Black please report to the manager's office."

3.2.3. Alerting hotel guests

Hotel guests can be warned of the impending danger in several ways depending on where the guests are currently located (bedrooms, restaurants, bars, discos, parking garages, etc.).

Acoustic alarms	Electronic sounders are regarded as the normal means of raising an alarm and are suitable for most hotel applications.
	The minimum sound pressure level regarded as being suitable to rouse a sleeping person is 75 dBA at the bed head. This will generally require an electronic sounder in the bedroom itself as there will be too great an attenuation of the sound level through the guest room door.
	In larger and noisier areas such as discos, parking garages or technical plant rooms more powerful horns or fire bells may be required.
Visual alarms	Strobes or rotating beacons may be regarded as supplementary alarms which enhance the effectiveness of sounders, with sounder beacons combining the advantages of both device types. Beacons are of particular importance for hearing-impaired persons or in noisy environments where people may be wearing ear protection.
	Where several beacons may be visible within a single area it is important that they are synchronized to avoid the risk for persons with photosensitive epilepsy to suffer a seizure.
Voice alarms	A voice alarm system consists of prerecorded voice messages (and acoustic signals) which can be activated manually or automatically, for example, by an alarm from the fire detection system. The preprogrammed evacuation process can then be initiated. Typically the system delivers an alarm signal (specified by local standards), followed by a stored voice message.
	Research has clearly shown that many people do not react quickly to a conventional acoustic fire alarm. The success of the voice alarm system relies on its ability to convince people of the seriousness of the event very quickly. For the majority of able-bodied hotel guests a successful self-rescue is then just a matter of course. Voice alarms are therefore becoming increasingly popular and can also incorporate a public address facility.
	An added advantage of a voice alarm signal over the normal acoustic sounder is that different messages may be conveyed to different areas within the premises. This flexibility can also be considerably improved by the live voice message feature, which gives a fire chief the ability to address people in specific areas of the building directly.
Alternative alarms	Vibration alarms for people with hearing difficulties
	Neither acoustic nor visual alarms may be sufficient to rouse a person from sleep if they are deaf or have severe hearing difficulties. In such cases the use of some form of vibrating device, may be employed. These however have inherent limitations: for example a pager can only alert a person if he is wearing it and for a vibrating pillow or mattress to be effective the person must be lying on the bed. This would suggest that there is no one solution to the problem of alerting a hearing impaired person and a combination of alternative solutions should be considered.

<u>Hospitality TV</u>

The television set in each guestroom can be utilized as an 'annunciator', as it can be switched on automatically via the hotel's hospitality TV-system. Emergency messages and evacuation instructions (and even prerecorded spoken messages) can be transmitted by state-of-the-art systems. In more basic systems the word FIRE can be displayed in a flashing format, possibly alternating with evacuation instructions or an escape route plan.

<u>Hotel telephone</u>

The in-house telephone system may also be used to inform guests about emergency situations (e.g. in a similar manner to the automatic wake-up call service). Each guest could also be called by the front desk and personally informed: a list could then be compiled of rooms that did not respond. Such a list would be useful for the fire brigade when checking the completeness of an evacuation.

3.2.4. Alerting the public fire department

The municipal fire department may be alerted in one of two ways:

- Automatically via the fire detection system by remote transmission.
- Manually from the hotel front desk or control room by telephone.

In certain regions the initial alarm may be transmitted to an Alarm Receiving Center (ARC) which, in turn, will notify the local fire department.

3.2.5. Alarm strategies

General alarms

A general alarm is a defined audible signal which is sounded throughout the building. The alarm is automatically activated by the fire detection system, or manually from the hotel front desk (or control room). In the majority of buildings this should trigger the immediate and total evacuation of the building.

Staged alarms

Staged alarms are based on systems capable of generating an 'alert signal' and a different 'evacuate signal'. Such systems may be applicable in large or complex buildings. Generally those people potentially most at risk are those closest to the point where the fire was detected or where the manual call point was activated. These people should leave the building immediately and therefore an 'evacuate signal' will be sounded in this area. In other areas of the building an 'alert signal' will be sounded, indicating that people in those areas will only have to leave the building if it becomes necessary, see phased evacuation.

As mentioned earlier, systems based on the interpretation of different acoustic signals may be useful for office buildings (or similar) where employees can be trained to recognize and understand the difference. In hotel environments, however, guests are unfamiliar with the system and are unable to interpret the alarm signals correctly and reliably. Only a voice alarm system (including live voice messaging) can be recommended for hotel applications.

3.2.6. Alarm Verification Concept AVC
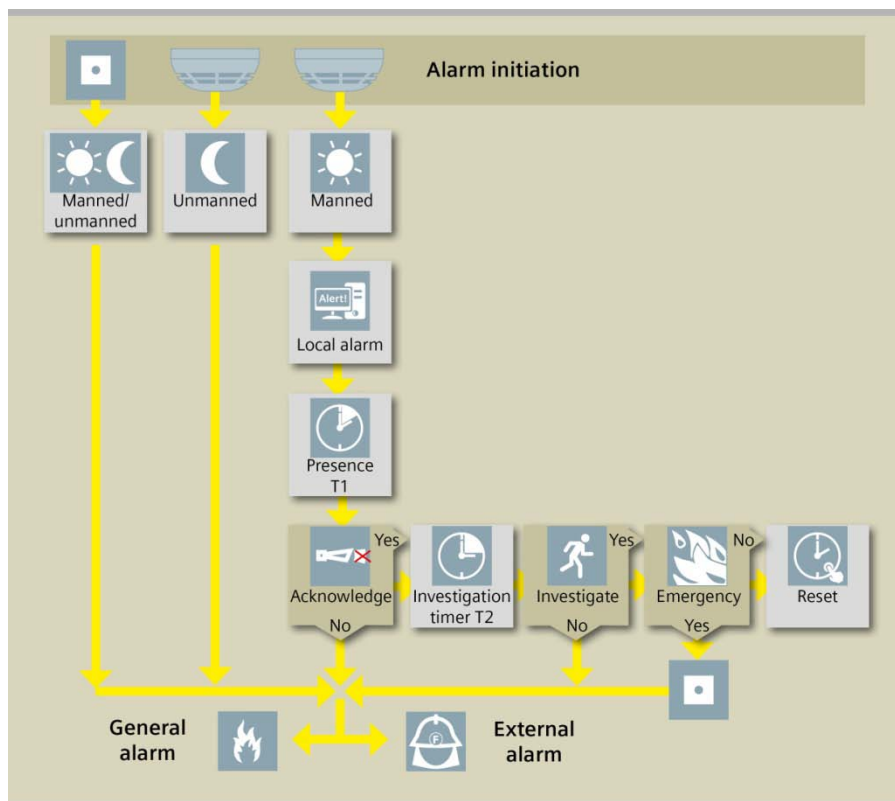
Figure 3.2.6-1 Alarm Verification Concept

The Alarm Verification Concept (AVC) allows in-house personnel to carry out a local investigation before the municipal fire service is alerted or the building evacuated. This reduces the number of unnecessary calls and is based on a dual timing principle. It is only applicable to the "day/manned" mode of the fire detection system. In the "night/unmanned" mode (when a local investigation cannot be ensured) the fire service will be alerted without delay. Manual call points and sprinkler flow switches also alert the fire service without delay (at all times).

In the "day/manned" mode any alarm initiated from an automatic smoke detector will start timer T1. If T1 times out without any response from an operator, the fire service is called immediately. If the alarm is acknowledged on the fire alarm panel while T1 is running, the system recognizes this as a sign that an operator is present. In this case, timer T2 is started for a predetermined investigation period. The duration of this investigation period should be determined in consultation with the fire service.

If the local investigation verifies the existence of a major fire, the fire service can be summoned immediately by simply activating any manual call point. The fire service will also be called if T2 times out. On the other hand, if local investigation establishes that only a minor, easily dealt with fire exists, the fire alarm can be reset while T2 is still running.

3.3. Smoke control

3.3.1. Objectives

Smoke presents the greatest danger to life in the case of a fire. This is not only due to smoke inhalation injuries and asphyxiation, but also due to smoke-filled corridors and staircases, which make evacuation considerably more difficult and raise panic levels. For this reason it is imperative that smoke is restricted to the immediate locality of the fire for as long as possible and is actively extracted from the building by appropriate means. Many buildings are subdivided into fire compartments by fire doors and fire-resisting walls and floors. Customized smoke control systems are designed to restrict the spread of fire and smoke, conducting the heat and smoke through the installed ducting into the external atmosphere (generally through the roof of the building).

3.3.2. Elements

Fire doors	Fire doors are used to compartmentalize a building, effectively restricting smoke to the immediate locality of the fire. Many fire doors are held open magnetically and these will normally swing closed as the retaining power is removed when the fire control panel detects a fire.
Smoke dampers and extraction fans	Effective smoke control prevents it from spreading in an uncontrolled manner throughout the building, for example, via the heating, ventilation and air conditioning system. This is achieved by smoke dampers which are installed in the air ducts and are controlled automatically by the fire protection system. The smoke is conducted through the air ducts to the outside world and the efficiency of this process can be increased by the use of extraction fans.
Pressurization fans	It is of paramount importance that the stairways should be kept as free from smoke as possible. For this reason high-rise buildings are usually equipped with pressurization fans, which maintain the pressure in the stairways above that of the connecting floors.

3.4. Evacuation

3.4.1. Objectives

The basic objective is to move those people in an endangered area to a place of safety. The evacuation of a building, however, is a drastic measure and should only be initiated when absolutely necessary.

The measures required to ensure safe evacuation will vary from building to building and priority must be given to the requirements specified by the local authorities. Unfortunately these regulations differ widely from country to country and the local fire services often specify very distinct and individual evacuation concepts for buildings within their jurisdiction.

Key objectives:

a. Hotel guests should remain undisturbed for as long as possible.
b. An evacuation should be initiated as soon as it becomes unavoidable.
c. The evacuation should be carried out as quickly and efficiently as possible.

3.4.2. Evacuation concepts

For each hotel an appropriate evacuation strategy must be defined in accordance with the physical organization of the building, local regulations and in discussions with the local fire authorities.

Simultaneous evacuation (general alarm)
In small hotels, evacuation will simply consist of everyone reacting to the warning signal given when a fire is discovered, and then making their way to a place of safety outside the building. This is known as a simultaneous evacuation and will normally be initiated by the sounding of the general alarm (see above) via the fire detection system or voice alarm system.

Phased evacuation (staged alarm)
State-of-the-art fire detection and voice alarm systems are able to handle the fully-automatic, step-by-step evacuation of a building. This results in the following advantages:

- Reduced clogging (or blocking) of the escape routes and especially of staircases. When the whole building is evacuated simultaneously, people flock to the staircases on all floors at the same time, which may lead to considerable tailbacks.
- Reduced probability of any panic reaction. The awareness of being in danger without being able to get out quickly (blocked exits) easily leads to panic reactions, the consequences of which may be even worse than those of the fire itself.

Restriction of evacuation to the minimum is absolutely necessary. The complete evacuation of an entire building is only recommended when the fire can no longer be controlled. It is mostly sufficient to evacuate one or several fire compartments.
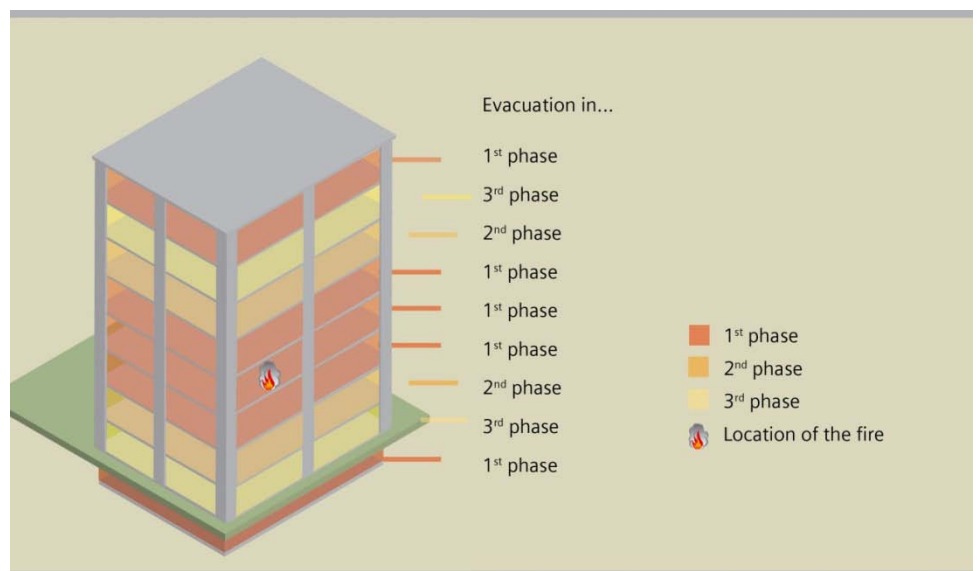
3.4.2-1 Phased evacuation

During the first phase of an evacuation, the currently accepted procedure is to evacuate the following groups of people:

- People on the floor where the fire was detected.
- People on the floor immediately above and below that floor.

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Depending on region and usage, the top floor and all basement floors may also be evacuated during this first phase. As the fire spreads, all other floors are evacuated one after the other in subsequent evacuation phases. During the first phase, a warning message instructs people on these floors to wait.

3.4.3. Organization

A successful evacuation can only be achieved when the appropriate infrastructure and management organization are in place and are regularly reviewed.

Up-to-date evacuation plans

In many countries approved plans for fire alarm and evacuation measures are required by law. These plans must detail all necessary actions to be taken during emergencies and designate the persons responsible for the implementation of such actions. In countries where no such legislation exists, the individual hotel manager must create his own plans. Department heads and senior staff should consult with local authorities and the fire service to formulate the most effective plans for the premises.

Regular fire drills

Regular meetings and fire drills are essential in keeping evacuation plans up to date and the staff fully prepared for any emergency.
Regular checks should be made to ensure:
- Escape routes are always free from blockages of any sort and that any emergency fire exits remain unlocked (although they will generally be supervised by an in-house alarm system for security purposes).
- Emergency lighting is well-maintained and always in perfect working order.

3.4.4. Evacuation instruction

The single most important factor in a successful evacuation is providing the hotel guests with clear instructions on what they have to do. In a hotel environment it is generally considered inadequate to rely on the guests being able to correctly interpret the meaning of the acoustic 'alert' and 'evacuate' signals from simple sounders.

Evacuation announcements (voice)

As mentioned earlier, the most effective way of getting the information to the hotel guests is by way of a voice alarm system. However, the messages transmitted by such a system can only be effective if they are both heard and understood.

Intelligibility
Although the ambient noise level in hotel guest rooms is relatively low (under 35 dBA with the TV off and up to 70 dBA with the TV on), it is recommended that speakers are installed in all guest rooms and that these should provide an acoustic output of at least 75 dBA. However, what really counts is not just whether the message can be heard, but that the information being announced can be understood: the quality of the system is crucial. This can be quantified according to the Speech Transmission Index (STI) and a good system should attain at least 0.5 on this scale. The type, quantity and the positioning of the speakers are important factors in fulfilling this intelligibility criterion in all parts of the building.

Language
In international hotels the guests may come from many countries and speak different languages. However, it is considered best practice to transmit the evacuation messages in the local language and the more common internationally spoken languages only. Broadcasting the messages in too many languages may be counterproductive, taking excessively long and affecting the evacuation time.

Zonal messages

As a voice alarm system permits different messages to be conveyed to different areas within the premises, they are of particular importance in phased evacuation, or in buildings where escape routes may vary according to the location of the incident. This can be controlled automatically, based on the alarm signals from the fire detection system or may be executed manually from the control room. The efficiency of an evacuation is heavily dependent on the appropriate voice messages being transmitted to the relevant areas.

Live messages

Voice alarm systems also provide a microphone input, which allows the fire chief to 'speak' directly to people in particular parts of the building. This additional flexibility is an important feature in large multi-story hotels.

3.4.5. Escape routes

Once the guests have understood that they need to evacuate the building, then following the appropriate escape route must be made as straightforward as possible. Clear signage is essential.

**Fire escape plans
(in corridors and guest rooms)**

Clear fire escape plans should be displayed in all guest rooms indicating the recommended escape route(s) from that particular location.

Escape route identification

Hotel guests are not generally familiar with the layout of the building, making it imperative that the emergency escape routes are adequately signposted to help guide occupants to a place of safety. As there may be numerous hotel guests who do not speak the national language, the international pictogram signs (as described in ISO 7010) should be used. The general guideline is that an escape route directional sign should be readily visible from any location within the building, other than the hotel room itself. The escape route should be regularly confirmed by repetition signs, especially at "decision" points, e.g. where corridors meet or open onto lift lobbies and landings. All evacuation or escape plans should conform to the format as described in ISO 23601. The ambient lighting levels should also be taken into account when determining which type of sign should be used (e.g. back-lit, reflective, etc.).

3.4.5-1 Escape route sign

The problem with this type of sign is that they may not be easily visible in smoky conditions. For this reason the concept of way guidance is becoming more widespread.

Way guidance

To complement emergency escape lighting, way guidance equipment can be very useful in helping people to follow exit routes. Way guidance systems usually consist of photo luminescent material, lines of LEDs, or strips of miniature incandescent lamps, forming a continuous marked escape route at a lower level (e.g. handrail or floor). These systems have proved particularly effective for partially sighted people and when visibility is already affected by smoke.

Emergency lighting	The primary purpose of emergency escape lighting is to illuminate escape routes, but can also be used to illuminate other safety equipment. Following a power failure the emergency lighting should automatically switch on within 5s. The size and type of the premises and the risk to the occupants will determine the complexity of the escape lighting required.
Elevator controls	Due to the risk of power failure during a fire, the use of the elevators as a means of evacuation is not generally permitted. Appropriate signals from the fire detection system will direct the public elevators to a predetermined floor, where they remain out of service with the doors open. This is usually the hotel lobby; however, if the fire has been detected in the lobby area, then the elevators will be automatically dispatched to a preprogrammed alternative floor. Members of the fire department, who are better able to assess the risks involved, may still be able to use some elevators (e.g. to transport firefighting equipment) by means of a special key.

3.5. Applications in various types of hotels

Hotels vary considerably in size and complexity. For the purposes of this document we will limit the discussion to the following four categories:

- Roadside hotels/motels
- Regional hotels
- Metropolitan hotels
- High-rise hotels

3.5.1. Roadside hotels/motels

Characteristics	One- or two-story buildings - in some cases multiple buildings spread out over a relatively large area, with individual buildings often separated by parking lots.

3.5.1-1 Roadside hotel/motel

Alarm and evacuation	For single buildings a fire detection system alone may be considered sufficient to alert the occupants by means of a general alarm, followed by a simultaneous evacuation of the building. In the case of multiple buildings, however, it would make little sense to evacuate all buildings if a fire is detected in one location only.

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In one- or two-story buildings the danger of panic may be considered to be relatively small.

However, even here a simple voice system could be of great assistance in helping people grasp the situation more quickly. The infrastructure already available in many hotels to provide background music in public areas (e.g. lobby, bar, restaurant, fitness room, etc.) may include a personal address function, which could also be utilized for voice alarms.

Other considerations

Escape routes
Escape routes in such buildings are usually straightforward and firefighter access via the parking lots is uncomplicated. In general, staircases are fully exposed and smoke can escape fairly easily, so the danger of suffocation is limited.

3.5.2. Regional hotels

Characteristics

Low-rise buildings up to 5 stories high, with parking lots at the front or rear of the main building.

3.5.2-1 Regional hotel

Alarm and evacuation

For buildings of up to 3 floors a general alarm and simultaneous evacuation could be considered an acceptable solution. This should be complemented with a basic voice alarm system to improve the response of the hotel guests. For buildings of 4 or 5 floors, however, a phased evacuation is recommended, with a voice alarm system capable of automatically transmitting different warning and evacuation messages to the relevant areas.

Typically evacuation signals are sounded in the area in which the fire has been detected, as hotel guests in this area are considered to be at most risk. For the adjacent areas, warning signals are transmitted to alert the occupants to prepare for possible evacuation. The ability to manually select any combination of zones for spoken messages is an important feature, permitting a fire chief to react quickly and easily to the changing situation and transmit his messages precisely to people in specific areas according to the circumstances.

Other consideration

Escape routes
Escape routes are slightly more complex than in roadside hotels/motels, since guest rooms may only be accessible via a main lobby.
Smoke control
In case of a fire alarm, the fire detection system should control the air

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conditioning system via its control outputs. The types of control may vary greatly depending on the construction and layout of the individual building and the air conditioning systems. As a general guideline, however, exhaust fans should be running and supply fans should be stopped for zones in alarm. This creates an under pressure in the area of smoke, and an overpressure in smoke-free areas, thereby greatly reducing the chance of smoke spreading. Escape routes, such as staircases, are usually switched to 100% fresh air supply and kept pressurized as long as the emergency situation persists.

3.5.3. Metropolitan hotels

Characteristics
Buildings more than six stories high, typically consisting of a single building with an underground parking areas.

3.5.3-1 Metropolitan hotel

Alarming and evacuation
See regional hotels with 4 or 5 floors.

Other considerations
Escape routes
Escape routes may be complex and include separate, enclosed staircases, which lead directly outside.

Smoke control
Because of the air conditioning and air-handling systems usually found in metropolitan hotel buildings, the problem of smoke control must be closely considered. This may be addressed by utilizing the existing HVAC equipment or by the installation of additional pressurization and smoke extraction fans.

Fire detection may be complemented by a well-designed control concept for air handlers via the fire detection system's outputs. As a result, hazard to human life and damage to property can be reduced well before a situation gets out of hand.

Elevators
In full blast fires, elevator shafts can develop a chimney effect. Therefore, elevators must not be used, mainly to reduce the risk of persons being trapped within. They may, however be used by the fire department to transport materials to the upper floors. The fire detection system, therefore, should send a signal to the elevators via its control outputs, to bring them to the fire brigade access level (usually the main lobby) where they are put out of service with the doors open. Firefighters are able to use the elevators in "fire service mode".

<u>Infrastructure</u>
The fire control room of such a building should contain a ventilation control panel from which the firechief can override any automatic controls.

3.5.4. High-rise hotels

Characteristics
These buildings are usually found in the heart of large cities. They are characterized by their skyscraper appearance and usually have underground parking areas.

3.5.4-1 High-rise hotel

General
Because of their design and the extremely high concentration of people and property, these hotels are potentially high-risk buildings.

They must conform to very stringent building standards in terms of fire resistance and protection. High-rise buildings are usually segmented (fire compartmentalization) and are equipped with fire doors, escape stairways and air handling systems designed to minimize smoke-related problems.

Alarm and evacuation
See regional hotels with 4 or 5 floors.

In an emergency, many people in high-rise buildings tend to feel trapped. It is therefore essential that the information over the voice alarm system is clear and only endangered areas are evacuated in an initial phase. Clear directions must be given to escaping persons via live voice messages.

Toxic smoke is one of the foremost hazards in high-rise hotels. Very early smoke detection by sensitive and reliable detectors is extremely important. Early warning allows prompt initiation of countermeasures and possible evacuation before dangerous situations can develop.

Other considerations
<u>Escape routes</u>
Due to their height and numerous doors, they may have extensive escape routes. These buildings are usually inaccessible to firefighters from the outside and by conventional means (ladders). Escape routes in such buildings are extremely vulnerable. Since elevators are the principal means of transportation and must not be used in case of fire, (pressurized) emergency staircases are the only means of vacating the building in a conventional manner.

Smoke control
The fire control room of such a building should contain a display and control panel that not only provides current information from the fire detection system but also for all HVAC systems in the building. This should enable the firechief to react to the changing situation and override any automatic controls as circumstances require (see also metropolitan hotel buildings.)

Elevators
In European countries specially protected firefighter elevators (EN81-72) must be installed in all new buildings taller than 30 m.

Infrastructure
In case of an emergency, the fire-chief will usually remain in the fire command center, where he needs access to the fire detection system, which indicates the zones in alarm, and thereby shows the speed and direction of spread. By means of a voice alarm system he can inform and direct escaping persons, while also directing the actions of his firefighters via their own radio communication links.

3.5.5. Summary table

	Roadside	Regional	Metropolitan	High-rise
Characteristic	One- or two-story buildings	Lowrise buildings: • Up to 5 stories	Single building: • 6 or more stories	City hotels of skyscraper appearance
Alarm and evacuation	• General alarm • Simultaneous evacuation	<u>Up to 3 stories:</u> • General alarm • Simultaneous evacuation • Basic voice alarm system <u>4 and 5 stories:</u> • Staged alarm • Phased evacuation • Voice alarm system • Live voice directed to selected areas	• Staged alarm • Phased evacuation • Voice alarm system • Live voice directed to selected areas	
Escape routes	• Straightforward	• Clogging of stairways possible as all exit routes may lead through main lobby	• Complex with separate stairways • Signage at all decision points • Emergency lighting essential	• Extremely vulnerable • Signage at all decision points • Emergency lighting essential • Pressurized emergency staircases • Fire resisting elevators
Smoke control	• Smoke escapes easily via open staircases • Limited danger of suffocation	• Air conditioning system controlled via fire detection system • Zones in alarm: - exhaust fans running - supply fans stopped	• Existing HVAC equipment • Pressurization and smoke extraction fans	• A sophisticated smoke control system is essential
Elevators	• No elevators	• Out of service at fire-brigade access level • Open doors • Function allowing firefighter use	• Out of service at fire-brigade access level • Open doors • Function allowing firefighter use	• Out of service at fire-brigade access level • Open doors • Firefighter elevators
Special infrastructure			Display and control panel with access to: • Fire detection system • Air handling system • Voice alarm system (including microphone for live voice messaging)	

4. Extinguishing

4.1.   Introduction

For a fire to exist, four elements need to be present:

- Oxygen to sustain combustion.
- Fuel to support the combustion.
- Heat to raise the material to its ignition temperature.
- A chemical reaction between the above three elements.

Extinguishing a fire implies interfering with the combustion process in such a way that the preconditions to maintain combustion are no longer present. This can be achieved by removing any one of the first three elements or by interfering directly with the combustion process. This results in the four basic extinguishing mechanisms:

- Cutting off the supply of oxygen (smothering).
- Physically separating the inflammable materials from the flames (starvation).
- Reducing the temperature of the inflammable materials or the flames (cooling).
- Use of chemicals to inhibit the combustion process.

4.2.   Extinguishing agents

A variety of extinguishing agents are used, each of which utilizes one (or more) of the above mentioned mechanisms.

4.2.1. Water

The most commonly used extinguishing agent is water. Water is not only an effective extinguishing agent; in most cases it is readily available, ecologically acceptable and inexpensive.

The extinguishing effect of water relies not only on the cooling of the burning material but also on the suppression of oxygen by the steam that is generated. Water has a very high latent heat of vaporization, which is four times that of all other non-combustible liquids. Water is absolutely non-toxic and can be stored at room temperature and pressure.

The boiling point of water (100 °C) is considerably lower than the temperature range where the pyrolysis (thermochemical decomposition) of solid combustible material can be expected to occur (250 - 400°C). It therefore permits the surface temperature of the fuel to be cooled to well below these temperatures.

However, water also has a number of disadvantages and can itself cause considerable damage to property. As it boils at 100 °C and freezes at 0 °C, it can also lead to damage of any water-carrying pipes. Water is a conductor of electricity, making its unsuitable for electrical fires. It is ineffective in extinguishing certain combustible liquids, particularly those that are not water soluble or float on water (such as oil, petrol or diesel). Water is also unsuitable for some hot metals (e.g. magnesium) or for chemicals. For such materials other extinguishing agents must be used, for example foam, gas or powder.

4.2.2. Gas

Gases are fast, highly efficient, electrically non-conductive and clean. Their properties make them particularly suitable for rooms with high value content. Some types of extinguishing gas rely on the removal of oxygen, while others rely on chemical inhibition of the combustion process:

Natural gases (removal of oxygen)

The following natural gases are suitable for extinguishing purposes:

- Carbon dioxide (CO_2)
- Citrogen (N_2)
- Argon (Ar)

Mixtures of these gases are also commercially available:
e.g. Inergen (52% N_2, 40% Ar, 8% CO_2) or Argonite (50% N_2, 50% Ar).

Automatic extinguishing systems using such gases (or gas mixtures) rely on the partial displacement of air (and consequently oxygen) from the protected area. The concentration of oxygen in air is 20.8 vol.-% and reducing this concentration to below 13% will stop the combustion process for most combustible materials.

When CO_2 is not used then the remaining oxygen concentration (generally between 10 and 13 vol.-%) is not life threatening. However, this is not the case if CO_2 is used; as a concentration of as little as 5 vol.-% of CO_2 gas can be life threatening. This has nothing to do with the reduced oxygen content of the air, but is purely due to the toxicity of the CO_2 itself. As concentrations of up to 50% may be reached in some extinguishing systems, it would be fatal for anyone remaining in the gas-flooded area.

Chemical extinguishing gases (inhibition of combustion process)

Due to their chemical properties, extinguishing gases such as Novec™ 1230 and HFC227ea inhibit the combustion process by extracting energy from the fire. On being released into the atmosphere, these gases form an extinguishing mixture. A correctly controlled concentration of this mixture extracts heat from the fire and cools the burning material down to the point where the fire is extinguished.

For HFC227ea and Novec™ 1230, the concentration level used in practice is below the NOAEL value (No Observed Adverse Effect Level). It does not therefore pose a health threat to people present in the protected area. However, the area should always be evacuated before the gas is released.

4.2.3. Foam

Blanketing the burning surface of a combustible material (either solid or liquid) with foam effectively separates it from the surrounding air, depriving the fire of the necessary oxygen. The cooling effect of the foam also contributes to the extinguishing process. Foam is particularly suitable for use in fire extinguishers.

4.2.4. Chemical powder

Extinguishing powder relies on interrupting the combustion process by interfering with the chemical reaction and the associated extraction of energy. Powder is mainly used in fire extinguishers. One disadvantage of this type of extinguisher is that it leaves a very fine residue which is difficult to remove and is highly corrosive. The powder is also incompatible with electrical and electronic equipment.

4.3. Extinguishing systems

4.3.1. Sprinkler systems

These automatic systems use water as the extinguishing agent and provide a very effective protection both for property and human life. The advantages of sprinkler systems are their high reliability and wide application spectrum in the protection of people and material assets. Not only do they stand out due to their relatively simple and robust technology, there is generally a plentiful supply of the extinguishing agent – water.

Further advantages:

- Sprinklers only extinguish areas which need to be extinguished.
- Sprinklers outside the fire source remain closed.
- Extinguishing water released reduces smoke and dangerous gases.
- The cooling effect of extinguishing water increases the safety of rescue forces.
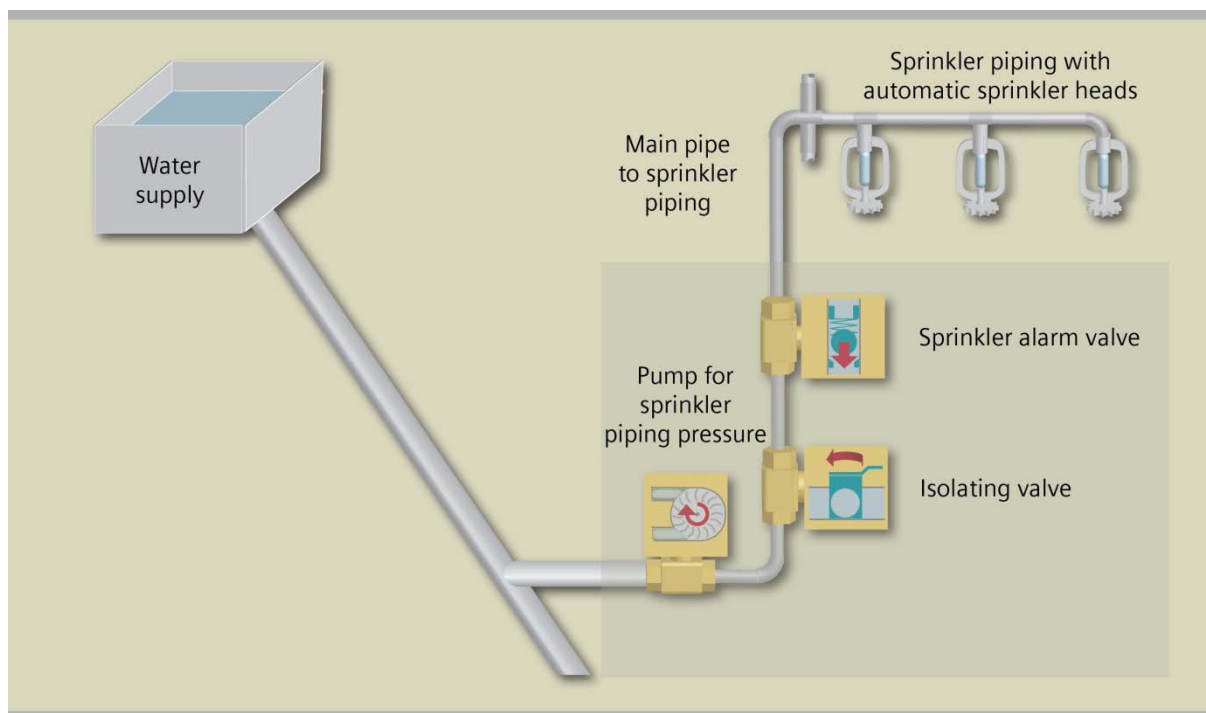

Figure 4.3.1-1 Schematic of an automatic sprinkler system

Sprinkler systems consist of a network of water pipes with sprinkler heads distributed evenly on the ceilings and positioned such that (in case of fire) all areas to be protected would be reached by the extinguishing water spray. The sprinkler heads react individually to heat, opening to discharge a pressurized water spray when the temperature is sufficiently high. In this way an incipient stage fire can be suppressed at its source as only those sprinklers in the immediate vicinity of the fire will be activated, minimizing any unnecessary water damage.

The pipework which feeds the sprinklers is generally subdivided into sections. This enables parts of the system to be taken temporarily out of service to allow maintenance and repair work to be carried out on individual sections. Each of these sections is connected to the main water supply via an alarm valve, which serves several purposes. Activation of one (or more) sprinkler heads causes a drop in pressure in the corresponding section causing the alarm valve to open and allowing water from the main riser to pass through. At the same time an alarm (generated by a pressure switch) will be automatically transmitted to a continuously manned location – usually the fire service.

Local conditions such as temperature and building usage determine which type of sprinkler system should be implemented.

Wet-pipe systems	Wet-pipe systems should only be installed in situations where the water in the piping network is not subject to freezing or overheating (+95 °C) during the year. This includes most applications in heated buildings. Such systems are permanently filled with water, which is maintained under pressure so that in case of fire the water can be immediately discharged from the sprinklers.
Dry-pipe systems	Dry-pipe systems should be installed in situations where there is a risk of frost. Typical applications include unheated buildings, underground car parks, loading bays and commercial freezers.
	The pipework is similar to that used in wet-pipe systems; however, the pressurized water is retained behind the dry-pipe alarm valve. The piping on the sprinkler side of this valve is filled with air or an inert gas under pressure. In the case of fire, the air must first escape before the water can reach the sprinklers, leading to an inevitable delay: this is one of the disadvantages of this type of system.

4.3.2. Gas extinguishing systems

The main application area for gas extinguishing systems is the protection of closed rooms. They are particularly suitable for rooms that contain sensitive objects or equipment where water cannot be used. These typically include all types of electrical equipment, computer rooms, archives and document safes.

The gases are stored in pressure tanks:

- The non-liquefiable inert gases Ar, N_2 and gas mixtures are stored in gas cylinders at pressures of 200 to 300 bar.
- In high-pressure systems CO_2 (which does liquefy under pressure) is stored in gas cylinders at 56 bar; in low-pressure systems it is stored in large cooled containers.
- Chemical gases are stored in gas cylinders, pressurized with nitrogen which acts as a propellant. The industry norm storage pressure is 42 bar in Europe (and 25 bar in the USA).

Extinguishing is controlled either manually or preferably automatically by means of a fire detection system. Only a quick, faultless actuation prevents consequential damage, as a fire should be extinguished during its formation phase. However, to prevent human casualties, an alarm must first be sounded to warn people of the imminent flooding of the area. The gas will only be released after a predefined delay has given people sufficient time to evacuate the area.

When the system is actuated, the cylinder valves of high-pressure systems (or the container valves of low-pressure systems) will be opened. Doors and other openings are closed automatically and any other air-handling equipment (e.g. ventilation systems and smoke dampers) are controlled to ensure that the area is sealed off. However, the inrush of the extinguishing gas into a closed room will automatically increase the pressure within the room. To prevent damage occurring, overpressure relief dampers mechanisms temporarily open, before re-closing again automatically.

The extinguishing gas is guided through a network of piping to nozzles that are evenly distributed on the ceiling. The gas quickly fills the room and a homogenous concentration is built up throughout the room. To completely extinguish the fire, this concentration must be maintained over a sufficiently long period of time.
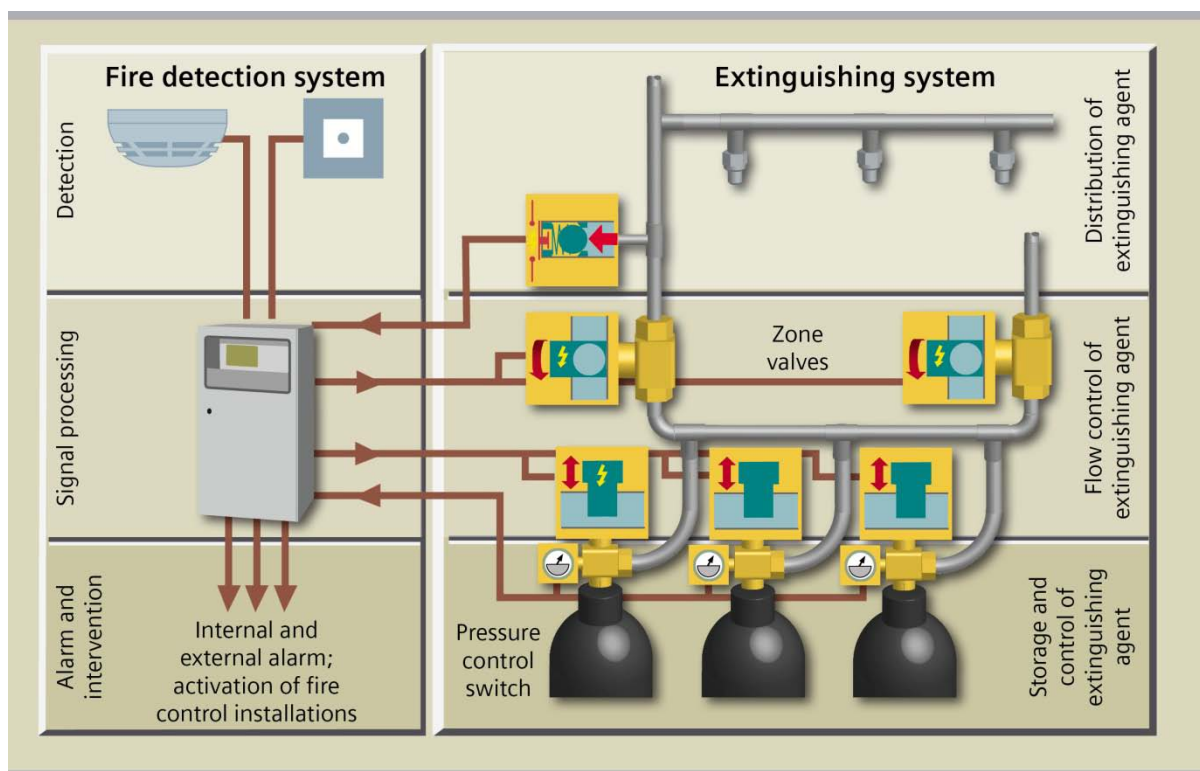
Figure 4.3.2-1 Principle of a gas extinguishing system

4.3.3. Fire extinguishers

Fire extinguishers are mobile or portable manual devices designed for preventing incipient stage fires from getting out of control. The extinguishing agent is expelled under pressure. In some types of extinguisher the agent is kept under constant pressure, while in others the pressure is generated by releasing a propellant gas at the time that the extinguisher is activated.

Extinguishing agents include water, foam, carbon dioxide and powder. These substances function in different ways and are suitable for different types of fires. Fires are categorized into five main fire classes A, B, C, D and F.

Fire class	Description
A Solid materials	Solid materials subject to thermal decomposition which normally for members. Examples: wood, paper, leather, textiles and coal
B Liquids	Liquids or materials which melt under heat and only create flames. Examples: alcohol, oil, wax, resin, paraffin, petrol, paints, tar and acetone
C Gases	Gaseous materials which are often stored under pressure. Examples: hydrogen, natural gas, acetylene, methane, ethane, propane and butane
D Metals	Strongly ember-forming, combustible metals. Examples: aluminum, magnesium, potassium, sodium, beryllium, lithium and barium
F Cooking oils	Combustible cooking oils and fats commonly found in commercial kitchens.

Figure 4.3.3-1 Material fire classes

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Notes:

1. In the European norms electrical fires are not considered to constitute a fire class on their own, as electricity is a source of ignition that will feed the fire until removed.
2. The above table reflects the European classification system. Definitions used by regulatory bodies in other parts of the world may show some minor differences.
   For example in the USA: Cooking materials   ➜ Class K
      Liquids + Gases   ➜ Class B
      Electrical equipment   ➜ Class C

Extinguisher types	Class of Fire				
	A	B	C	D	F
	Solids	Liquids	Gases	Metal	Cooking oils
Water	Yes	No	No	No	No
Foam	Yes	Yes	No	No	No
ABC Powder	Yes	Yes	Yes	No	No
Dry powder (Metal Fires)	No	No	No	Yes	No
CO_2	No	Yes	No	No	No
Wet chemical	No	No	No	No	Yes

Figure 4.3.3-2 Fire extinguisher applications

4.3.4. Wall hydrants

Wall hydrants are used to complement fire extinguishers in dealing with incipient stage fires. They are intended both for trained staff and fire service use. Wall hydrants are evenly distributed throughout the building, providing water outlets from the building's extinguishing water pipe network. Care must be taken to prevent contamination of the drinking water supply by the water used for extinguishing. For this reason the extinguishing water is generally taken from a separate water supply tank and fed under pressure into the pipe network via fire pumps.

4.4. Extinguishing in hotels

A hotel is a complex building with diverse demands on the extinguishing infrastructure to be provided.

What is installed will be largely determined by:

- Local building codes
- Insurance guidelines
- Official fire safety reports
- Size of the property

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4.4.1. General recommendations

Fire extinguishers
As a hotel is a commercial building fire extinguishers must always be provided: National fire codes (e.g. BGR 133) specify the type, size and quantity of extinguishers required with regard to the floor area and danger level of each location. It is important to provide an adequate number of fire extinguishers, which should be installed throughout the building. They should be mounted where they are clearly visible, easily accessible and at a convenient height. Typically the extinguisher handle should be between 0.8 and 1.2 m from the floor.
Foam extinguishers are the most suitable type for general hotel applications: Their use does not create any visibility problems and they can deal with the most common types of fires in a hotel environment. Whenever possible, foam should be given preference over other extinguishing agents. The weight of the extinguishers is also a factor that should be taken into consideration during the selection process: the 6 liter extinguishers are recommended.
Other types of extinguisher that need to be provided for special risk areas include, for example, wet chemical extinguishers in the kitchens (for cooking oil fires) and CO_2 extinguishers in plant rooms (for electrical fires).

Wall hydrants
Wall hydrants should be provided when the hotel size and layout could affect the access time of fire service personnel or where trained staff (who are capable of using the hydrants) are normally present. If wall hydrants are installed, care should be taken to ensure that the hoses are long enough to reach all areas.

Sprinkler systems
When planning a sprinkler system, a choice must be made between the two different concepts: partial coverage and blanket coverage. Partial coverage is designed to protect specific areas of the premises only, for example: store rooms, underground car parks and escape routes. In the case of blanket coverage, on the other hand, the sprinkler network is installed in all areas of the building with only a few exceptions (e.g. plant rooms and wet rooms).

4.4.2. Areas requiring special attention

When planning the extinguishing concept for a hotel the following areas should be given special attention:

- Underground car parks
- Plant rooms
- Kitchens

Underground car parks
In many European countries underground car parks exceeding 1000 m^2 must be protected with an automatic sprinkler system. Unless the danger of frost can be excluded, then a dry-pipe system would be the most appropriate solution. Wall hydrants should also be installed in the neighborhood of each stairwell access point.

Plant rooms
A gas extinguishing system provides efficient fire protection for electrical and electronic installations. This would be an appropriate solution for the protection of plant rooms, particularly as no residues are left behind as a consequence of an extinguishing incident and fire damage can be restricted to an individual piece of equipment. Such systems are very effective in putting out fires and preventing any reignition, allowing normal operation to be resumed as quickly and smoothly as possible.

Standard applications include centralized systems and modular systems. In a centralized system, all gas cylinders are installed in a central location outside the protected zone and preferably in a dedicated storage room. Centralized systems

always require a site-specific design, as all pipe diameters and nozzles must be calculated individually according to the particular application.

Modular systems, on the other hand, consist of space-saving compact units that are installed within the protection zone itself. These units combine fast and reliable detection with quiet and safe extinguishing in one compact package. They are particularly suitable for the protection of small enclosures with volumes up to 120 m³ that contain electronic and electrical equipment. The main cost-saving advantage of such systems is that they can be installed quickly and easily, and service and maintenance costs are very low.
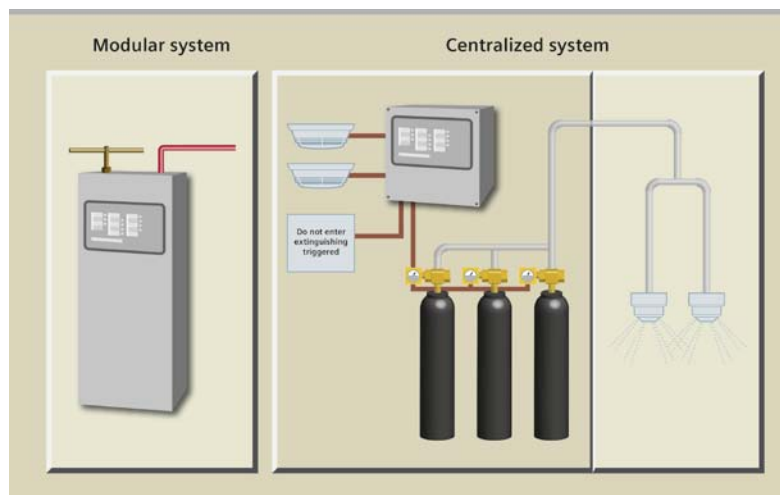

Figure 4.4.2-1 Modular and centralized extinguishing system

Kitchens

The fire risk in kitchens is relatively high. This is due to a combination of the cooking materials used (cooking oils, fats, etc.) and the hot cooking equipment (hot-plates, ovens, vats, etc.). Kitchen fires are predominantly fat fires, which often start spontaneously and rapidly generate an intense heat. The flames are also fed by the highly combustible fat vapors and can only be checked by interrupting the oxygen supply and reducing the temperature of the cooking oil.

An additional problem related to kitchen fires is their inherent ability to spread through the kitchen's own air extraction system to the rest of the building. The critical areas (e.g. cooking range, deep fat fryers, ovens and air extraction system) should be protected by specially designed extinguishing systems. Wet chemical fire extinguishers (Class F) should also be provided.

When extinguishing systems are used in commercial kitchens, then these are wet chemical systems, which are installed immediately above the protection area or within the air extraction hoods. They are stand-alone systems, which both detect the fire and extinguish it automatically. The effectiveness of this extinguishing agent relies on the cooling of the hot surfaces together with a highly efficient fire suppression mechanism. On contact with the hot fat, the extinguishing agent foams up to produce a soapy layer. This creates a dense barrier between the hot fat and the surrounding air, effectively preventing the highly volatile fat vapors from escaping and reigniting the fire.

If the hotel is equipped with a sprinkler system, then this should be extended to protect the other parts of the kitchen. However, it must be ensured that the water spray from the sprinklers cannot reach the critical areas of the cooking range, deep fat fryers, ovens and air extraction system.

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4.4.3. Summary

Although complying with the local standards, codes of practice and insurance guidelines is a legal obligation for hotel owners, they are also well aware that it is in their own interest to ensure that both the hotel and the occupants are well-protected. Extinguishing systems not only protect people and property extremely effectively, they also contribute to the smooth running of the hotel operations.

A well-planned extinguishing concept that is appropriate to the size, situation and substance of the hotel is essential. For example in small hotels just the installation of an adequate number of fire extinguishers may be sufficient. In all cases, however, regular service and maintenance are indispensable to ensure that the extinguishing systems and fire extinguishers are in perfect working order whenever they need to be used in an emergency situation.

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