# INDUSTRIAL FIRE PROTECTION

*H. A. D. P. Mervyn Gunasekera, BSc.(Eng), C.Eng, MICE, MASCE, MIE (SL).*

## 1. Introduction

Fire safety for an industrial project should be considered at the planning and designing stage of the project. To design and install fire detection and suppression systems after completion of a project or during its construction stage will be very costly. Moreover, loss prevention or fire risk management has become more difficult and more complex in the modern industrial world. The following are a few of the reasons for that :

* Increased production of old and new products has created the need for new production processes and procedures. Many of the up dated methods involve more extensive use of combustible and hazardous chemicals than before.
* The increased storage needs of both raw materials and finished products has resulted in storage being piled higher and higher.
* The need for electricity requires larger power generating units.
* Very expensive computers and other equipment, as well as valuable record storage, is common and will increase (this requires more expensive fire detection and suppression systems in order to minimize the damage in case of fire).
* As space becomes more scarce (costly) the number of employees working in congested areas will increase.

However, available new technology, new inventions relating to fire protection and continued research in the fire field has helped designers to select more reliable and dependable fire detection and suppression systems.

In this article the writer will briefly discuss a few basic safety requirements to be considered during the design stage of industrial facilities. Some of the most common fire protection systems that are used in industrialized nations will also be discussed. However, discussion of protective signalling systems such as fire alarm boxes and heat, smoke and flame detectors is not within the scope of this article.

## 2. Design Features

The designer's prime responsibility is to provide the client with the most economical structure that will suit the needs of the intended occupancy. A part of this responsibility is to explore methods of protecting lives and the structure from fire. He also owes it to his client to research the most practical and economical way of doing this.

The following listed items are only some of those a designer should consider when researching for the proper protection system :

* Type of occupancy
* Building construction
* Floor areas
* Mean of egress
* Building set-back and neighbouring occupancies
* Reliability of private and public water supplies
* Cost of the fire protection system

### 2.1 Type of Occupancy

Occupancy is the purpose for which a building, or part thereof, is used or intended to be used. Therefore, the type of occupancy is one of the most important factors that has to be considered in fire protection planning. Special consideration is given to the following aspects :

* The number of people who will occupy the building, their activities and location within the building.
* Industrial processes, raw materials, products.
* Type and severity of fire that might occur in the building.

### 2.2 Building Construction Materials

Building construction is generally one of 4 types or a combination of these four types.

* Wood frame construction (all combustible).
* Ordinary masonry construction (walls are generally masonry, floors and roof are combustible materials).
* Non-combustible (the walls and roofs are non-combustible, an example is an all steel building).
* Fire resistive (the building walls and roofs will contain a fire for a period of 3 hours or more).

Combustibility and fire rating of construction mater rials (structural members, floors, exterior and interior walls, windows, doors, staircases, ceiling, roofs and

finishing work etc.) and internal decorative work will affect the fire safety planning. In addition to that it is very important for fire fighters to know the structural stability of a building when on fire. In other words how long will a burning structure last without collapsing. The fire department's tactics and strategy can be conceived and the attack organized accordingly in the event of fire.

### 2.3 Floor Areas

Modern building codes specify acceptable floor areas for different types of construction, and for different types of occupancies. Generally the floor areas can be enlarged with the addition of fire suppression systems.

### 2.4 Mean of Egress

The National Fire Protection Association (hereafter referred to as NFPA Life Safety Code) provides invaluable guidelines for arrangements of means of egress and number of exits required for all occupancies. When deciding how many exits there should be in a building one of the most important factors to consider is the maximum distance a person must travel to get to an exit. This travel distance in general will not exceed 100 ft, except when the building is completely protected by an automatic fire sprinkler system. For such buildings the travel distance is increased to 150 ft. Regardless of size, every high hazard building must have at least two (2) separate and remote exits with a maximum of 75 ft travel distance to an exit.

### 2.5 Building Set-Backs and Neighbouring Occupancies

Usually, a city building code regulation specifies certain minimum distances from property lines, roads to buildings and storage areas. In general, all buildings and storage areas are located away from all boundary lines mainly for safety reasons.

The set-back from the property line to the building will provide the following :

* Access for fire vehicles and working space for fire fighters, should a fire occur.
* Ease of evacuation.
* Fire gap for protection of neighbouring properties.

It is very important for designers to know the fire exposures from surrounding properties prior to preparing the layout of a proposed facility. For example, if oil installations, petrol stations, chemical factories or the like are located nearby, then they will affect the fire protection plan of the proposed facility.

### 2.6 Reliability of Water Supplies

Water is the agent most commonly used to extinguish fires. Designers must therefore know what water sources are available. For example, if a factory is located within city limits, there will probably be a municipal water supply available. If not, then a private water system may have to be installed to supply fire fighting water. Aspects of the water supply that a designer should investigate are :

* Is water system available?
* If available, will the water supply provide adequate volume and pressure for brigade use or for a fire suppression system.
* How reliable is the available water supply system (e.g. if the electricity goes off are there other methods of maintaining water pressure and flow?)
* What about times of drought?
* Is a secondary supply available?

If, after considering the above mentioned aspects, the designer in anyway doubts the integrity and reliability of the water supply he should give consideration to installing additional fire pumps and on site storage etc.

### 2.7 Cost of the Fire Protection System

This item is listed last, however, in the real world it is usually the first thing on the client's (owner's) mind. For most people fire is something that only happens to others. Fire protection systems are like everything else in a building, it must be shown to the client that they will pay for themselves. There are many ways in which this can be explained. In most countries where large investments are made they must be insured. Most insurance companies recognize the advantages of fire protection systems and allow premium credit, some as much as 75 percent. Another way is to demonstrate how cheaper construction can be used and areas can be larger if protected by automatic fire protection systems. Time lost as a result of fire will be minimized. Last, but definitely not the least of the considerations, is the danger to life as a result of fire.

## 3. Fire Protection Systems

The following sections will briefly discuss (with reference to the NFPA Standards) some of the most common fire protection systems employed in industrial facilities.

### 3.1 Portable Fire Extinguishers

At the start, most fires are relatively small and could be easily extinguished in their incipient stage, provided the proper type of extinguishing agents in adequate quantities are readily available and can promptly be applied. Portable fire extinguishers are designed to fulfil this need.

To specify an extinguisher the designer needs to assess the likely nature of a fire at each location. Extinguishers must therefore, be specified according to the type, size and intensity of the fire that might be encountered at a particular location.

The NFPA extinguisher standards divides fires into the following four classes in order to show the proper extinguishers to be used :

Class A : Fires involving ordinary combustible materials, such as wood, cloth, paper, rubber and plastics.

Class B : Fires involving inflammable liquids, oils, greases, oil base paints, lacquers and flammable gases.

Class C : Fires which involve energized electrical equipment where the electrical non-conductibility of the extinguishing media is of importance (when electrical equipment is de-energized extinguishers for Class A or B fires may be used safely).

Class D : Fires involving combustible metals, such as magnesium, titanium, zinconium, sodium, lithium and potassium.

Fire extinguishers are labelled with the letters A, B, C, or D indicating the classes of fire in which they should be used. In some cases fire extinguishers can be used on more than one class of fire. For example the A.B.C. or multi purpose dry powder extinguisher, is suitable for 3 classes of fire. However, it must always be remembered that a multi purpose extinguisher will be better on one type than on others. For instance, the best extinguishing agent for a class "A" fire is water, for although dry powder will work it is not as effective as water since the powder has no cooling power but only cuts off the oxygen.

#### 3.1.1 Distribution of Fire Extinguishers

One of the questions that is frequently asked is, how many extinguishers are needed and where should they be located? The answer is dependent upon the nature of the hazards and the general layout of the building.

The size and type of hazard determines how many extinguishers are needed.

In general fire extinguisher location should be selected so as to :

* provide uniform distribution of extinguishers throughout the building.
* provide easy accessibility.
* be relatively free from obstruction by stored goods and equipment.
* be close to the normal path of travel.
* be near entrance and exit doors.
* be free from potential physical damage.
* be readily visible.

The tables 1 and 2 are a guide for determining the minimum number and rating of extinguishers for Class A and B fires.

Class C fires are usually either Class A or B fires involving energized electrical wiring and equipment.

Extinguishing equipment for Class D fires should be located no more than 75 ft. from Class D hazards.

### 3.2 Standpipe and Hose Systems

A standpipe and hose system is an arrangement of pipes and hose outlets providing a means for manual application of water to fires in buildings.

TABLE 1

**Fire Extinguisher Size and Placement for Class A Hazards**

| *Basic Minimum Extinguisher Rating for Area Specified* | *Maximum Travel Distances to Extinguishers* | *Areas to be Protected per Extinguisher* | | |
|---|---|---|---|---|
| | | *Light Hazard Occupancy** | *Ordinary Hazard Occupancy* | *Extra Hazard Occupancy* |
| 1 A | 75 ft | 3,000 sq ft | † | † |
| 2 A | 75 ft | 6,000 sq ft | 3,000 sq ft | † |
| 3 A | 75 ft | 9,000 sq ft | 4,500 sq ft | 3,000 sq ft |
| 4 A | 75 ft | 11,250 sq ft | 6,000 sq ft | 4,000 sq ft |
| 6 A | 75 ft | 11,250 sq ft | 9,000 sq ft | 6,000 sq ft |
| 10 A | 75 ft | 11,250 sq ft* | 11,250 sq ft* | 9,000 sq ft* |
| 20 A | 75 ft | 11,250 sq ft* | 11,250 sq ft* | 11,250 sq ft* |
| 40 A | 75 ft | 11,250 sq ft* | 11,250 sq ft* | 11,250 sq ft* |

*11,250 sq ft is considered a practical limit.

† Protection requirements may be fulfilled by several extinguishers of the minimum specified rating with the approval of the authority having jurisdiction.

(FROM NFPA FIRE PROTECTION HANDBOOK)

TABLE 2

**Fire Extinguisher Size and Placement for Class B Hazard Excluding Protection of Deep Layer Flammable Liquid Tanks**

*A. FOR EXTINGUISHERS LABELLED BETWEEN 1955 AND JUNE, 1969*

| *Type of Hazard* | *Basic Minimum Extinguisher Rating* | *Maximum Travel Distance to Extinguishers* |
|---|---|---|
| Light .. .. | 4 B | 50 ft |
| Ordinary .. .. | 8 B | 50 ft |
| Extra .. .. | 12 B | 50 ft |

*B. FOR EXTINGUISHERS LABELLED AFTER JUNE 1, 1969*

| *Type of Hazard* | *Basic Minimum Extinguisher Rating* | *Maximum Travel Distance to Extinguishers* |
|---|---|---|
| Light .. .. | 5 B | 30 ft |
| | 10 B | 30 ft |
| Ordinary .. .. | 10 B | 30 ft |
| | 20 B | 50 ft |
| Extra .. .. | 20 B | 30 ft |
| | 40 B | 50 ft |

**(FROM NFPA FIRE PROTECTION HANDBOOK)**

*Note.*—Fire extinguisher ratings (ex. 1-A, 4-A) given in the tables (1, 2) are standard NFPA ratings which are based on tests carried out by the Underwriters Laboratories for the purpose of evaluating fire extinguisher performance.

### 3.2.1 Types of Systems

Depending on the situation, the following standpipe systems are commonly used in industrial premises :

* Wet standpipe system with the supply valve open and water pressure maintained at all times. This is the most commonly used and desirable type of system.
* Standpipe system so arranged through the use of approved devices as to admit water to the system automatically by opening a hose valve.
* Standpipe system arranged to admit water to the system through manual operation of a remote control device located at each hose station.
* Dry standpipe system having no permanent water supply, but with connections and shut-off valves for Fire Department hose and equipment connection.

### 3.2.2 Water Supply for Standpipe System

The water supply for standpipe system depends on the size, number of hose streams and the required throw of these streams. Standpipes other than dry standpipes shall have a reliable water supply. Acceptable water supplies include the following :

* Municipal water system (if available), with adequate pressure.
* Automatic fire pumps.
* Manually controlled fire pumps with pressure tanks.
* Pressure tanks.
* Gravity tanks.
* Manually controlled fire pumps operated by remote control devices which are located at each fire hose station.

### 3.3 Sprinkler Systems

There are situations where fire cannot be reached with hose streams. In addition to that, fire extinguishers and hose streams have very little value unless a fire is discovered in its early stage. Although fire control can be achieved by improving building construction, the automatic sprinkler system is the system which can be reliably depended upon for earlier fire detection and subsequent complete extinguishing or at least prevention of spreading.

### 3.3.1 Sprinkler System Operation

The automatic sprinkler system is a system which is activated by heat from a fire and will then discharge water over the fire area. In any sprinklered building, the most readily identifiable part of the system is the sprinkler head, which is the point where water is discharged onto the fire. Sprinkler heads are equipped with deflectors, to provide a uniform discharge pattern. Water for the sprinkler system must be taken from a reliable source such as a city main, a gravity feed link or other storage device. The water passes through a sprinkler control valve and water flow alarm and then through piping which distributes it to the individual sprinkler head.

### 3.3.2 Classification of Occupancies

For the purpose of evaluating hazards, the following three main classifications are recognized by the NFPA Sprinkler Standard :

#### 3.3.2.1 Light Hazard Occupancies

Occupancies where the quantity and/or combustibility of materials is low and where fires have a relatively low rate of heat release. Examples are education facilities, public buildings, offices (including Data Processing Installations) and commercial facilities.

#### 3.3.2.2 Ordinary Hazard Occupancies

This class is divided into three groups :

Group 1 : This group covers occupancies where combustibility is low, the quantity of combustibles is moderate, stock piles of combustibles do not exceed 8 ft. in height and potential fires have moderate rates of heat release (examples are canneries, laundries and electronic plants).

Group 2 : Occupancies where the quantity and/or combustibility of the contents is moderate, stock piles do not exceed 12 ft. in height and potential fires have moderate rates of heat release (examples are cereal mills, textile plants, printing and publishing plants and shoe factories).

Group 3 : Occupancies where the quantity and/or combustibility of the contents is high and potential fires have high rates of heat release. (examples are paper manufacturing and storage warehousing).

#### 3.3.2.3 Extra Hazard Occupancies

Occupancies where the quantity and/or combustibility of materials is very high (examples are chemical processing or manufacturing explosives and pyrotechnics manufacturing, and woodworking with flammable finishing).

### 3.3.3 Types of Sprinkler System

The following are the types of sprinkler systems commonly used for fire protection :

* **Wet-pipe System**

  This is the most common type used to protect buildings. This system consists of automatic sprinklers which are attached to a piping system filled with water and pressurized at all times. When a fire occurs, sprinklers are individually activated by the heat, and water flows through these sprinklers immediately, covering the fire endangered area (sprinklers in non-affected areas remain inactive).

**Dry-pipe System**

The dry-pipe system is often installed in buildings where the surrounding temperature would cause the water in the pipe to freeze. In this system, automatic sprinklers are attached to a pipe system which contains air or nitrogen under pressure. When the sprinklers are activated by heat the pressure is reduced, the dry valve is opened, the water displaces the pressurizing medium and then flows through the activated sprinklers.

* **Pre-action System**

  This system is very similar to the dry-pipe system, but it may or may not be under pressure. When a fire occurs, heat sensors or detectors allow the water to flow into the piping system and it is discharged through automatic sprinklers opened by the heat of the fire.

* **Deluge System**

  A deluge system will be installed in areas that are subject to high fire hazard or where rapid spread of fire is possible. This system is very similar to the pre-action system except that all sprinklers are permanently open.

### 3.3.4 Designing of Sprinkler System

NFPA provides pipe schedules to designers to be used in the design of sprinkler systems. However, for large systems, hydraulically designed systems are generally far more economical since in most cases hydraulic designs allow the use of substantially smaller pipe diameters. For small application, systems sized according to the regular pipe schedule are more suitable.

### 3.3.5 Fire Department Connection

It is always recommended to install one or more fire department connections in the supply side of the sprinkler or standpipe system. The purpose of the fire department connection is to allow the fire department to connect their pumps and pump water into the building fire protection system. This provides a desireable auxiliary supply for maintaining the required system pressure.

Fire department connection size and specifications must be identical with local fire department hose connections.

## 3.4 Special Fire Protection Systems

There are buildings (for example : computer rooms, magnetic type-storage vaults, electronic equipment and control rooms, and special storage areas for art work and books) where water cannot be used as an extinguishing agent because of possible water damage to installed equipment and valuable stored items in those buildings. Usually designers recommend carbon dioxide and halogenated (for example Halon) extinguishing systems to protect such facilities.

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