Cairo University
Faculty of Engineering
Mech. Power Department

دبلوم تطبيقات التحكم الأوتوماتيكى فى نظم القوى الميكانيكية

MEP 599 Diploma Project-Spring Term 2019-2020

Hotel Fire Fighting Systems

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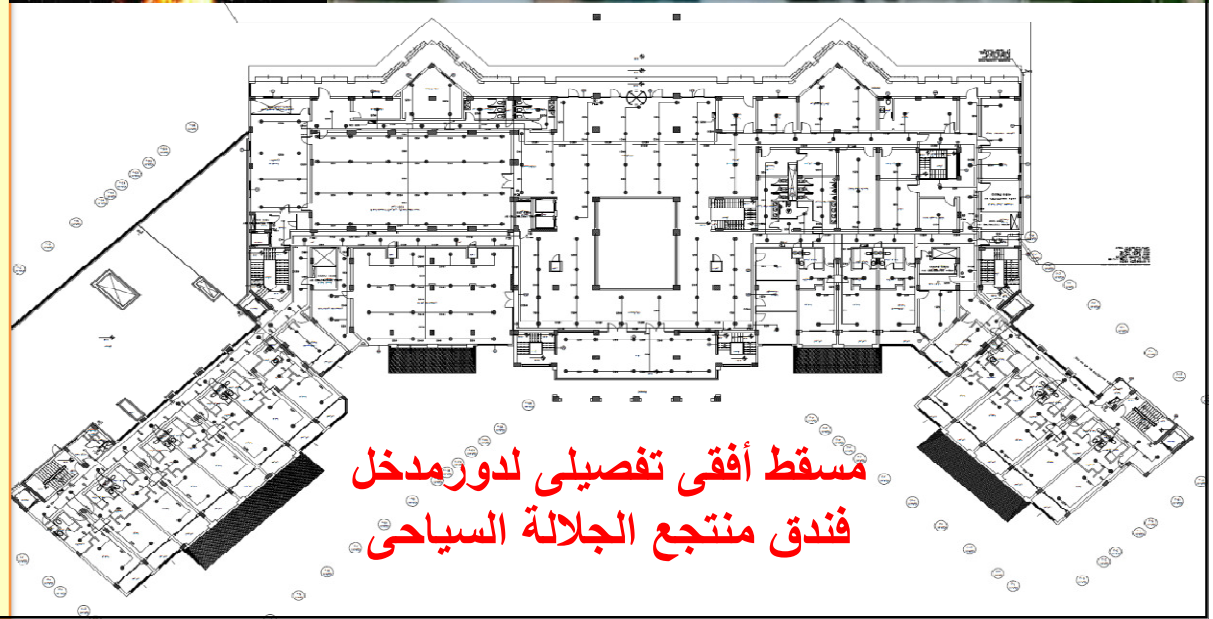
Abstract: Large hotels are very complex utility buildings which have many gust rooms and several types of fire hazards zones such as restaurant, kitchen, conference rooms, HVAC control rooms, employee offices …etc. Hotel fires thus represent major risk to large numbers of people's safety, hotel property & business continuity. Hotel fires not only result in human & financial losses, but they can also severely damage a hotel's reputation. This project is a practical application of large hotel fire fighting systems used in Al-Galala Hotel. The project includes detailed design of 3 different types of automatic fire fighting system as per NFPA standards. The systems are CO_2 & FM-200 gaseous fire extinguishing systems & Wet pipe automatic water sprinklers. Systems design covers fire detection, alarming, evacuation & fire extinguishing. Fire fighting system is an essential application of a pipe line automatic control system which includes flow of fluid from some source –through pipe networks- to final points to be protected from hazard of fire. Effective design includes calculation of flow rates of water or gaseous fluids, pressure drop at several destinations, selection of proper control sensors and fluid power units and using different types of flow control and safety valves.



Fire risks

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

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.

Kitchens

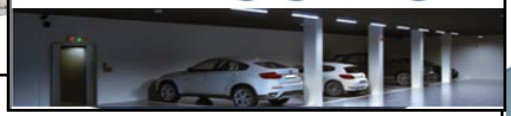
Plant rooms

Restaurants

Stairways

Laundries

Parking garages



Guest rooms

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.

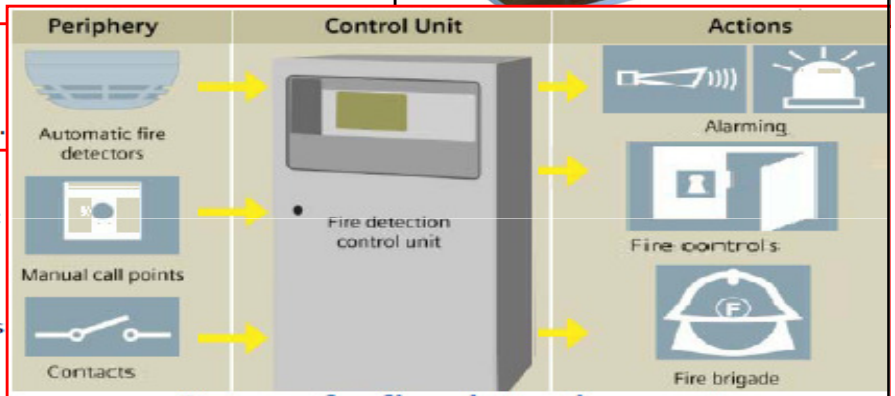
Fire protection concept

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.

Fire protection Passive & Active measures

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.



Setup of a fire detection system

Organizational measures

- 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 Optimal product selection combined with appropriate knowledge

Alarm and evacuation measures a (acoustic) alarm is to warn people of potential hazard.

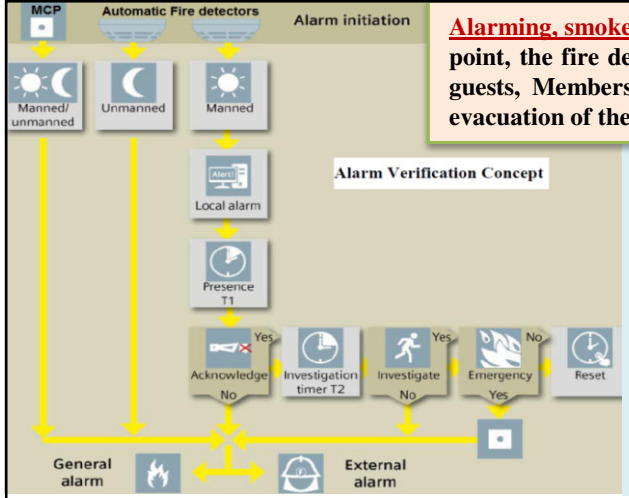
- Hotel guests for whom a hazardous situation has been detected.
- Hotel staff who should coordinate the evacuation. • people who should deal with the fire

Intervention measures Intervention measures activated by the fire control panel include:

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

Important firefighting systems include:

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

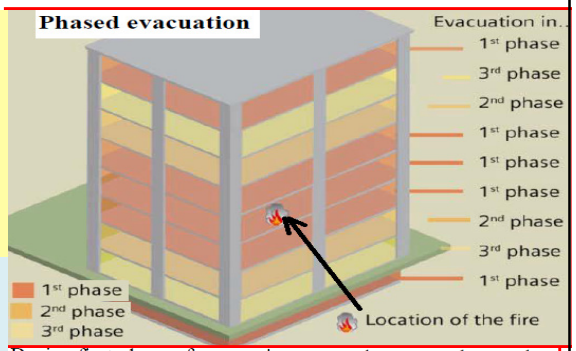


Alarming, smoke control and evacuation Once fire is detected by automatic detector, by sprinkler flow monitoring, or by a person activating a manual call point, the fire detection system will generate preprogrammed control and alarm signals. In a hotel, the purpose of an alarm is to warn 3 groups: Hotel guests, Members of staff, and municipal fire service. 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.

Alarm strategies **1-General alarm;** is a defined audible signal sounded throughout the building. The alarm is automatically activated by fire detection system, or manually from the hotel front desk (or control room). In majority of buildings this should trigger immediate and total evacuation of the building. **2-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 (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.

Smoke Control: Smoke presents the greatest danger to life in case of fire. This is not only due to smoke inhalation injuries and asphyxiation, but also due to smoke-filled corridors and staircases, which make evacuation 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).

Elements of Smoke controls: ***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.



During first phase of evacuation, 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.

Evacuation: 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.

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 sounding general alarm via fire detection system or voice alarm system.
Phased evacuation (staged alarm): State-of-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 (blocking) of the escape routes and staircases. When whole building is evacuated simultaneously, people flock to staircases on all floors at 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 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. 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.

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.

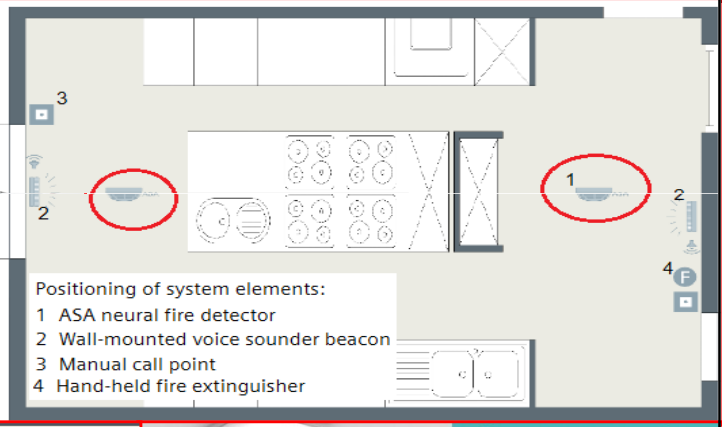
Fire protection in guestrooms

Details (see Figure)	
Detector for normal rooms Smoke detector with voice sounder beacon base	
Detector for small rooms ASA neural fire detector with voice sounder beacon base	
Positioning of detectors	

Related measures	Comments/Notes
Sprinkler system	In a number of countries local regulations require that a sprinkler system should be installed in hotels and guesthouses.
Fire extinguishers	An adequate number of hand-held (foam) fire extinguishers should be installed on corridors, landings, escape routes and public areas throughout the hotel.

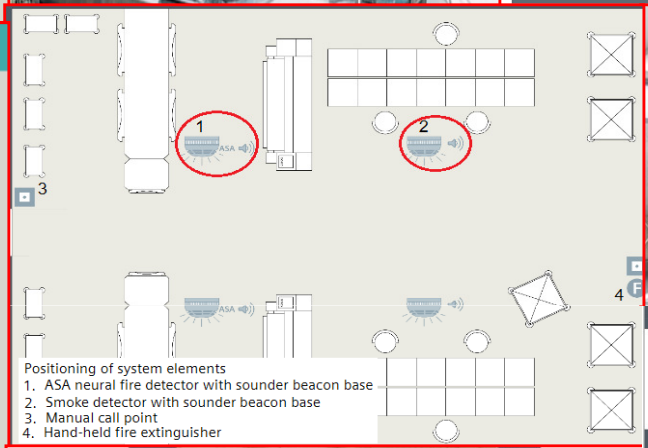
Fire protection in kitchens

Details	Comments/Notes
Automatic fire detectors ASA neural fire detectors ▪ IP protection at least IP43	Early detection of all types of fire and a robust response to deceptive phenomena (steam, heat): operation in a harsh environment with high humidity ▪ Parameter set with robust behavior to deceptive phenomena
Manual call points MCPs	▪ Single or double action (depending on local regulations) ▪ IP protection of at least IP43 (for operation in a humid environment)
Warning devices Voice sounder beacons	These devices provide optimal warning for kitchen personnel (in particular due to the spoken warning messages)
Positioning of system elements (see Figure)	



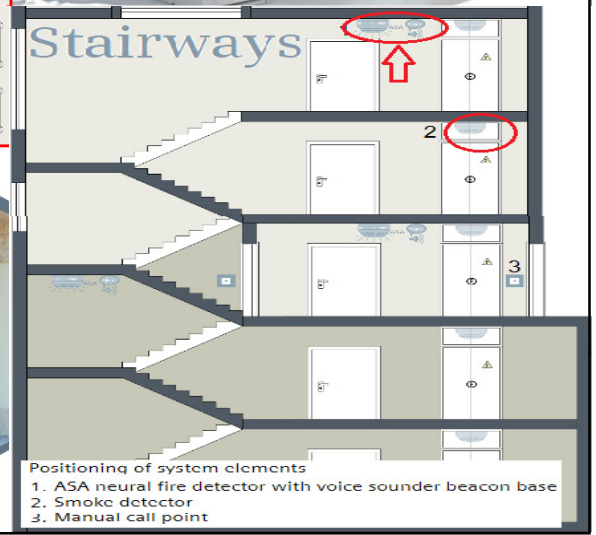
Fire protection in laundries

Details	Comments/Notes
Automatic fire detectors ASA neural fire detectors Smoke detectors	Detector behavior must be adapted according to whether the laundry is in operation or not. A robust response to deceptive phenomena (steam, heat) is required during operating hours, whereas a sensitive response is required at Detectors in the area of the machines ▪ During hours of operation: Parameter set with a high immunity ▪ Outside hours of operation: Parameter set with a sensitive response Detectors outside the area of the machines ▪ During hours of operation: balanced ▪ Outside hours of operation: high sensitivity Operation in a high humidity environment ▪ All detectors require IP protection of at least IP43
Manual call points	▪ Single or double action (depending on local regulations)
Warning devices	All detectors should be equipped with sounder beacon bases
Manual suppression Fire extinguishers	Hand-held fire extinguishers suitable for Fire Category A (solid substances and textiles) are recommended e.g. Foam.
Positioning of system elements (see Figure)	

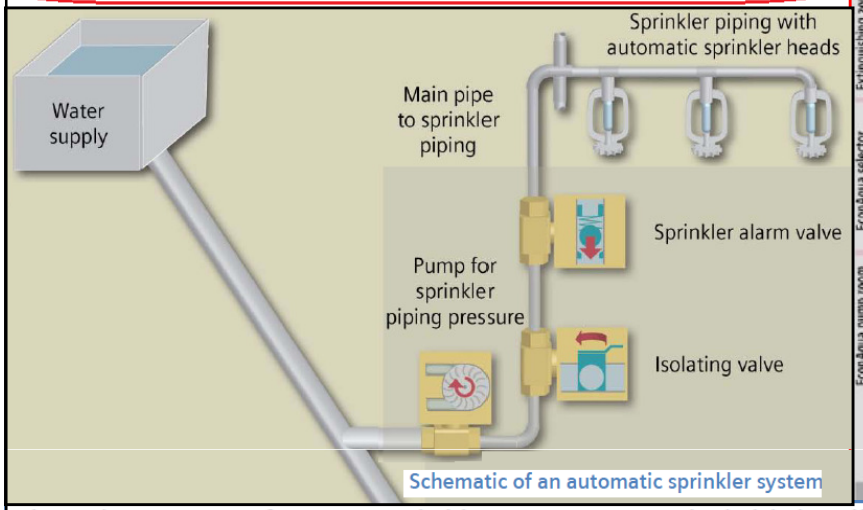


Fire protection in restaurants

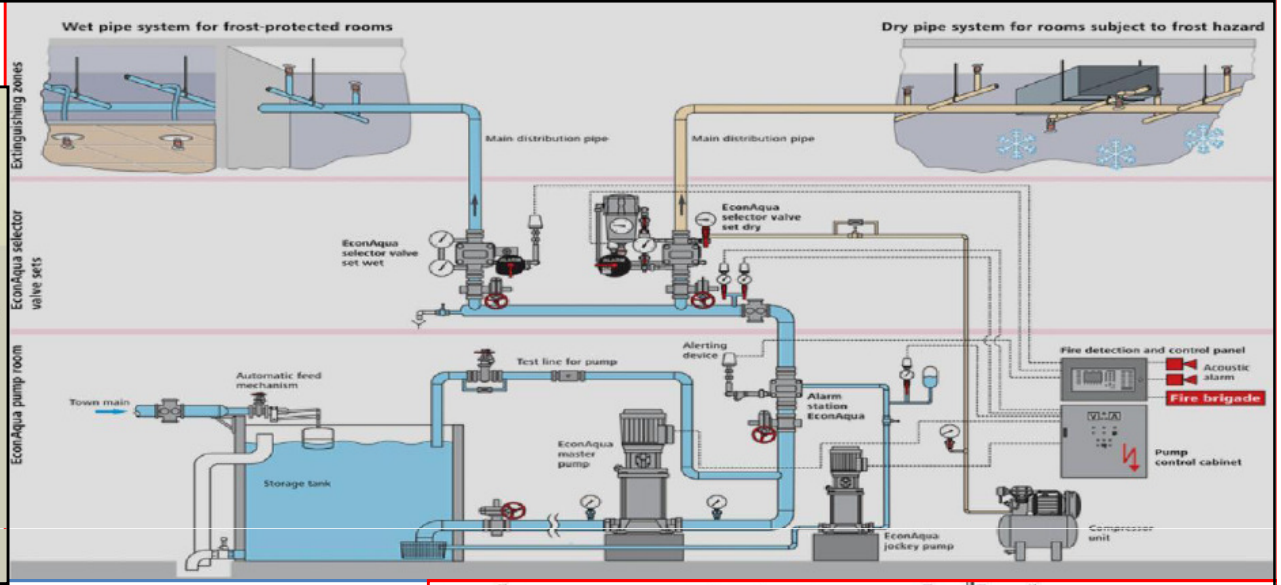
Stairways



Extinguishing Sprinkler systems



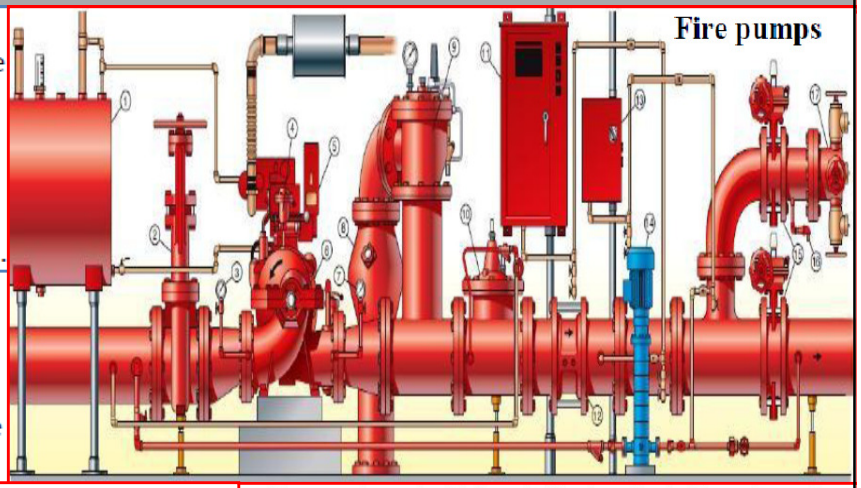
Schematic of an automatic sprinkler system



The advantages of **Water** 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 simple and robust technology, there is generally a plentiful supply of water.

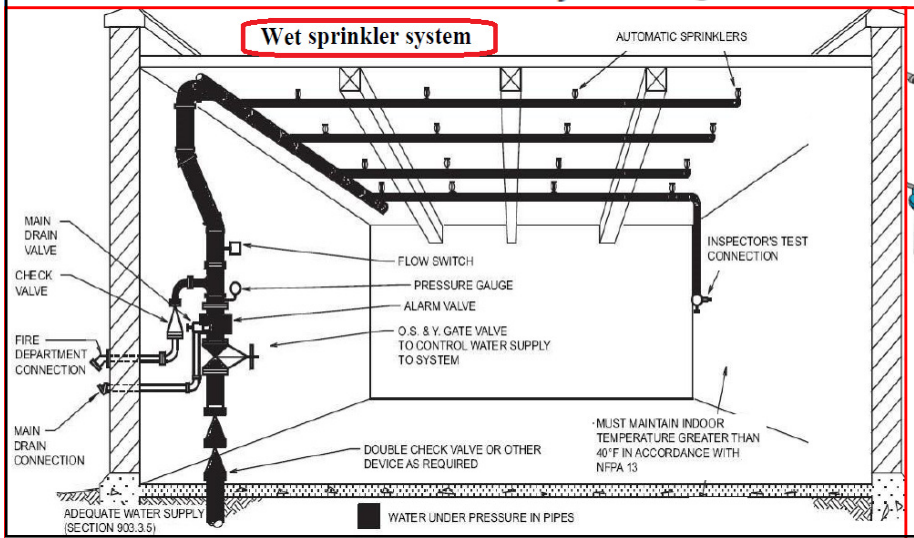
Further advantages:

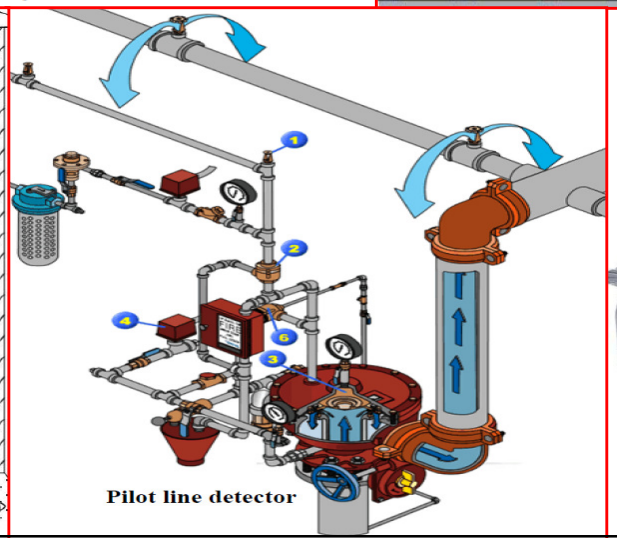
- Sprinklers only extinguish areas which need to be extinguished.
- Sprinklers outside the fire source remain closed.
- Extinguishing water released reduces smoke and dangerous gases.
- The cooling effect of extinguishing water increases the safety of rescue forces.

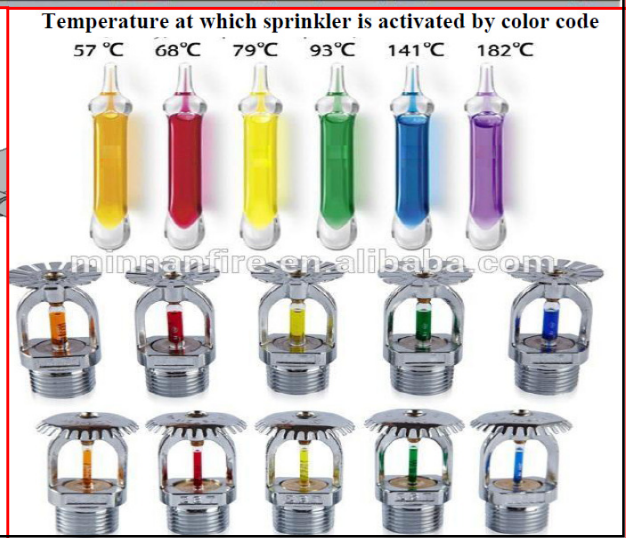


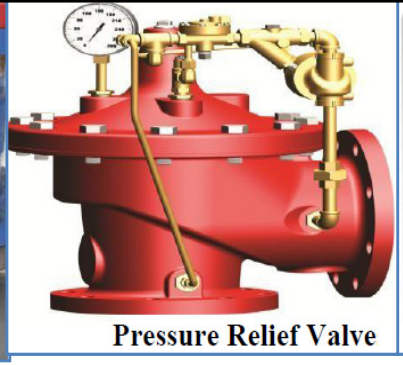
Wet-pipe systems

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.









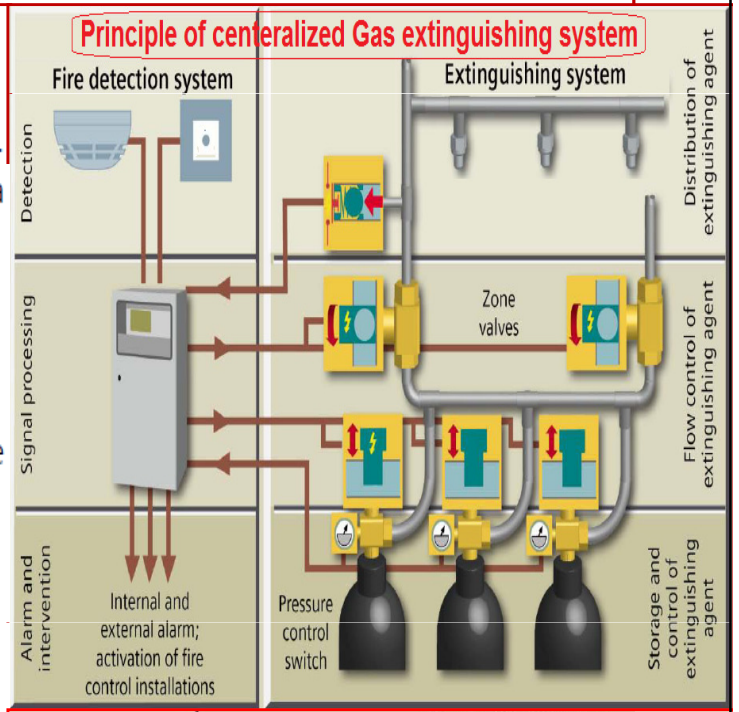
Gas extinguishing systems (CO2 and FM200)

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. In high-pressure systems CO_2 (which does liquefy under pressure) is stored at 56 bar; in low-pressure systems it is stored in large cooled containers.

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.

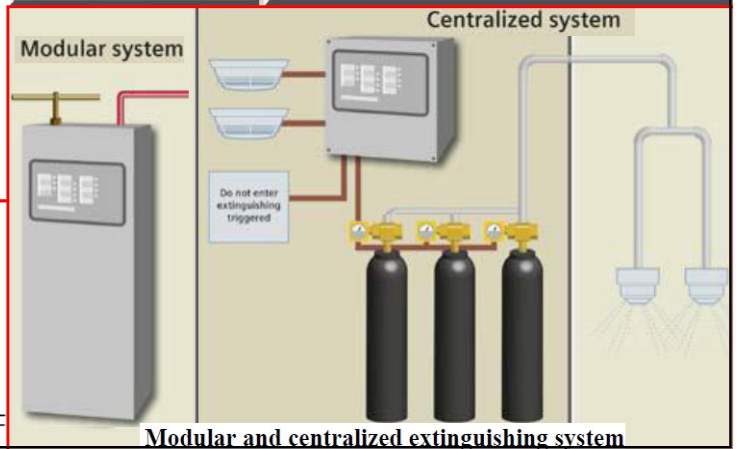
When the system is actuated, the cylinder valves of high-pressure systems (or the container valves of low-pressure systems) will be opened. Doors and other openings are closed automatically and any other air-handling equipment (e.g. ventilation systems and smoke dampers) are controlled to ensure that 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.



Mobile or portable Fire extinguishers are manual devices designed for preventing incipient stage fires from getting out of control. The extinguishing agent is expelled under pressure. In some types, 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



Modular and centralized extinguishing system

Elite's Fire Software Calibration

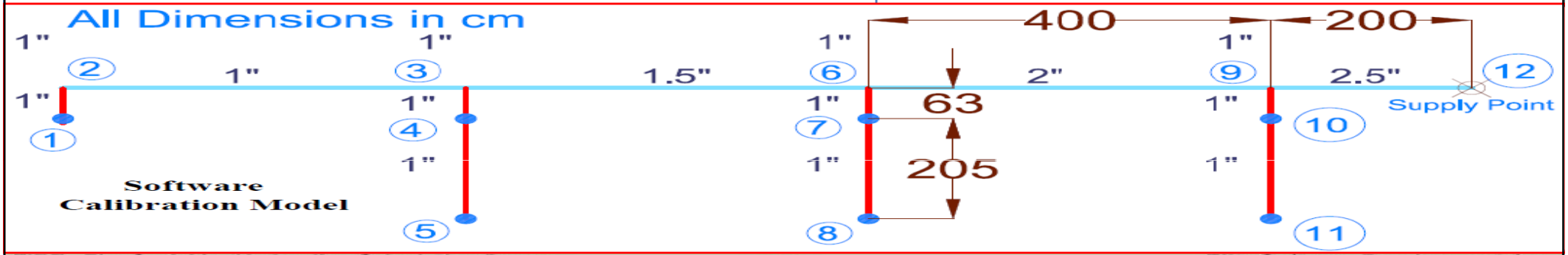
- To insure that the answers of the program a simple model has developed and calculated manually, and by using Elite software.
- The model consists of a light hazard area with minimum acceptable design area =1500 ft2 according to *(NFPA.13 -Chapter23)*.
- Number of sprinklers in the mode = 7 sprinklers, with coverage area for each one = 225 ft2

In order to simplify the calculations its assumed that the supply point directly supply the sprinkler network model without any special fittings other the required for the geometry of the network, like Tee connections.

Elite's Fire Hydraulic Calculations

Elite's Fire Program quickly performs all necessary hydraulic calculations as required by the National Fire Protection Association (NFPA 13).

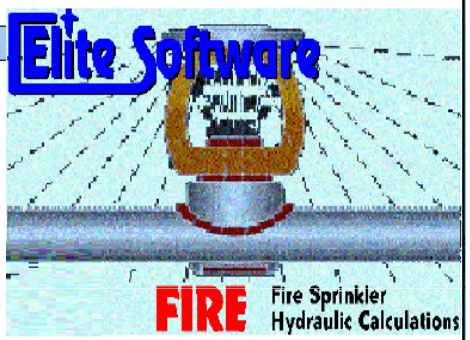
The program outputs are according to NFPA 13 instructions and recommendations, like output report of project, graphs, information.



General Project Data Report

General Data

Project Title:	ALGALALA HOTEL	Project File Name:	HOTEL.fiw
Designed By:	Eng.Karim Kishar	Date:	October 24, 2019
Code Reference:		Approving Agency:	
Client Name:	ARMED FORCE	Phone:	
Address:		City, State Zip Code:	
Company Name:	GID	Representative:	
Company Address:		City And State:	
Phone:			
Building Name:	ALGALALA HOTEL	Building Owner:	ARMED FORCE
Contact at Building:		Phone at Building:	
Address Of Building:		City, State Zip Code:	



Project Data

Description Of Hazard: Light Hazard

Sprinkler System Type: Wet

Overall Network Summary General Report

Number Of Unique Pipe Sections:	28	
Number Of Flowing Sprinklers:	12	
Pipe System Water Volume:	1066.14	gal
Sprinkler Flow:	364.69	gpm
Non-Sprinkler Flow:	500.00	gpm
Minimum Required Residual Pressure At System Inflow Node:	132.05	psi
Demand Flow At System Inflow Node:	864.69	gpm