Lecture 7: Fire Detection & Alarm Design

7.0 Introduction

Fire detection and alarm systems are designed to provide warning to the outbreak of fire thus allowing evacuation and appropriate firefighting action to be taken before the situation gets out of control.

When designing a fire detection and alarm system, in addition to deciding the type of system, detectors, call points and sounders to be used etc. Other aspects to be considered include:

- Measures to limit false and unwanted alarms.
- Method of installation.
- Materials required during installation.
- User training.
- Routine maintenance procedures and service agreement.
- ✓ As a rule, conventional systems are appropriate only in buildings of limited size and complexity, where a simple indication of the zone in which there is a fire will be sufficient. In other buildings, an indication of the exact location of the detector's that has responded to a fire, provided by an addressable system, will be of value.

A fire alarm and detection system includes the following system components:

- Manual call points
- Smoke detectors
- Duct smoke detectors
- Fixed temperature heat detectors
- Rate of rise heat detectors
- Fire gas detectors
- Indicating devices
- Indicating appliances-i.e. LED beacons
- Fire alarm control panel (FACP)
- Sounders
- Remote indicators
- Beam detectors.

7.1 Some definitions.

Alarm signal: Signifies a state of emergency requiring immediate action. Pertains to signals from operation of an alarm-initiating device.

Notification appliance: A bell, horn, chime, flashing strobe or combination thereof.

Supervisory signal: Indicates abnormal status or need for action regarding fire suppression or other protective system.

Alarm or trouble signal: Indicates that a fault, such as an open circuit or ground, has occurred in indicating appliance circuit, initiating device circuit, or internal to FACP.

Zone: Initiating device or combination of devices connected to a single alarm-imitating device circuit.

Main FACP: This is an analog addressable fire alarm or conventional fire alarm panel located at 24 hour/day guard/main entrance area and is responsible for protecting primary building and monitoring all sub- FACP's, and communicating selected zone information with slave FACP.

Slave FACP: An independent conventional hard-wired fire alarm system that protects a designated area within primary building. Slave FACP exchanges selected zone information with main FACP. Main FACP maintains certain control aspects over the slave FACP such as, resetting slave indicating appliances after main FACP imitation.

Sub-FACP: A stand-alone fire alarm system that may be conventional or analogue addressable microprocessor fire alarm system. Microprocessor based systems generally have the ability to communicate to the main fire alarm system via a communication network. Typically, a sub FACP protects an out-building such as a generator house or pump house.

Communication Center: An enclosure, room or series of rooms housing electrical electronic communications equipment and systems important to government department fire safety and hazard control division i.e. city council/urban council fire brigade, and police.

7.2 Choice of Detectors

Smoke Detectors will generally detect a fire far sooner than heat detectors. It is therefore preferable to fit Smoke Detectors unless there is any possibility of false or unwanted alarms. It is not advisable for example to fit a Smoke Detector in a kitchen, as anybody burning toast would cause an unwanted alarm. Heat Detectors should be fitted in boiler rooms, generator rooms, garages and dusty areas. The products of combustion produced by a boiler, a leaky exhaust on a generator or exhaust fumes from a vehicle could all cause a smoke detector to operate and produce an unwanted alarm.

Fixed Temperature Heat Detectors should be installed in areas where one would normally expect a sudden rise in temperature for instance kitchens and boiler rooms.

Rate of Rise Heat Detectors should be installed where Smoke Detectors would be unsuitable but one would not expect a sudden rise in temperature for instance, garages, car parks, dusty.

Types of Smoke Detectors:

- Multisensor
- High Performance Optical Smoke Detector
- Optical Smoke Detector
- Infra–Red Flame Detector
- Optical Beam Detector
- Aspirating Detector
- Linear Heat Detector
- Duct Probe Unit

As each type of detector responds to a particular fire product, the relative speed of response of the detectors is therefore dependent upon the type of fire being detected.

As smoke is normally present at an early stage in most fires, smoke detectors (Ion Chamber, Optical, High Performance Optical or Multi-sensor) are considered the most useful type available for giving early warning.

Most fires, in their later stages, emit detectable levels of heat. Therefore in areas where rapid fire spread is unlikely and environmental conditions preclude the use of smoke detectors, heat detectors (Rate of Rise or Fixed Temperature) are a general purpose alternative, but these should not be used in the escape routes of a Category L system.

Fires tend to produce carbon monoxide, particularly in situations in which there is insufficient ventilation to enable fire to burn rapidly. Accordingly, carbon monoxide fire detectors provide useful warning of such fires. The carbon monoxide fire detector is well suited to provide early warning of slow smoldering fires. Slowly developing and smoldering fires produce large quantities of carbon monoxide before detectable smoke aerosols and particulates reach smoke detectors in sufficient quantities to detect the fire. These detectors can often be used in applications in which heat detectors are insufficiently sensitive, but smoke detectors may cause false alarms from sources such as steam from a shower or smoke from burnt toast.

In situations where a burning liquid, for example alcohol, paint thinner, etc. is likely to be the prime source of a fire, and flame is most likely to be the first indication a fire has started, then an Infra–Red Flame detector should be incorporated into the system.

Although heat, smoke and carbon monoxide detectors are suitable for use inside most buildings, flame detectors may be used to supplement these where necessary. Flame detectors need an unobstructed line of sight, their greatest use being for such special applications as the supervision of an outdoor storage area or an area where petro–chemical processes are taking place, for example offshore oil platforms. Infrared flame detection can also be used to protect very high spaces, such as cathedrals, where the height is such that point smoke detectors cannot be used.

Enclosed stairways should have a detector on the top of the stairway and on each main landing.

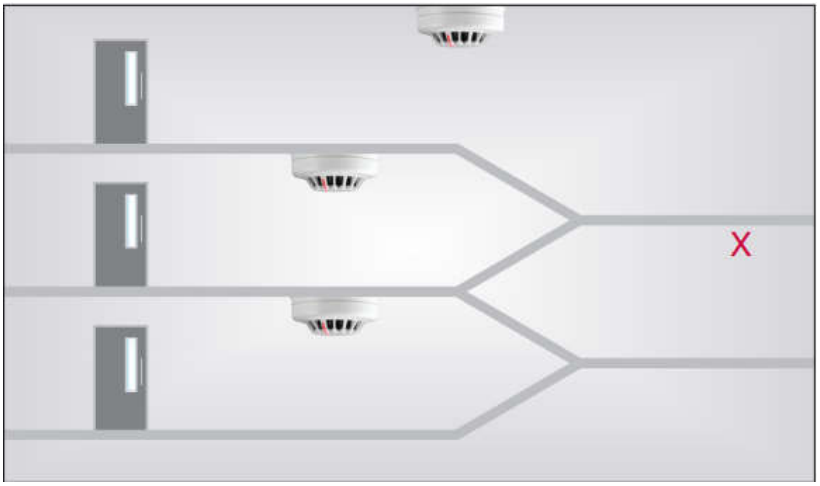

Figure 7.1: Smoke detectors.

7.3 Smoke Detector Spacing.

Spacing under Flat Ceilings.

In open spaces under flat horizontal ceilings, every point should lie within a horizontal distance of 7.5m from a smoke detector or 5.3 m from a heat detector.

This means that at least one detector must cover each point within the protected area; the coverage of a detector is a circle centered on the detector and having a radius of 7.5m for smoke detectors and 5.3 m for heat detectors. For beam detectors, the horizontal distance should be taken to the nearest point on the infrared light beam, and the coverage should be taken as extending to that distance on both sides of the centerline of the beam.

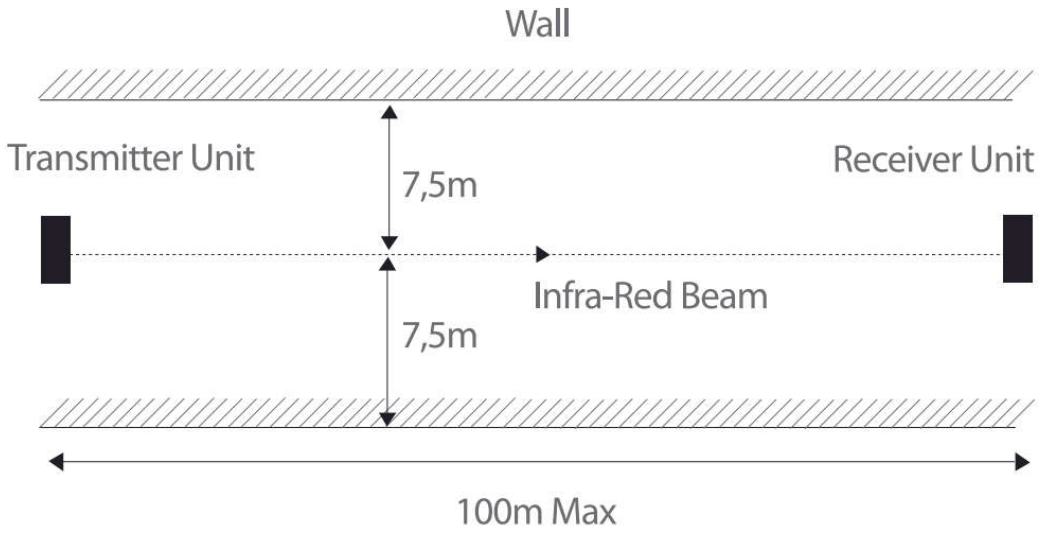

Figure 7.2: Spacing under Flat Ceilings.

The sensitive elements of smoke detectors should normally lie within the range of 25mm to 600mm from the ceiling, and for heat detectors within the range of 25mm to 150mm.

Stairways:

In enclosed stairways, fire detectors should be sited at the top of the stairway and on each main landing.

An open stairway forms a path for vertical spread of smoke and fire. It is desirable to detect products of combustion before they pass up the stairway and as they pass out of the stairway. For this reason, a fire detector should be sited at the top and, on each level, within approximately 1.5m of the floor penetration.

Corridors.

In corridors, the number of detectors required depends on the corridor width.

Obstructions.

Ceiling obstructions, such as structural beams, deeper than 10% of the overall ceiling height should be treated as walls. The area on each side of the obstruction should, therefore, be regarded as a separate area for the purpose of protection. The same applies in the case of partitions or storage racks that extend within 300mm of the ceiling.

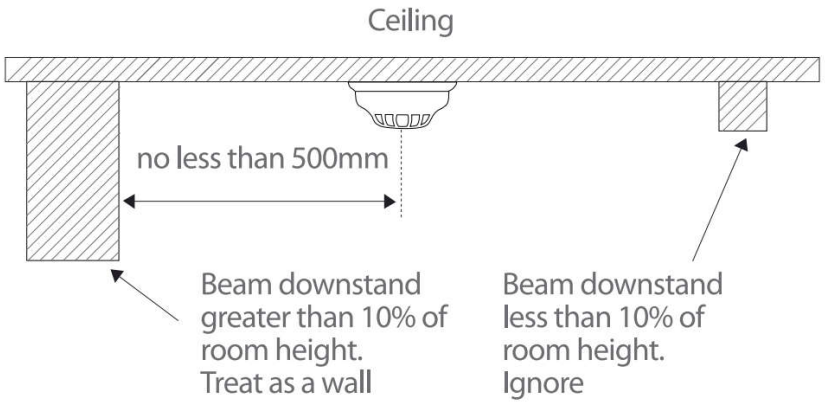

Figure 7.3: Spacing under obstructions.

Where structural beams, ductwork, lighting fittings or other fixings to ceilings, not greater than 250mm in depth, create obstacles to the flow of smoke, detectors should not be mounted closer to the obstruction than twice the depth of the obstruction.

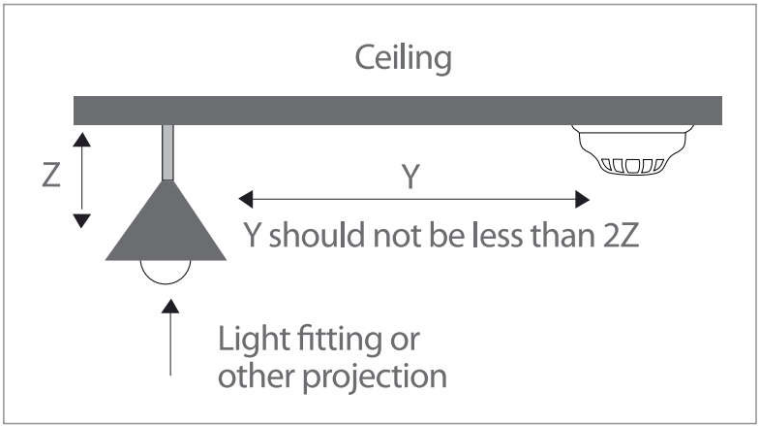

Figure 7.4: Spacing under obstructions.

Ventilation

Ventilation systems in buildings should also be taken into account when designing fire systems because air movements in a space can have a number of effects on the operation of the devices.

Extraction systems can draw the fire products away from normally sited detectors, and fresh air inlets can stop clean air passing over detectors even when the room air is smoky. Increased air turbulence can give increased dilution of the smoke, and, in the case of ionization smoke detectors, clean air can cause a false alarm if it is moving fast enough.

Detectors should not be mounted directly in the fresh air input from air conditioning systems. In general, a spacing of not less than 1m between the detector and the air inlet should be maintained. Where the air inlet is through a perforated ceiling, the ceiling should be non-perforated for a radius of at least 600mm around each detector.

7.4 Control Equipment

The Fire Alarm Control Equipment should normally be sited in an area as follows:

- Preferably in an area of low fire risk and on the ground floor by the entrance used by the Fire Brigade and preferably viewable from outside of the building.
- It should be located in an area common to all building users and where automatic detection is in use, the Control Panel should be in a protected area.
- An alarm sounder should be sited next to the Control Unit, but not too near the telephone position.

7.5 Sounders and strobes

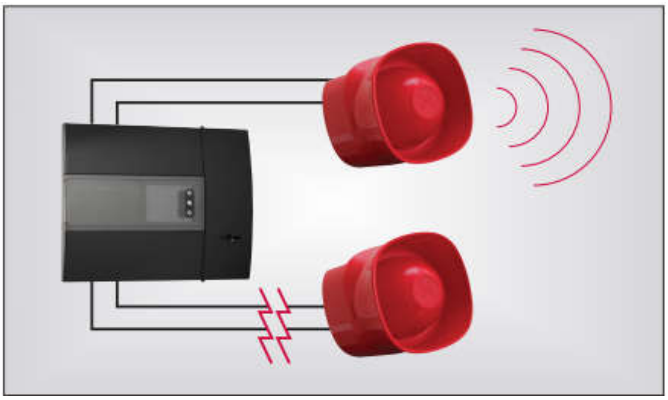

Figure 7.5: Sounders and strobes.

Sounders and strobes are generally provided for systems designed to protect life. However, on the rare occasion when only the property is being protected it is still essential to mount a sounder adjacent to the fire control panel as well as immediately outside the main entrance for the fire fighters.
Before deciding on the number and location of sounder/visual, alarms it is important to establish what the 'Fire Plan' or cause and effect will be.
If the building is not going to have a one 'out all' out arrangement the evacuation procedures must be established Once this is known you can then establish the alarm zone areas where different alarm messages may be given for example an alert or an evacuation tone.

Sounder device cabling should be arranged so that in the event of a fault, at least one sounder located within the vicinity of the control and indicating panel will remain in operation.

Visual alarms such as beacons should always be mounted at a minimum height of 2.1m from floor level, in a position that is likely to attract attention.

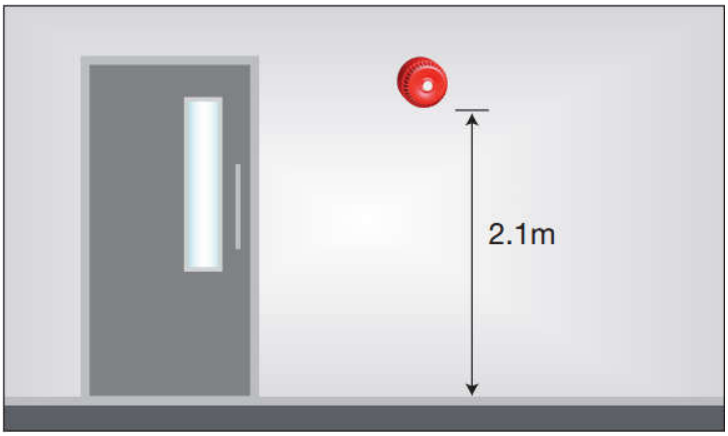

Figure 7.6: Sounders and strobes.

7.6 Level of Protection/ System Category

Systems designed for Protection of Property only, fall into two classifications P1 or P2.

The objective of a Category P1 is to provide the earliest possible warning of a fire to minimize the time between ignition and the arrival of the fire fighters.

P1 is designed to protect the whole building whilst P2 is installed in defined parts of the building only, which may have an extraordinary high risk or hazard.

Life protection on the other hand will often depend on the number of people accessing a particular building and depending on the variations; the systems can range from simple Type M to L1 categories, these being detailed in the diagrams on this page.

A **Category M** system requires manual call points on all exits as well as corridors where persons are not expected to walk more than 45m.

Category L5, designed for buildings that have a particular risk identified which warrants some special attention. For example if there is an area of high risk which is considered worthy of having some automatic detection but a manual system is also needed, then this will be termed as L5/M.

Category L4 provides detection within the escape routes only, whereas L3 not only covers these areas but all rooms leading onto the escape route. The reasoning behind this is to alert people of the danger prior to the corridor becoming "Smoke logged" so people can escape safely.

L2 is a further enhancement of protection with all the areas covered by an L3 category as well as all high-risk areas such as boiler rooms etc.

L1 provides protection throughout the building, and where Property Protection is the prime reason for the system (this allows for a choice between the P1 or P2 categories). M**L5L4L3L2L1**

7.8 Cabling Considerations

Correct operation of a fire alarm system depends on the interconnections between the control equipment, detectors, call points and sounders. Unless these interconnections operate correctly when required, the system will not fulfil its intended functions. Cables connect the components of most fire detection and alarm systems. For specialized applications where cabling cannot be used, fiber optics and/or radio links are used.

When selecting cables for a fire alarm system due consideration should be given to the following:

1. Resistance to fire

2. Current carrying capacity.

3. Voltage drop under maximum current conditions.

4. Insulation characteristics.

5. Mechanical robustness, resistance to corrosion and rodent attack, etc.

6. Screening (where applicable).

7. Suitability for carrying data (where applicable).

All cables used in fire detection and alarm systems (including those serving the mains supply to the system) must be fire resisting.

7.9 Communication with the Fire Service

When a fire occurs in an occupied building, the most important initial action is to provide a warning to all occupants. However, the immediate summoning of the fire service is also important. Accordingly, clause 15 of BS 5839-1 is concerned purely with communication with the fire service.

The code recommends that, in occupied buildings, the primary means of summoning the fire service should always comprise a call to the fire service by occupants using the public emergency call system. This manually dialed call will usually be sufficient in the case of a Category M system, since, by definition, there must be occupants in the building in order for the alarm to be raised.

Equally, even if there is a means for transmitting alarm signals automatically to an alarm-receiving center (ARC), from where the fire brigade are then summoned, if the building is occupied a manually dialed emergency call to the fire service should still be made. In some areas of the country, this manually dialed call has an additional benefit, as some fire brigades dispatch more fire appliances to a confirmed fire than to a call from an ARC.