



Overview of Fire Alarm and Detection Systems

An Online Continuing Education Course for Engineers

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Overview of Fire Alarm and Detection Systems

A. Bhatia, Mechanical Engineer

In order to undertake the process of designing a fire system for a building, it is necessary to have a sound understanding of the relevant design standards, the legal framework surrounding building safety legislation, and a sound working knowledge of product application theory. The following system design process is intended to give a reasonable overview of all the areas of knowledge required for the successful design of a fire alarm system. Due to the complex nature of legislation and design standards relating to fire alarm system design, this course is not intended to be a comprehensive to all aspects of fire alarm design but rather a very useful source of background information to which further application-specific detailed information can be added from other sources as required.

Why have a fire alarm system?

The answer to this question depends on the premises in question and the legal requirements. Your local fire marshal may require a fire alarm system based upon the occupancy of the building. Generally, the legal requirement for a fire alarm system relates to the protection of life. In general fire alarm systems are installed to:

1. To provide for the safety of occupants in buildings, and to make provision for their evacuation or refuge during a fire or other emergency.
2. To provide the fire department with early notification of a fire in a building and to direct them to the area of risk
3. To reduce the loss of property. The property may have considerable intrinsic value and the insurers either require a fire detection system or may incentivize its use.
4. To reduce building damage. The building may be unoccupied for periods where equipment is still powered and the owner wishes to ensure that if anything goes wrong fire department is called to the scene in a timely manner. Sometimes fire detection and alarm systems are used to compensate for structural fire protection shortcomings or to give special cover for items of high value.

5. To reduce the amount of business lost
6. Minimize risk to the public who attend unfamiliar properties. It is often a mandatory requirement by the Building Codes.

Whatever the reason, automatic fire detection and alarm system generally provide a network of manual call points, heat, and smoke detectors, alarm warning devices over the area covered. Once activated, the devices send signals to the fire alarm panel, which in turn activates audio and visual devices, including lights and sounders. The system may also send its signal to an off-site monitoring station.

RISK ASSESSMENT

The first step in the design process is the risk assessment. It underpins the whole system strategy and, therefore, could be argued as being the most important stage. Risk assessment is the process of considering each part of a building from the point of view of what fire hazards exist within an area and what would happen in the event of fire or if an explosion were to occur. This would normally be done when considering the building from the point of view of general safety. Clearly, very small premises only require a first level of fire protection, such as safe construction, clear escape routes, and a fire extinguisher. Equally obvious, large hotels will require a fully automatic fire detection and alarm system, multiple sets of fire protection equipment, and adequate emergency lighting and escape signage. The Risk Assessment process is to help building owners of buildings between these two extremes make adequate and appropriate provision.

Building owners or operators will often want to employ the services of a professional risk assessor to ensure that the building is considered impartially and in adequate detail. However, there are checklists and technical advice available so that the task can be done 'in-house.'

CONSULT WITH ALL INTERESTED PARTIES

Before embarking on a detailed design, it is highly recommended as a minimum to consult the following agencies so as to ensure that the fire detection and alarm system meets the requirements of all concerned.

1. The authority responsible for enforcing health and safety legislation
2. The property insurer

3. The building user (where appropriate)
4. The proposed installer
5. Fire engineering specialists (where appropriate)

DESIGN PROCESS

A fire alarm system should be designed to provide early detection and warning of a fire. The designer must consider the size, complexity, and use of the building, and the degree of detection and warning desired. While the design of fire alarm systems is normally regulated by building codes, the level of protection specified is usually a minimum, and the designer should consider providing higher levels of protection where circumstances indicate the need. Before looking at the details of the alarm system, it is necessary to understand some of the concepts that are used to assist the system designer. Buildings are divided up into sections in three ways as far as fire safety engineering is concerned; fire compartments, detection zones, and alarm zones.

Review of the Building

1. Review the physical properties of the building
 - Building height?
 - Number of floors?
 - Area of each floor?
 - Smoke compartments?
 - Sprinklers?
2. What fire alarm equipment is required in this occupancy?
3. Where are fire alarm devices required?
4. Determine if there is a special use or occupancy (refer Model Building Code - Chapter 4 and Life Safety Code - Chapter 11)

Fire Compartments

A fire compartment is a part of a building that is separated from the rest of the building by a fire-resistant structure so as to limit the spread of fire within the building. The requirements for

designing a building and hence its fire compartments are defined in building regulations. It is necessary, however, for the designer of fire detection and alarm system to be familiar with the design of the building, in particular the position and extent of its fire compartments.

Detection Zones

Fire detection zones are essentially a convenient way of dividing up a building to assist in quickly locating the position of a fire. The zone boundaries are not physical features of the building, although it is normal to make the zone boundary coincide with walls, floors, and specifically fire compartments. The size and position of the detection zones will, therefore, tend to be dependant on the shape of the buildings, but will also depend on what the building is used for and to some extent the number of people the building is expected to contain at any one time. Some specific recommendations with respect to detection zones are:

1. Zones should be restricted to single floors, except where the total floor area of a building is less than 3000 ft²
2. Voids above or below the floor area of a room may be included in the same zone as the room so long as they are both in the same fire compartment.
3. Zones should not be larger than 20000 ft² except for manual systems in single story open plan buildings, such as a warehouse, where up to 100000 ft² is allowed.
4. Fire detectors in an enclosed stairwell, lift shaft, or the like should be considered as a separate zone.
5. The search distance within a zone should be less than 300ft in any direction (all possible entrance points must be considered). This can be relaxed when using addressable systems if the information provided at the control and indicating equipment would allow firefighters, unfamiliar with the building, to proceed directly to the location of the fire. The search distance only relates to the distance from entering a zone to being able to determine the location of the fire. It is not necessary to travel to the fire.
6. Zones should not crossfire compartments, *a fire compartment can contain several zones, but a zone should not contain more than one fire compartment.*

Alarm Zones

Alarm zones are only needed in buildings where the operation of the alarms needs to be different in certain parts of the buildings. If the only requirement is to activate all the alarm sounders to provide a single common evacuate signal once a fire is detected, then alarm zones are not needed, the whole building is one alarm zone.

For more complex buildings where it is necessary to operate alarm devices differently in parts of the building, then the building should be divided into alarm zones such that all of the alarm devices in one alarm zone operate in the same way.

Here are some recommendations for alarm zones:

1. The boundaries of all alarm zones should comprise fire-resisting construction
2. Signal overlap between alarm zones should not cause confusion
3. The same alarm and alert signals should be used throughout a building
4. A detection zone must not contain multiple alarm zones, alarm and detection zone boundaries should coincide. An alarm zone may contain multiple detection zones.

Once the building zones and fire alarm requirements are determined, install per the applicable standards.

RELEVANT STANDARDS

The design, installation, and testing of the fire detection and alarm system shall comply with all state and local codes with no exception. Standards produced by agencies such as Underwriters Laboratories (UL) and/or Approved by Factory Mutual (FM) and National Fire Protection Association (NFPA) are generally endorsed by relevant building codes. Often these standards are called up within guidance documents for pieces of legislation, and since they represent best current practice, they can be generally be used by building owners to demonstrate that equipment they have installed is adequate and appropriate. Fire alarm system requirements are found in:

- NFPA 72, National Fire Alarm Code
- NFPA 101, Life Safety Code
- Model Building Codes

NFPA 72 was written to provide requirements for the installation, performance, testing, inspection, and maintenance of the fire alarm system. If you want to know if a fire alarm system is required for a given occupancy, then NFPA 101, Life Safety Code and other related codes (building codes) make that determination.

The following organizations issue guidelines and standards that relate to the USA, and other countries will have their own standards.

NFPA Codes and Standards

NFPA publishes standards for the proper application, installation, and maintenance of automatic smoke detectors. The principal codes which should be reviewed before specifying or installing automatic smoke detectors are listed below:

NFPA publishes codes and standards concerning all phases of fire protection. Among those which directly concern automatic smoke detectors are:

1. NFPA 70 National Electrical Code
 - Article 210, Branch Circuits
 - Article 760, Fire Protective Signaling Systems
 - Article 500, Hazardous Areas
 2. NFPA 72 National Fire Alarm and Signaling Code
 3. NFPA 72 code requirements for the installation, performance, testing, and maintenance of fire alarm systems
 4. NFPA 90A Standard for the Control of Smoke and Heat in Buildings
 5. NFPA 92A Standard for the Control of Smoke and Heat in Buildings
 6. NFPA 101 Life Safety Code
- NFPA 101 specifies requirements for fire alarm systems in new and existing buildings dependent on occupancy, building height, and area.
- NFPA 90A and 92A specify requirements for smoke and heat detectors in ducts of HVAC systems and smoke exhaust systems.

