A.8.6 Part 6 : Special Fire Extinguishing Systems

CHAPTER 1
OBJECTIVE AND SCOPE

6.1 OBJECTIVE AND SCOPE

6.1.1 Objective

This standard for special fire extinguishing system in part 6 is fire extinguisher using for important area and reducing loss of fire damage. The selection of using special fire extinguishing systems for part 6 depend on advantage and disadvantage on characteristic of system, such as classification of extinguishing agents, profile of protection area, and life safety to operators in protection area, etc.

6.1.2 Scope

Scope of work and operation for special fire extinguishing systems in part 6 can be separated in performance and characteristic of extinguishing agents using in those systems. Therefore, scope of work and operation of each special fire extinguishing system shall be identified in part 6. Other special fire extinguishing systems that are not mentions in part 6 shall consult with fire extinguishing manufacturers or Engineering Institute of Thailand.

SECTION 2
CLEAN AGENT FIRE EXTINGUISHING SYSTEMS

6.2 CLEAN AGENT FIRE EXTINGUISHING SYSTEMS

6.2.1 GENERAL

6.2.1.1 Objective

The clean agent fire extinguishing system in this standard is suitable for fire extinguishing on high-priced electronic devices and area where is parts of important business, such as computer room, telecommunication control room, warehouse or valuable properties such as museum, etc. The using of clean agent shall not damage to any devices and properties.

6.2.1.2 Scope

The clean agent fire extinguishing system in this standard is total flooding system. The protection area must be good enclosure to contain the agent during the agent discharges.

6.2.2 Types of Clean Agent

The clean agent fire extinguishers use for total flooding application have two type as followings;

6.2.2.1 Halocarbon Agent. An agent that contains as primary components one or more organic compounds containing one or more of the elements fluorine, chlorine, bromine, or iodine.

6.2.2.2 Inert Gas Agent. An agent that contains as primary components one or more of the gases helium, neon, argon, or nitrogen. Inert gas agents that are blends of gases can also contain carbon dioxide as a secondary component.

The selection of agent concentration of each clean agent fire extinguisher shall consult the clean agent manufacturers. All clean agent fire extinguishers can not extinguish fire class D.

6.2.3 Personal Safety

Suitable safeguards shall be provided to ensure prompt evacuation of and prevent entry into hazardous atmospheres and also to provide means for prompt rescue of any trapped personnel. Safety items such as personnel training, warning signs, discharge alarms, self-contained breathing apparatus (SCBA), evacuation plans, and fire drills shall be considered.

6.2.4 Components of Clean Agent Fire Extinguishing System

To proper operation and using of each equipment and meet to objective of clean agent fire extinguishing system, it shall comply to following requirements;

6.2.4.1 Devices and equipment that use for operating of system shall be approved by recognized fire test laboratory.

6.2.4.2 The design, installation, maintenance and test of clean agent fire extinguishing system must carry on by expertise person only.

6.2.4.1 Properties of Clean Agent Fire Extinguisher

6.2.4.1.1 must be approved by recognized fire test laboratory and can extinguish fire in place where human operates.

6.2.4.1.2 must no harm to human life if select the proper concentration.

6.2.4.1.3 must no harm to ozone level.

6.2.4.1.4 must no damage to equipment and properties that equipped inside the protection area.

6.2.4.2 Storage containers

6.2.4.2.1 Agent storage container shall be located where it can properly access to inspection, test, and maintenance

6.2.4.2.2 Agent storage container shall be securely installed as close as possible to hazards it protect and there are good protections to container and equipment due to environmental damage and accidental damage.

6.2.4.2.3 The refill of agent for storage container must be followed the manufacturer's recommendations.

6.2.4.2.4 The information tag or label on storage container must indicate weight of agent, weight of storage container, and other important information.

6.2.4.2.5 The safety valve for releasing over pressure must be installed on storage container and

the discharge outlet of safety valve must no harm to people and area nearby.

6.2.4.3 Distribution and Pipe

6.2.4.3.1 Pipe, fitting, and valve must made from material which is strong, durable and resist an operating pressure not less than the pressure inside the storage container at least 55 °C (130 °F) of each agent.

6.2.4.3.2 Distribution pipe system and components must be clean before installation of discharge nozzle.

6.2.4.4 Discharge Nozzle

6.2.4.4.1 must be made from durable material and good corrosion resistance.

6.2.4.4.2 must clearly indicate size of orifice, manufacturer name and type of product on discharge nozzle.

6.2.4.5 Detection, Actuation and Control Systems

6.2.4.5.1 Detection, actuation, alarm, and control systems shall be installed, tested, and maintained in accordance with the latest standard of fire alarm systems of Engineering Institute of Thailand.

6.2.4.5.2 Operation control of clean agent extinguishing system must be automatic detection and automatic actuation only.

6.2.4.5.3 The supervisory system and warning signal must be installed to check fault operation of device in clean agent fire extinguishing system.

6.2.4.5.4 Operation shall be by listed mechanical manual, electrical, or pneumatic means.

6.2.4.5.5 Pre-discharge alarm shall be by sound and lighting means.

6.2.4.5.6 Warning signage must place on both sides of entrance door where installed clean agent fire extinguishing system.

6.2.5 System Test

The system test of clean agent fire extinguishing system shall comply to international standard and recommendations of agent manufacturers.

SECTION 3
CARBON DIOXIDE SYSTEM

6.3 Carbon Dioxide System

6.3.1 General

6.3.1.1 Objective

The carbon dioxide system in this standard is suitable for fire extinguishing in protection area that installed electrical devices, electronic devices or high value properties and important business. The using of carbon dioxide shall not damage to any properties that protection area must be unman operates.

6.3.1.2 Scope

The carbon dioxide system in this standard is mentioned only type of operation, system components, installation, and system inspection on high pressure system.

6.3.2 Types of Carbon Dioxide System

6.3.2.1 Properties of Gas and System

6.3.2.1.1 Properties of Gas

Carbon dioxide is a colorless, odorless, electrically nonconductive that is a suitable medium for extinguishing fires. Carbon dioxide gas is 1.5 times heavier than air. Carbon dioxide extinguishes fire by reducing the concentrations of oxygen, the vapor phase of the fuel, or both in the air to the point where combustion stops

6.3.2.1.2 Types of System

The carbon dioxide system can separate into 2 systems as followings;

1. Low Pressure System
   Carbon dioxide gas shall fill in storage container under pressure 2,068 kPa. (300 psi) at retaining temperature –18 °C (0 °F) all time.
2. High Pressure System
   Carbon dioxide gas shall fill in storage container under pressure 5,860 kPa (850 psi) at temperature 21 °C (70 °F).

6.3.2.1.3 Discharged Applications

Both low pressure system and high pressure system shall separate into 3 discharged applications.

6.3.2.1.3.1 Local Application

A system consisting of a supply of extinguishing agent arranged to discharge directly on the burning material

6.3.2.1.3.2 Total Flooding Application

A system consisting of a supply of carbon dioxide arranged to discharge into, and fill to the proper concentration, an enclosed space or enclosure around the hazard. In case that there is an opening space, additional gas shall be provided by calculation only. The types of total flooding application can separate into 2 types as below;

1. Surface Fire; Gas must be fully discharged into protection area within 1 minute which is discharge start to discharge stop.
2. Deep Seat Fire; Gas must be fully discharged into protection area within 7 minutes that need to meet 30 % concentration within first 3 minutes from starting of discharge.

6.3.2.1.3.3 Hand-Held Hose Lines

A hose and nozzle assembly connected by fixed piping or connected directly to a supply of extinguishing agent.

6.3.2.1.3.4 Standpipe System and Mobile Supply

A system consisting of a mobile supply of carbon dioxide, designed to be quickly moved into position and connected to a system of fixed piping, supplying fixed nozzles or hose lines or both that are designed for either total flooding or local application.

6.3.2.2 Limitation of Operation

6.3.2.2.1 Advantages of carbon dioxide system in operation are followings;

(1) Where an inert electrically nonconductive medium is essential or desirable.

(2) Where cleanup of other media presents a problem.

6.3.2.2.2 Some of the types of hazards and equipment that carbon dioxide systems can satisfactorily protect include the following:

(1) Flammable liquid materials

(2) Electrical hazards such as transformers, switches, circuit breakers, rotating equipment, and electronic equipment

(3) Engines utilizing gasoline and other flammable liquid fuels

(4) Ordinary combustibles such as paper, wood, and textiles

(5) Hazardous solids

6.3.2.2.3 Carbon dioxide will not extinguish fires where the following materials are actively involved in the combustion process:

(1) Chemicals containing their own oxygen supply, such as cellulose nitrate

(2) Reactive metals such as sodium, potassium, magnesium, titanium, and zirconium

(3) Metal hydrides

6.3.3 Personal Safety

6.3.3.1 Hazards to Personnel

The discharge of carbon dioxide in fire-extinguishing concentration creates serious hazards to personnel, such as suffocation and reduced visibility during and after the discharge period. Consideration shall be given to the possibility of carbon dioxide drifting and settling into adjacent places outside of the protected space

6.3.3.2 Warning Sign

Appropriate warning signs shall be affixed in a conspicuous location.

6.3.3.2.1 Typical sign in every protected space

W A R N I N G
CARBON DIOXIDE GAS
WHEN ALARM OPERATES VACATE IMMEDIATELY

6.3.3.2.2 Typical sign at every entrance to protected space

W A R N I N G
CARBON DIOXIDE GAS
WHEN ALARM OPERATES DO NOT ENTER UNTIL VENTILATED

6.3.3.2.3 Typical sign in every nearby space where carbon dioxide can accumulate to hazardous levels

CAUTION:
CARBON DIOXIDE DISCHARGE INTO A NEARBY SPACE CAN COLLECT HERE. WHEN ALARM OPERATES VACATE IMMEDIATELY

6.3.3.2.4 Typical sign outside each entrance to carbon dioxide storage rooms

CAUTION:
CARBON DIOXIDE GAS
VENTILATE THE AREA BEFORE ENTERING. A HIGH CARBON DIOXIDE GAS CONCENTRATION CAN OCCUR IN THIS AREA AND CAN CAUSE SUFFOCATION

Appropriate warning signs shall be placed at every location where manual operation of the system can occur. A typical sign at each manual actuation station is as follows:

W A R N I N G
ACTUATION OF THIS DEVICE WILL CAUSE CARBON DIOXIDE TO DISCHARGE. BEFORE ACTUATING, BE SURE PERSONNEL ARE CLEAR OF THE AREA

6.3.3.3 Pre-Discharge Alarm

6.3.3.3.1 Pre-discharge alarms shall be provided to give positive warning of a discharge where hazard to personnel could exist. Such alarms shall function to warn personnel against entry into hazardous areas as long as such hazards exist or until such hazards are properly recognized.

6.3.3.3.2 Audible pre-discharge alarms shall be at least 15 dB above ambient noise level or 5 dB above the maximum sound level, whichever is greater, measured 5 ft (1.5 m) above the floor of the occupiable area. Audible signal appliances shall have a sound level not more than 120 dB at the minimum hearing distance from the audible appliance. The pre-discharge alarm shall have a minimum decibel rating of 90 dBa at 3 m.

6.3.4 Specifications, Plans, and Approvals

6.3.4.1 Specifications

Specifications for carbon dioxide fire-extinguishing systems shall be prepared under the fully experienced engineer and qualified in the design of carbon dioxide extinguishing systems

6.3.4.2 Layout Plan

These plans shall contain sufficient detail to evaluate the hazard and to evaluate the effectiveness of the system. The details shall include the following:

6.3.4.2.1 Materials involved in the protected hazards

6.3.4.2.2 Location of the hazards

6.3.4.2.3 Enclosure or limits and isolation of the hazards

6.3.4.2.4 Surrounding area that could affect the protected hazards

6.3.4.3 Approval of Installations

The completed system shall be inspected and tested by qualified personnel to meet the approval of the authority having jurisdiction. Only listed or approved equipment and devices shall be used in the system. To determine that the system has been properly installed and will function as specified, the following shall be performed.

6.3.4.3.1 A thorough visual inspection of the installed system and hazard area. The piping, operational equipment, and discharge nozzles shall be inspected for proper size and location. The locations of alarms and manual emergency releases shall be confirmed. The configuration of the hazard shall be compared to the original hazard specification. The hazard shall be inspected closely for unclosable openings and sources of agent loss that could have been overlooked in the original specification.

6.3.4.3.2. A check of labeling of devices for proper designations and instructions. Nameplate data on the storage containers shall be compared to specifications.

6.3.4.3.3 Nondestructive operational tests on all devices necessary for proper functioning of the system, including detection and actuation devices.

6.3.4.3.4 A full discharge test shall be performed on all systems. Where multiple hazards are protected from a common supply, then a full discharge test shall be performed for each hazard.

Local Application

Full discharge of design quantity carbon dioxide through system piping to ensure carbon dioxide effectively covers the hazard for the full period of time required by the design specifications, and all pressure-operated devices function as intended.

Total Flooding

Full discharge of entire design quantity of carbon dioxide through system piping to ensure that carbon dioxide is discharged into the hazard and the concentration is achieved and maintained in the period of time required by the design specifications, and all pressure-operated devices function as intended.

Hand-Held Hose Lines

Full discharge test of hand-held hose line systems. Requires evidence of liquid flow from each nozzle with an adequate pattern of coverage.

6.3.5 Detection, Actuation and Control

6.3.5.1 Detection

Detection shall be heat detector, smoke detector, and flame detector, etc. All detector must be approved by recognized fire test laboratory.

6.3.5.2 Actuation Types

Automatic detection shall be by any listed or approved method or device that is capable of detecting and indicating heat, flame, smoke, combustible vapors, or an abnormal condition in the hazard such as process trouble that is likely to produce fire. Types of operated actuation shall be shown as followings;

Automatic Operation. Operation that does not require any human action.

Normal Manual Operation. Operation of the system requiring human action where the location of the device used to cause operation makes it easily accessible at all times to the hazard. Operation of one control shall be all that is required to bring about the full operation of the system.

Emergency Manual Operation. Operation of the system by human means where the device used to cause operation is fully mechanical in nature and is located at or near the device being controlled. A fully mechanical device can incorporate the use of system pressure to complete operation of the device.

6.3.5.3 Operating Devices

Operating devices shall include carbon dioxide releasing devices or valves, discharge controls, and equipment shutdown devices, shall have been listed or approved. Manual controls shall not require a pull of more than 178 Newton and shall be positioned not more than 4 ft (1.2 m) above the floor. These devices shall be clearly marked to indicate this concept with a warning placard. Alarms shall function to warn personnel against entry into hazardous areas as long as such hazards exist.

6.3.5.4 Power Sources

The primary source of energy for the operation and control of the system shall have the capacity for intended service and shall be reliable. Where failure of the primary source of energy will jeopardize protection provided for the hazard, the life safety, or both, an independent secondary power supply shall supply energy to the system in the event of total failure or low voltage, less than 85 percent of the nameplate voltages, of the primary power supply. The secondary supply shall be capable of operating the system under maximum normal load for 24 hours and then be capable of operating the system continuously for the full design discharge period. The secondary power supply shall automatically transfer to operate the system within 30 seconds of the loss of the primary power supply.

6.3.6 Carbon Dioxide Supply

6.3.6.1 Quantities

The amount of the main supply of carbon dioxide in the system shall be at least sufficient for the largest single hazard protected or group of hazards that are to be protected simultaneously.

6.3.6.2 Replenishment

The time needed to obtain carbon dioxide for replenishment to restore systems to operating condition shall be considered as a major factor in determining the reserve supply needed.

6.3.6.3 Quality

Carbon dioxide shall have the following minimum properties:

6.3.6.3.1 The vapor phase shall be not less than 99.5 percent carbon dioxide with no detectable off-taste or odor.

6.3.6.3.2 The water content of the liquid phase shall not more than 0.01 % by weight at dew point 34 °C (-30 °F)

6.3.6.3.3 Oil content shall be not more than 10 ppm by weight.

6.3.6.4 Storage Container

6.3.6.4.1 Storage containers and accessories shall be so located and arranged to facilitate inspection, maintenance, and recharging.

6.3.6.4.2 Storage containers shall be located as near as possible to the hazard or hazards they protect, but they shall not be located where they will be exposed to a fire or explosion in these hazards.

6.3.6.4.3 Storage containers shall not be located where they will be subject to severe weather conditions or to mechanical, chemical, or other damage.

6.3.6.4.4 High-pressure cylinders used in fire-extinguishing systems shall not be recharged without a hydrostatic test (and remarking) if more than 5 years have elapsed from the date of the last test.

6.3.6.4.5 Cylinders continuously in service without discharging shall be permitted to be retained in service for a maximum of 12 years from the date of the last hydrostatic test. At the end of 12 years, they shall be discharged and retested before being returned to service.

6.3.6.4.6 The safety relief valve shall be installed on cylinder to protect overpressure. The size of pipe and fitting shall be followed manufacturer's recommendations.

6.3.6.4.7 Individual cylinders shall be used having a standard weight capacity of 2.3, 4.5, 6.8, 9.1, 11.4, 15.9, 22.7, 34.1, 45.4, or 54.4 kg. of carbon dioxide contents.

6.3.7 Distribution System

6.3.7.1 Pipe and Fittings

6.3.7.1.1 Pipe and fittings for carbon dioxide shall be black or galvanized steel pipe that shall be either ASTM A 53 seamless or electric welded, Grade A or B.

6.3.7.1.2 Class 150 and cast-iron fittings shall not be used in carbon dioxide system

6.3.7.2 Valves

6.3.7.2.1 All valves used in this system shall be listed or approved.

6.3.7.2.2 Material of valve body and components must resist operating pressure and do not damage to valve components.

6.3.7.3 Discharge Nozzle

6.3.7.3.1 Discharge nozzles shall be suitable for the use intended and shall be listed or approved for discharge characteristics.

6.3.7.3.2 The discharge nozzle shall select the orifice size, nozzle type and any shield in according to room size and installation method.

6.3.7.3.3 Discharge orifices shall be of corrosion-resistant metal.

6.3.7.3.4 Discharge nozzles shall be permanently marked to identify the nozzle and to show the equivalent single-orifice diameter.

6.3.7.3.5 The support of discharge nozzle shall be strong enough and resist of operating pressure when the gas discharges.

6.3.7.3.6 In explosion hazard area, metal discharge nozzle shall be ground, including other metal component in system shall be ground to protection ignition from static electric.

6.3.8 Inspection and Maintenance

At least annually, check and test the carbon dioxide system for proper operation. At least semiannually, all high-pressure cylinders shall be weighed and the date of the last hydrostatic test noted. If, at any time, a container shows a loss in net content of more than 10 percent, it shall be refilled or replaced with reserve cylinder immediately.

SECTION 4
FIRE FIGHTING FOAM SYSTEM

6.3 FIRE FIGHTING FOAM SYSTEM

6.4.1 General

6.4.1.1 Objective

The purpose of fire fighting foam system is to extinguish flammable and combustible liquid fires which is included hydrocarbon and solvent fire. The fire hazard of liquid fires is very dangerous and shall affect to life and properties. Therefore, fire fighting foam system and components is very important.

6.4.1.2 Scope

Fire fighting foam system in this section shall present to bladder tank foam system only that normally used and does not complicate. The fire fighting foam system is suitable to following areas, such as oil terminal, chemical storage, oil & chemical transportation accidents, helipad, etc. For other foam systems, such as in-line eductor and metered proportioning etc., shall be briefly present in this standard.

6.4.2 Types of Fuel

6.4.2.1 Flammable liquids shall be or shall include any liquids having a flash point below 37.8º C and having a vapor pressure not exceeding 276 kPa. (absolute) at 37.8º C. Flammable liquids shall be subdivided as follows:

Class I liquids shall include those having flash points below 37.8º C and shall be subdivided as follows:

6.4.2.1.1 Class IA liquids shall include those having flash points below 22.8º C and having a boiling point below 37.8º C.

6.4.2.1.2 Class IB liquids shall include those having flash points below 22.8º C and having a boiling point above 37.8º C.

6.4.2.1.3 Class IC liquids shall include those having flash points at or above 22.8º C and below 37.8º C.

6.4.2.2 Combustible liquids shall be or shall include any liquids having a flash point at or above 37.8º C. They shall be subdivided as follows:

6.4.2.2.1 Class II liquids shall include those having flash points at or above 37.8º C and below 60º C.

6.4.2.2.2 Class IIIA liquids shall include those having flash points at or above 60º C and below 93.3º C.

6.4.2.2.3 Class IIIB liquids shall include those having flash points at or above 93.3º C.

6.4.3 Properties and Types of Foam Concentrate

6.4.3.1 Fire-fighting foam does not extinguish fire class D and fire on pressure tank

6.4.3.2 Fire-fighting foam is a stable aggregation of small bubbles of lower density than oil or water that exhibits a tenacity for covering horizontal surfaces. Air foam is made by mixing air into a water solution called finished foam, containing a foam concentrate, by means of suitably designed equipment. Fire-fighting foams can separate to three ranges are as follows:

6.4.3.2.1 Low-expansion foam — expansion up to 20

6.4.3.2.2 Medium-expansion foam — expansion from 20 to 200

6.4.3.2.3 High-expansion foam — expansion from 200 to 1000

6.4.3.3 Foam concentrate is a concentrated liquid foaming agent as received from the manufacturer which do not mix with water and air for using. Foam concentrate can separate as follows;

6.4.3.3.1 Protein-Foam Concentrates consist primarily of products from a protein hydrolysate to prevent corrosion of equipment and containers. They are diluted with water to form 3 percent to 6 percent solutions depending on the type.

6.4.3.3.2 Fluoroprotein-Foam Concentrates are very similar to protein-foam concentrates but have a synthetic fluorinated surfactant additive. They are diluted with water to form 3 percent to 6 percent solutions depending on the type.

6.4.3.3.3 Synthetic-Foam Concentrates. Synthetic-foam concentrates are based on foaming agents other than hydrolyzed proteins and include the following:

Aqueous Film-Forming Foam (AFFF) is based on fluorinated surfactants plus foam stabilizers and usually are diluted with water to a 1 percent, 3 percent, or 6 percent solution. The foam produced with AFFF concentrate is dry chemical compatible and thus is suitable for combined use with dry chemicals.

Medium- and High-Expansion Foam Concentrates. These concentrates are used in specially designed equipment to produce by blower-fan type.

6.4.3.3.4 Film-Forming Fluoroprotein (FFFP) Foam Concentrates. These concentrates use fluorinated surfactants to produce a fluid aqueous film for suppressing hydrocarbon fuel vapors. The foam is usually diluted with water to a 3 percent or 6 percent solution and is dry chemical compatible.

6.4.3.3.5 Alcohol-Resistant Foam Concentrates. These concentrates are used for fighting fires on water-soluble materials and other fuels destructive to regular, AFFF, or FFFP foams, as well as for fires involving hydrocarbons.

6.4.3.4 Types of Foam Proportioning

The methods of foam proportioning shall conform to the following

6.4.3.4.1 In-Line Eductor is located in the water supply line to the foam maker. The eductor is connected by single or multiple lines to the source of foam concentrate. It is precalibrated, and it could be adjustable.

6.4.3.4.2 Metered Proportioning Method is used foam concentrate pump to inject foam concentrate into the water stream. The control or measure the proportion of water to foam concentrate. Either manual or automatic adjustment of foam concentrate injection by pressure or flow control can be utilized.

6.4.3.4.3 Pressure Proportioning Tank is provided for displacing foam concentrate from a closed tank by water (with or without a diaphragm separator), using water flow through a venturi orifice.

6.4.4 System Components

The system components in this section shall present on bladder tank system and shall address only important components of the system to understand how system operates properly.

6.4.4.1 Bladder Tank

6.4.4.1.1 The tank of bladder tank system shall be listed or approved by recognized laboratory.

6.4.4.1.2 The tank material shall resist corrosion from containing of foam concentrates.

6.4.4.1.3 Size of bladder tank shall be suitable for foam concentrate quantity that size of tank shall meet with manufacturer's standard.

6.4.4.1.4 The bladder shall installed inside the tank and material, which made of bladder shall be synthetic rubber, shall be durable and elastic to proper operation.

6.4.4.1.5 Refill of foam concentrate in bladder shall be followed on each manufacturer's procedures only and the wrong refill procedures shall damage to the bladder and impaired operation.

6.4.4.1.6 The tank shall locate outside fire hazard area and shall install firmly.

6.4.4.1.7 Surrounding of tank shall provide guard to protection mechanical impact that might cause to tank damages

6.4.4.1.8 The cover of tank shall be provide to protection heat from sun light that might cause to reduce of foam concentrate properties.

6.4.4.2 Foam Concentrate

6.4.4.2.1 Foam concentrate shall be listed and approved.

6.4.4.2.2 Foam concentrate which fills in the tank shall be suitable to fire hazard.

6.4.4.2.3 Percentage of foam concentration shall be met with proportioning devices such as foam concentration 3%, or foam concentration 6%, etc.

6.4.4.3 Foam Proportioner

6.4.4.3.1 Material of foam proportioner shall resist to corrosion of foam concentrates.

6.4.4.3.2 Size of foam proportioner shall be suitable to flow rate of foam solution for fire extinguisher.

6.4.4.3.3 Percentage of foam proportioner shall match with desired design such as 3% or 6% etc.

6.4.4.3.4 Connection of foam proportioner can be use screw or flange style.

6.4.4.4 Foam Discharge Device

6.4.4.4.1 Material of foam discharge shall resist to corrosion of foam concentrates.

6.4.4.4.2 Type of foam discharge device shall select to equal with foam application.

6.4.4.4.3 Location of foam discharge device shall install as manufacturer's recommendation.

6.4.4.5 Valve

6.4.4.5.1 Material of valve shall resist to corrosion of foam concentrates and environmental.

6.4.4.5.2 Valve shall resist operating pressure of system.

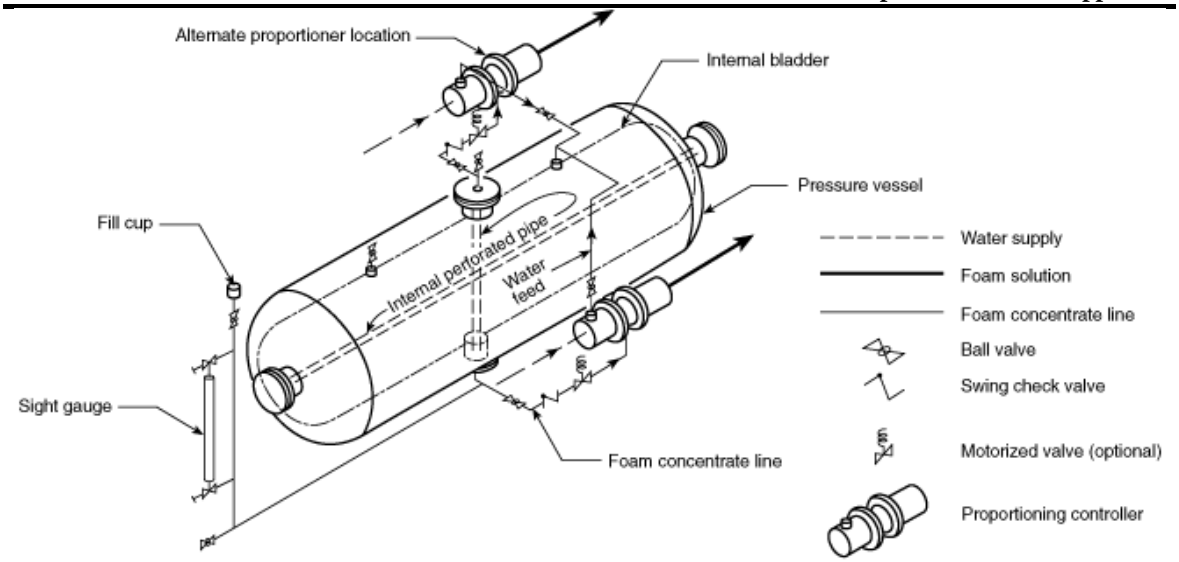
6.4.4.5.3 Valve shall locate outside fire hazard area and shall be safe from fire.

6.4.4.5.4 Valve shall locate in area that is easy to access to control on-off valve due to automatic system fails.

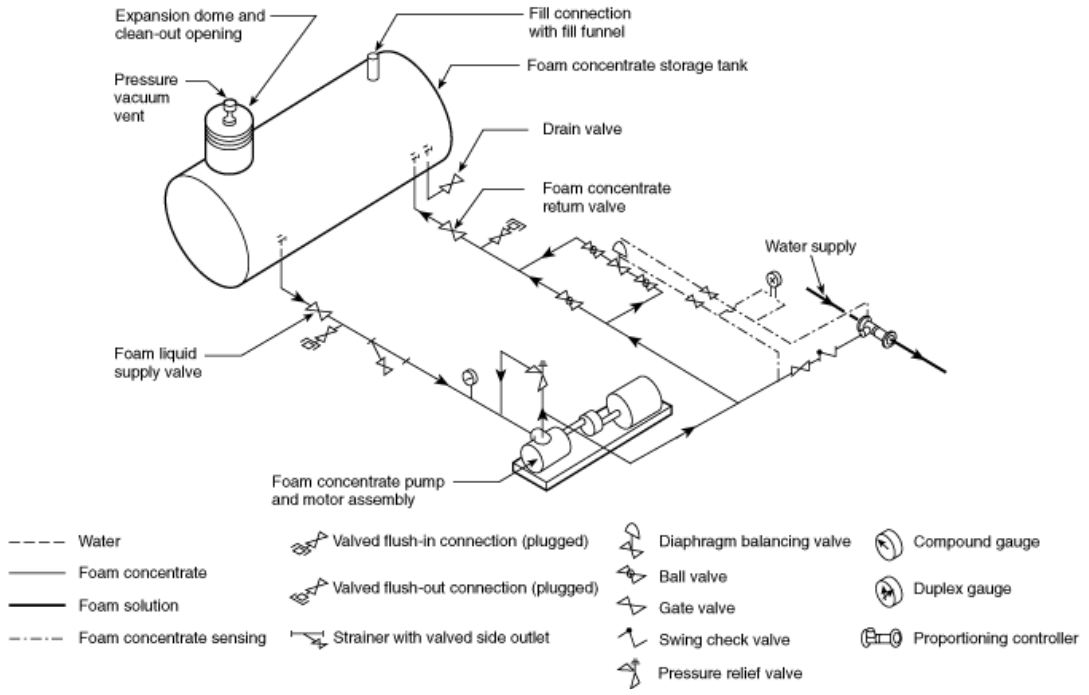
6.4.4.5.5 Cleaning and test of pipe shall be performed before installation of valve.

6.4.5 Maintenance

At least annually, test of system and components shall be performed, including test of foam concentrate where filled in the tank. The result of foam concentrate test shall be considered to change foam concentrate immediately when the foam concentrate properties is change more than 10% from original data.



Picture 6.4.1 Example of Metered Proportioning Diagram



Picture 6.4.2 Example of Pressure Proportioning Tank – Bladder Tank Type

SECTION 5
WATER MIST SYSTEM

6.5 WATER MIST SYSTEM

6.5.1 General

6.5.1.1 Objective

The purpose of this standard is to provide protection for life and property from fire through the standardization of design, installation, maintenance, and testing requirements for water-based fire suppression systems that use a specific spray (mist) that absorbs heat, displaces oxygen, or blocks radiant heat to control, suppress, or extinguish fires as required by the application.

6.5.1.2 Scope

Water mist system in this standard is to specific how to select the system, that there are many systems, to be suitable with hazard types.

6.5.2 Operation and Properties

A water mist system is a fire protection system using very fine water sprays (i.e., water mist). The very small water droplets allow the water mist to control or extinguish fires by cooling of the flame and fire plume, oxygen displacement by water vapor, and radiant heat attenuation. A water mist system is widely use with fire protection objectives as follows;

6.5.2.1 Fire extinguishment

6.5.2.2 Fire suppression

6.5.2.3 Fire control

6.5.2.4 Temperature control

6.5.2.5 Exposure protection

6.5.3 Personal Safety

In the event of a fire, safeguards shall be provided to ensure the following:

6.5.3.1 prompt evacuation of trapped personnel

6.5.3.2 prevention of entry by personnel into hazardous atmospheres

6.5.3.3 provision of means for prompt rescue of any trapped personnel.

Safety factors such as personnel training, warning signs, discharge alarms, self-contained breathing apparatus, evacuation plans, and fire drills shall be considered.

6.5.4 Type of System Pressure

Water mist systems are separated by operating pressure totally 3 systems as follows;

Low Pressure System

System pressure is exposed to pressures of 175 psi (12.1 bar) or less.

Intermediate Pressure System

System pressure is greater than 175 psi (12.1 bar) but less than 500 psi (34.5 bar).

High Pressure System

System pressure is exposed to pressures of 500 psi (34.5 bar) or greater.

6.5.5 System Components

6.5.5.1 Piping and Fitting

Piping and fitting used for water mist system is resist to operating pressure for each type of systems. Piping and fitting shall resist pressure at least 12.1 bar (175 psi).

In some areas that risk of corrosion to piping and fitting, the protection shall be considered such as painting or corrosion resistance metal.

6.5.5.2 Discharge Nozzle

Discharge nozzle for water mist system shall be listed or approved. The detail of discharge nozzle shall mark on nozzle such as product name, model, orifice size, etc.

The spare of discharge nozzle shall be provided as follows;

- In case that nozzles installed more than 50 nozzles, they shall spare not less than 3 nozzles.
- In case that nozzles installed more than 50 to 300 nozzles, they shall spare not less than 6 nozzles.
- In case that nozzles installed more than 301 to 1,000 nozzles, they shall spare not less than 12 nozzles.
- In case that nozzles installed more than 1,000 nozzles, they shall spare not less than 24 nozzles.

6.5.5.3 Valve

6.5.5.4 Gas & Water Container

Water and gas cylinders shall manufacture, test and install of equipment on cylinder shall be follow ASME standard or US-DOT (US-Department of Transportation) or other recognized fire test laboratory.

The safety relief valve shall install on each cylinder to relief over pressure.

6.5.5.5 Pump System

Installation of water mist pump shall follow the latest standard of Engineering Institute of Thailand. Type of pump, operating pressure, flow rate of pump shall meet with design of the system. The pump operation shall be automatic mean as receiving signal from control system.

6.5.5.6 Air Compressor

The air compressor for water mist system shall be designed and manufactured for this system only.

6.5.5.7 Detection & Control System

The detection and control shall be listed or approved and installation standard of detection and control shall follow the latest fire alarm system standard of Engineering Institute of Thailand.

The control system shall activate by automatic, manual, and emergency manual means, especially emergency manual shall be single operation to activate system at once.

6.5.6 System Design

The design of system shall prepare calculation of pressure loss and flow rate in pipe in accordance with international standard or manufacturer's recommendations.

6.5.7 System Operational Test

After completion of system installation, the discharge test shall be performed to check profile of discharge nozzle, leakage on fittings and components, block inside nozzle and pipe, function of system and other systems, and performance of system which compares with design. The system operation test shall include functioning test of all components in system to ensure that all components shall operate properly as design.

A.8.7 Appendix of EIT Standard

1.Fire Over 17 Floors Hotel

1.1 Building Character

This famous hotel, which comprised of more than 400 guestrooms, was located nearby the seashore. Banquet hall, seminar rooms, laundry and other were located on the second floor. Lobby, main kitchen and other were located on the first floor. Main structures were constructed with reinforced concrete. The roof of seminar room was constructed with steel truss structure. Staircase was in the middle of the building. Some level of staircases were enclosed with fire resistance enclosures, a couple level of staircase were enclosed with a number of glass windows. Fire stair was spiral shape and made of steel structure, and no fire rated wall was provided to protect fire stair. No fire rated enclosure was provided for lift lobby and utilities shafts closed to the lift lobby. No automatic sprinkler system was installed. Smoke detectors were installed for every guestroom.

1.2 Fire's Event

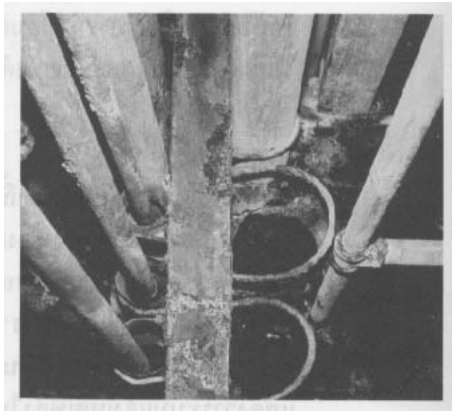
The fire was occurred during the preparation of banquet hall on the Saturday morning. The explosion of gas tanks was happened without any warning system. It means that fire alarm system was not operated. The attendant in seminar room on the second floor and the guest did not know what's going on. Fire spread to coffee shop, which was located nearby the exit, and move to the middle stairway. No enclosure was provided for stairway. Fire rapidly moves to the upper floor, grows up to the lift shaft and pass through the mechanical and electrical shaft which located at the middle of building. It took very long time for guest to know. When they knew, they found that smoke had already moved fire escape way, and the exit door was locked in order to prevent guest leaving the hotel without any payment. More than 90 persons were dead. If the hotel installed automatic sprinkler system and having protection of vertical opening for example; middle stairway, lift lobby, mechanical shaft, including to inspection of fire alarm system. This tragedy story was not happened.

2.Fire Over Office and 37 Floors' Hotel

2.1 Building Character

This site consisted of office building and 37 floors' hotel, which was located in the middle of city and closed to main road. This site was also near the construction site of sky-train's railway. The hotel comprised of more than 600 guestrooms.

2.2 Fire's Event



Fire happened on 7th floor, which was under the decoration of interior works in order to use as office space on the next week. Fireball from welding jumped to thinner caused fire incident. Fire spread to wooden access door of mechanical and electrical shaft. Wooden doors were not made of fire rating materials, so fire grew up very quickly. Fire and smoke move to the upper floor, especially to the guest floor. Approximate 9 persons were dead. Someone moved to the roof and escaped from helicopter. The helicopter was accident, but everybody was safe. Automatic sprinkler system was installed to this building, but the installation was not conformed to the standard so it could not work. This case should be studied and considered to the good practice of design, installation, testing and commissioning of the fire protection system including to the closing of any opening with fire barrier.

3.Big Bell Department Store (1987)

3.1 Building Character

The building comprised of department store and parking spaces on the lower zone (level 1-7) and the office spaces on the upper zone (the next 12 floors).

3.2 Fire's Event

Source

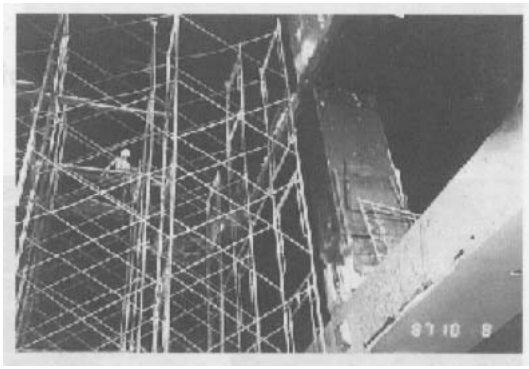
The causes and source of fire was investigated. It was found that fire was ignited from the short circuit of electricity in storage room of department store.

Causes of spread of fire

1. A lot of combustible material was contained in storage room.
2. Wall of storage room were not constructed with fire rated material.
3. Opaque external walls obstructed the operation of fire fighters.
4. Some parts of external walls were decorated with some material, which obstructed the operation of fire fighters
5. Fire moved through elevators' shaft, non-enclosed staircase and atrium.
6. No fire alarm system
7. Fire pump was undersized.
8. No fire protection standards / codes was conformed.

Damages

- Post tension floor slabs were collapsed.
- Elevators, escalators and air-conditioners were burnt.
- The business was closed.



Damaged life lobby and damaged hall

Collapsed escalator

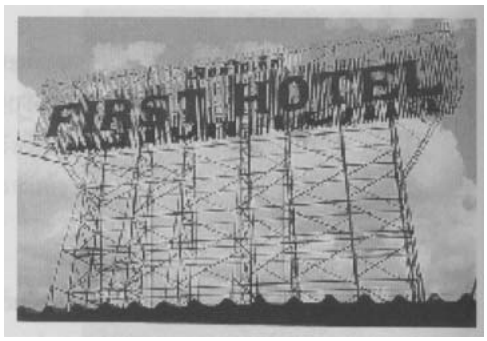
Damaged air handling unit

Damaged building floor

4.First Hotel (1988)

4.1 Building Character

This hotel comprised of 4 levels structure and more than 200 guestrooms.



4.2 Fire's Event

Source

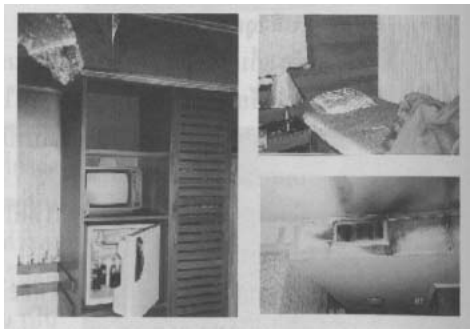
The causes and source of fire was investigated. Fire was happened on the 3rd floor and ignited from the guest who drunk the alcohol, smoked the cigarettes until he slept.

Causes of spread of fire

1. The guestrooms' door was made of plywood (No fire rating).
2. Fire moved through elevators' shaft, non-enclosed staircase and vertical openings.
3. No fire alarm system.
4. No fire pumps.
5. Exit signs were not clear.
6. No fire escape from the sky.

Damages

- The building got a lot of damages.
- Machine rooms were burnt.



Room near stair lobby

Damaged building structure

Damaged lift lobby, stair lobby and machine room above stair case

Opening and shaft that are fire spread way

5.Siam Shopping Center (1996)

5.1 Building Character

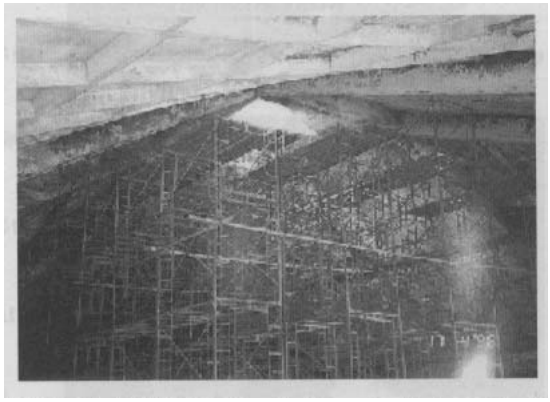
The building is shopping center of 4 floors.

5.2 Fire's Event

Source

One night, fire was caused from fireball of cigarette jump to thinner during the decoration of some retail shop on 2nd floor. It found that someone was dead from smoke.

Causes of spread of fire



1. Paint and thinner is flammable material
2. Fire moved through return air duct of air-conditioning system, which was common used with area on the upper floor. No fire damper was installed at floor opening.
3. Fire spread through sanitary shaft to 4th floor.
4. The 4th floor was occupied by a lot of tape & recorder shop.
5. Wall partition was made of general wood.
6. A lot of furniture, which hung from the ceiling, dropped to fireman during fighting the fire.
7. No fire alarm system.
8. No right exit sign.
9. No standard fire pumps.
10. No standard fire protection system.

Damages

- Main structure was damaged
- All business is closed for renovation

6.The Intertech Building (1992)

6.1 Building Character

The building has 2 floors.

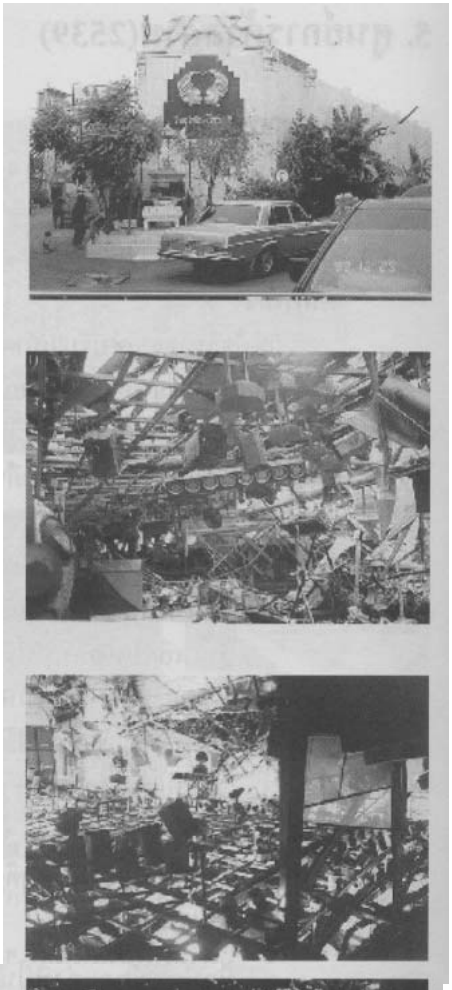
6.2 Fire's Event

Source
Sparking of electricity
Causes of spread of fire

1. Two floors were opened and connected together.
2. Wall was constructed of non-fire rating materials.
3. A lot of light & sound equipment, which hung from the ceiling, dropped to fireman during fighting the fire.
4. Many of flammable materials were stored.
5. No fire alarm system
6. No right exit sign.
7. No standard fire protection system.
8. Exit sign is not quite clear, and much less exit sign

Damages

- Main structure was damaged

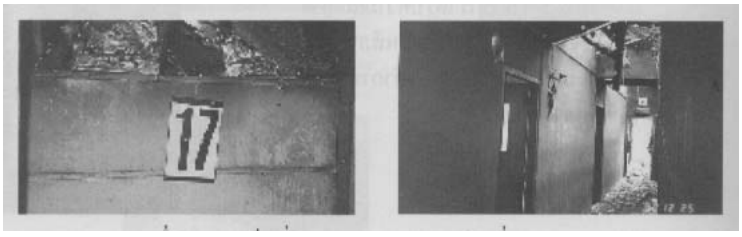


Damage inside the building

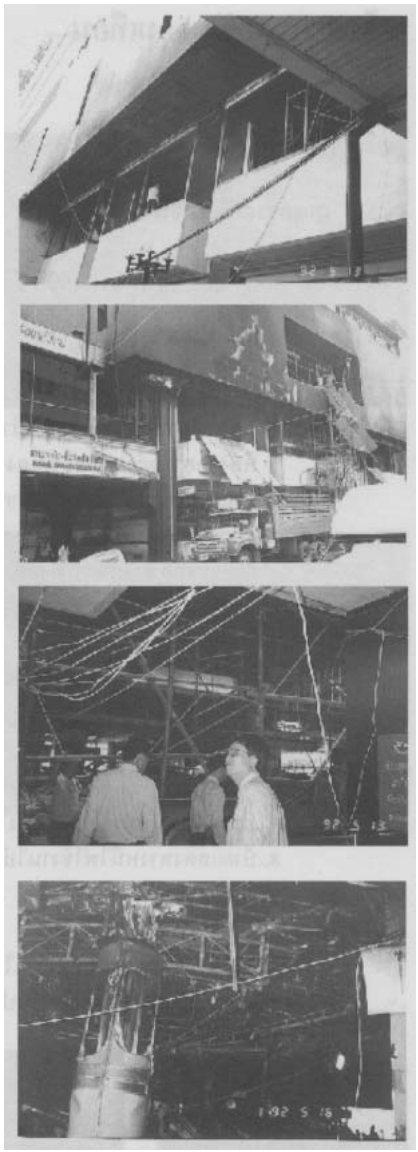
Collapsed roof structure

Damaged air handling unit

Exit sign that is not clear and enough



7.PATA Department Store (1992)



7.1 Building Character

The building comprised of shopping center, amusement park and zoo.

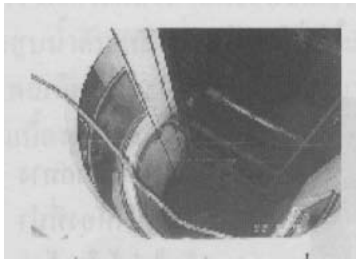
7.2 Fire's Event

Source
Sparking of electricity
Causes of spread of fire

1. A lot of flammable material was stored.
2. Storage room was not constructed from fire-rating materials.
3. The exterior wall was rigid opaque wall, which obstructed the operation of firemen.
4. A lot of furniture, which hung from the walls or ceiling, dropped to fireman during fighting the fire.
5. Fire spread through lift shaft, stair and atrium, which without fire enclosure.
6. No fire alarm system.
7. No right exit sign.
8. No standard fire protection system.

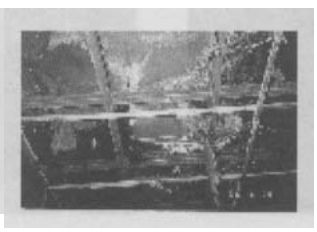
Damages

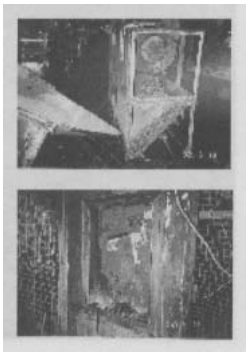
- Main structure was damaged
- Most of lifts, air-conditioning units and escalators are damaged.
- All business is closed for renovation



Damage lift lobby, lift shaft and escalator

Damaged amusement park and not useable fire extinguisher





8.Royal Jomtein Hotel

8.1 Building Character

16 floors height hotel with 400 guestroom

8.2Fire's Event

Source
Fire was occurred from gas leakage.

Causes of spread of fire

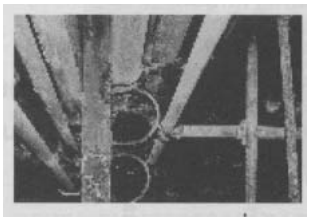
1. Fire moved from the front to the back of building by the suction pressure of stack effect via opening of plumb shaft.
2. Fire grew through lift shaft, stairway, openings and mechanical shaft opening. These opening have no any enclosures.
3. Building contained a lot of combustible materials.
4. Fire alarm system did not work.
5. Sprinkler system did not work.
6. Fire exit was obstructed, and the door was locked.
7. Guest's door was made of general wood.
8. Fire exit sign did not work.
9. No roof escaped way.

Lift shaft and stair case fire

Damaged building structure

Damages

- More than 91 persons were dead, and the hotel was closed.



opening and shaft that are fire spread way

Stair case and lift shaft that are fire spread way

Air duct that is conduct smoke from corridor to the room

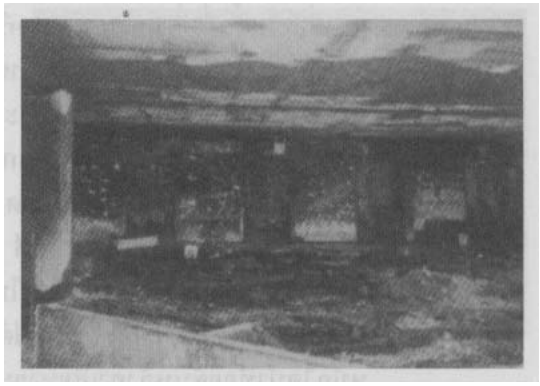
9.Fire Over Department Store

9.1 Building Character

The building comprised of department store, parking space and office tower on upper part of building. Total area was approximate 50,000 m^2, department store occupied 7 floors of the lower part of building and office tower occupied 12 floors of the upper part of building.

9.2 Fire's Event

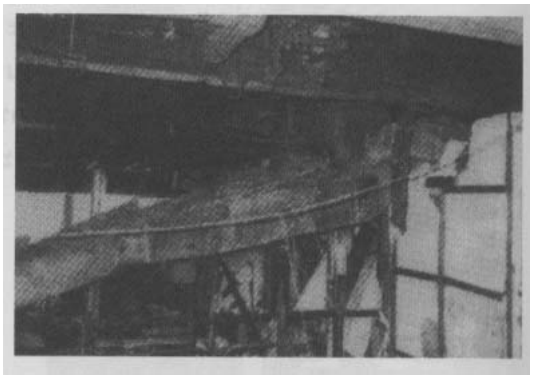
Shot circuit of electricity was occurred in storage room. Storage room was not constructed of fire-rating wall. Fire burnt the room and moved to the other area. Fireman could not access from the outside, because exterior was rigid opaque wall, including the interior finishing was covered over the inside surface of exterior wall. Fire and smoke upward moved to the upper floor via lift shaft and fire escape stairway. Fire doors were not provided for lift lobby. No fire alarm system was provided for this building. Fireman could not the fire, and the floor structure finally collapsed.



10.Fire Over 8 Floors Hotel

10.1 Building Character

The building was hotel with 8 floors height and 200 guestrooms, hotel closed to main road.



10.2 Fire's Event

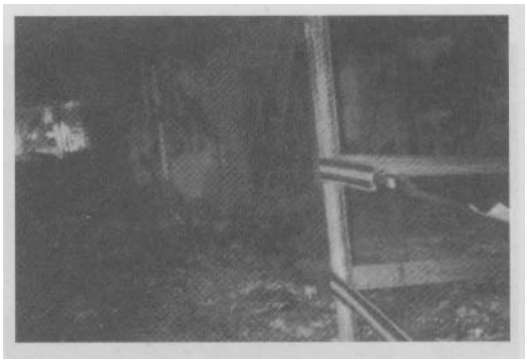
Fire occurred from the guestroom on the third floor. The causes of fire came from cigarettes, which was lighted. Guestroom's door was of plywood. Fire doors were not provided for lift lobby and fire stairway. Smoke move up to the lift machine room on the roof. No fire alarm system, fire pumps and exit signs were installed. Lifts and boilers, which were located on the roof, were damaged.

11.Fire Over Shopping Center

11.1 Building Character

The building was shopping center having 4 floors and having area of 35,000 m^2.

11.2 Fire's Event

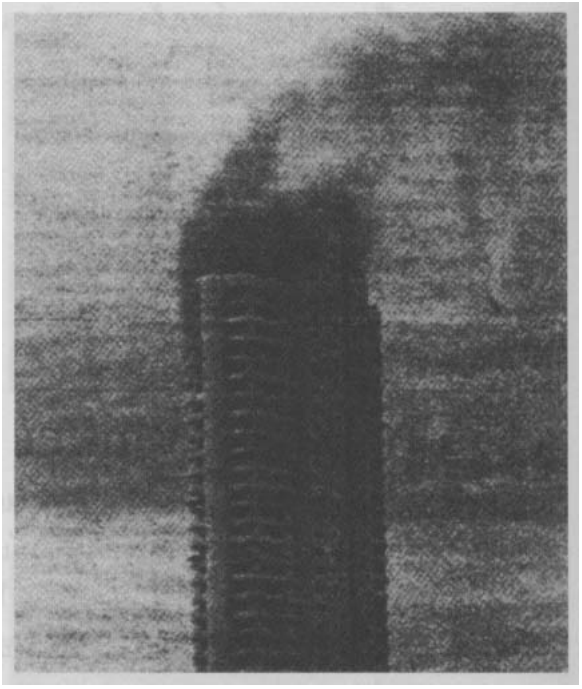


On the second floor, the interior contractor was working. Fire was ignited from thinner and paint. Fire moved through ductworks of air-conditioning system to another area. No fire dampers were installed on the ductworks. Fire grew up to the forth floor, which contained a lot of flammable materials. The most damages were occurred on the forth floor. No fire alarm system and sprinkler system were installed. The contractor was dead and initially the firemen could not resist the fire.

12.Fire Over Condominium

12.1 Building Character

The building has thirty floors, each floor occupied six dwelling units.



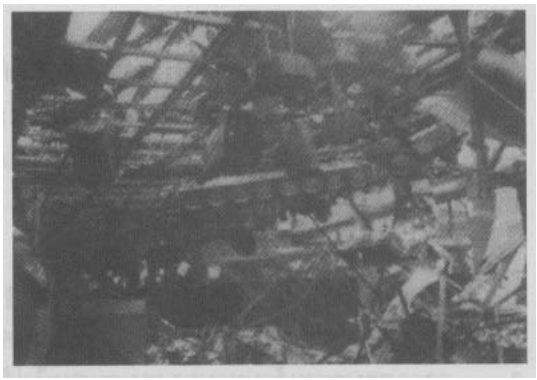
12.2 Fire's Event

The interior contractor smoked the cigarettes during working. Fire burnt inside only one room, but two contractors were dead. The contractor breathed the smoke, and tried to escape by the lift. No sprinkler system was provided for this building, and some fire protection system was not completed because the building was just finished the construction.

13.Fire Over Disco Tech

13.1 Building Character

The building has two floors, and separating to several individual rooms.



13.2 Fire's Event

Electricity short-circuit was the causes of fire. This building was constructed with combustible material and no fire-rating walls. No fire protection system was provided, except a couple portable fire extinguisher.

Instruction to prevention hazardous from fire incident

INTRODUCTION

The recommendation for prevention to hazardous from fire incident, which was happened in the past according to the case study, shall be indicated as follows:

1. Installation of electrical system must comply the code of practice, EIT standard or International standard. In case of department stores or shopping center, an installation for retail shop shall be controlled under the restricted instruction.
2. Electrical insulation testing shall be done for every five years, and next checking shall be done one time a year.
3. Establish a permanent team to take care of life & fire safety matter.
4. Provide supervisor to follow-up and take care of improvement works, renovation works or decoration works. No smoking is allowed for these kinds of works.
5. Avoid the welding within any occupied buildings or the buildings containing a lot of flammable material. Automatic sprinkler system shall be installed.
6. No plywood is allowed for wall of storage room, file room or room containing flammable material. Walls shall be constructed of fire rating walls.
7. Combustible materials; i.e. blooms, papers, furniture, boxes and etc, shall not be stored within the machine room or electrical room. Doors for these rooms shall be made of steel.
8. Fire seal shall be applied to any penetration through floors, vertical shafts and wire-ways. Common vertical ventilation shaft shall be avoided, except that fire dampers are installed to protect the fire spread.
9. Fire doors shall be provided for stairways and fireman lift-lobbies, conventional doors might be allowed for general lift-lobby.
10. Smoke exhaust system shall be provided for purging the smoke during fire incident.
11. Enough fire escape plans, fire escape routes and exit signs shall be provided.
12. Avoid construction the building with steel structure, except that structures have been already prepared for the situation or covered with fire protection materials and fully automatic sprinkler system must be installed.
13. Avoid using flammable material and material generating toxic gases; i.e. plastic, fiberglass and foam.
14. Avoid hanging too heavy items from the ceiling. They may be collapsed during fire incident. If required, the support must be enough strong.

B REQUIREMENTS IN THE MINISTERIAL REGULATIONS CONSULTED FROM NFPA

B. REQUIREMENTS IN THE MINISTERIAL REGULATIONS CONSULTED FROM NFPA

Requirements of the Ministerial Regulations consulted from NFPA (1/4)

Clause in MR	NFPA consulted in MRs		Description in NFPA
MR33	Issue No.	Section	
Cl.1	NFPA 101, 2000 edition	3.3.25.6	"High-rise Building" means a building greater than 23 m in height where the building height is measured from the lowest level of fire department vehicle access to the floor of the highest occupied story.
Cl.1	NFPA 14 2000 edition	1.4.28	"Standpipe System" means an arrangement of piping, valves, hose connections, and allied equipment installed in a building or structure, with the hose connections located in such a manner that water can be discharged in streams or spray patterns through attached hose and nozzles, for the purpose of extinguishing a fire.
Ch. 1 Cl. 8	NFPA 101 2000 edition	7.1.3.2.1 (a) , (b)	- The fire escape staircases shall have not less than a 1-hour fire resistance rating and 1-hour fire protection-rated door assemblies where the fire escape stairs connects 3 stories or less. - The fire escape staircases shall have not less than a 2-hour fire resistance rating and 1-hour 30 minutes fire protection-rated door assemblies where the fire escape stairs connects 4 or more stories
Ch. 2 Cl. 16	NFPA72 1999 edition	-	Fire detection and alarm system shall be installed in accordance with NFPA72, National Fire Alarm Code
Ch. 2 Cl. 18	NFPA 14 2000 edition	-	Standpipe system shall be installed in accordance with NFPA 14, Standard for the Installation of Standpipe, Private Hydrant, and Hose Systems
Ch. 2 Cl. 19	NFPA 10 1998 edition	-	Portable Fire Extinguishers shall be installed in accordance with NFPA10,Standard for Portable Fire Extinguishers
Ch. 2 Cl. 20	1)NFPA 13 1999 edition 2)NFPA 15 3)NFPA 11 1998 edition 4)NFPA 12 2000 edition 5)NFPA17 6)NFPA 750 2000 edition 7)NFPA2001 2000 edition	-	Automatic Fire Extinguishing System including : 1. Automatic Sprinkler System in accordance with NFPA13, Standard for the Installation of Sprinkler Systems 2. Water Spray System in accordance with NFPA15,Standard for Water Spray Fixed System 3. Foam System in accordance with NFPA11,Standard for Low Expansion Foam 4. Carbon Dioxide System in accordance with NFPA12,Standard on Carbon Dioxide Extinguishing System 5. Dry Chemical System in accordance with NFPA17,Standard for Dry Chemical Extinguishing System 6. Water Mist System in accordance with NFPA750,Standard for the Installation of Water Mist Fire Extinguishing System 7. Clean Agent System in accordance with NFPA2001,Standard on Clean Agent Fire Extinguishing System
Ch. 2 Cl. 22	NFPA 101 2000 edition	7.1.3.1	Corridor used as fire escape route and serving an area having an occupant load exceeding 30 shall be separated from other parts of the building by fire resistance wall having not less than a 1-hour fire resistance rating

Requirements of the Ministerial Regulations consulted from NFPA (2/4)

Clause in MR	NFPA consulted in MRs		Description in NFPA
MR33	Issue No.	Section	
Ch. 2 Cl. 23	NFPA 101 2000 edition	7.2.2.2.1	Stair Dimension Min. clear width of the stair = 112 cm Max. height of risers = 17.8 cm Min. height of risers = 10.2 cm Min. thread depth = 28 cm Min. headroom = 203 cm Max. height between landing = 3.7 m
Ch. 2 Cl. 24	NFPA 101 2000 edition	7.2.2.6.3	A fire escape stairs outside the building shall be separated from the interior of the building by fire resistance wall having 1-hour fire resistance rating and 1-hour fire protection-rated door assemblies if the outside stair served not more than 3 stairs or 1 hour 30 minutes fire resistance rating and 1-hour 30 minutes fire protection-rated door assemblies if the outside stair served more than 3 stories.
Ch. 2 Cl. 25	NFPA 101 2000 edition	7.1.3.2.1 (e)	Penetrations into and openings through an fire escape staircases shall be prohibited except for the following: (1) Electrical conduit serving the stairway (2) Required exit doors (3) Ductwork and equipment necessary for independent stair pressurization (4) Sprinkler piping (5) Standpipes
Ch. 2 Cl. 26	NFPA 101 2000 edition	1)7.8.1.3 2)7.10.6.1 3)7.10.1.4	1) The floors an other walking surface within an fire escape route shall be illuminated to values of at least 10 lux measured at the floor. 2) Letters size shall be 15 cm at least. 3) Exit sign placement shall be such that no point in an corridor is in excess 30 m from the nearest sign.
MR39			
Ch. 1 Cl. 3	NFPA 10 1998 edition	-	Portable Fire Extinguishers shall be installed in accordance with NFPA10,Standard for Portable Fire Extinguishers
Ch. 1 Cl. 4	NFPA72 1999 edition	-	Fire detection and alarm system shall be installed in accordance with NFPA72, National Fire Alarm Code
Ch. 1 Cl. 5	NFPA72 1999 edition	-	Fire detection and alarm system shall be installed in accordance with NFPA72, National Fire Alarm Code
Ch. 1 Cl. 6	NFPA72 1999 edition	-	Fire detection and alarm system shall be installed in accordance with NFPA72, National Fire Alarm Code
Ch. 1 Cl. 7	NFPA 101 2000 edition	1)7.8.1.3 2)7.10.6.1	1) The floors an other walking surface within an fire escape route shall be illuminated to values of at least 10 lux measured at the floor. 2) Letters size shall be 15 cm at least.
MR47			
Cl. 2	NFPA 101 2000 edition	3.3.25.6	“High-Rise Building” means a building greater than 23 m in height where the building height is measured from the lowest level of fire department vehicle access to the floor of the highest occupiable story.

Requirements of the Ministerial Regulations consulted from NFPA (3/4)

Clause in MR	NFPA consulted in MRs		Description in NFPA
MR47	Issue No.	Section	
Cl. 5	NFPA 101 2000 edition	7.1.3.2.1 Exception No 1 and 2	- The fire escape staircases in existing non-high-rise building shall have not less than a 1-hour fire resistance rating and 1-hour fire protection-rated door assemblies. - The fire escape staircases in existing high-rise building shall have not less than a 2-hour fire resistance rating and 1-hour 30 minutes fire protection-rated door assemblies. - The fire escape staircases in existing high-rise building protected throughout by an approved, supervised automatic sprinkler system in accordance with NFPA13, Standard for the Installation of Sprinkler Systems shall have not less than a 1-hour fire resistance rating and 1-hour fire protection-rated door assemblies
Cl.5(3)	NFPA 10 1998 edition	-	Portable Fire Extinguishers shall be installed in accordance with NFPA10,Standard for Portable Fire Extinguishers
Cl.5(4)	NFPA72 1999 edition	-	Fire detection and alarm system shall be installed in accordance with NFPA72, National Fire Alarm Code
Cl.5(5)	NFPA 101 2000 edition	1)7.8.1.3 2)7.10.6.1	1) The floors an other walking surface within an fire escape route shall be illuminated to values of at least 10 lux measured at the floor. 2) Letters size shall be 15 cm at least.
MR48			
Cl. 2	NFPA 101 2000 edition	3.3.25.6	"High-rise Building" means a building greater than 23 m in height where the building height is measured from the lowest level of fire department vehicle access to the floor of the highest occupied story.
Cl. 3 "Cl. 23"	NFPA 101 2000 edition	7.1.3.2.1 (a) , (b)	- The fire escape staircases shall have not less than a 1-hour fire resistance rating and 1-hour fire protection-rated door assemblies where the fire escape stairs connects 3 stories or less. - The fire escape staircases shall have not less than a 2-hour fire resistance rating and 1-hour 30 minutes fire protection-rated door assemblies where the fire escape stairs connects 4 or more stories
MR50			
Cl. 7 "Cl.8 in MR33"	NFPA 101 2000 edition	7.1.3.2.1 (a) , (b)	- The fire escape staircases shall have not less than a 1-hour fire resistance rating and 1-hour fire protection-rated door assemblies where the fire escape stairs connects 3 stories or less. - The fire escape staircases shall have not less than a 2-hour fire resistance rating and 1 hour 30 minutes fire protection-rated door assemblies where the stair connects 4 or more stories.
Cl. 8 "Cl.8 bis in MR33"	NFPA 101 2000 edition	7.1.3.1	Corridor used as fire escape route and serving an area having an occupant load exceeding 30 shall be separated from other parts of the building by fire resistance wall having not less than a 1-hour fire resistance rating
Cl. 12 "Cl. 25 in MR33"	NFPA 101 2000 edition	7.1.3.2.1 (e)	Penetrations into and openings through an fire escape staircases shall be prohibited except for the following: (1) Electrical conduit serving the stairway (2) Required exit doors (3) Ductwork and equipment necessary for independent stair pressurization (4) Sprinkler piping (5) Standpipes

Requirements of the Ministerial Regulations consulted from NFPA (4/4)

Clause in MR	NFPA consulted in MRs		Description in NFPA
MR55	Issue No.	Section	
Ch.2 Part 4 Cl. 27	NFPA 101 2000 edition	7.1.3.2.1 (a) , (b)	- The fire escape staircases shall have not less than a 1-hour fire resistance rating and 1-hour fire protection-rated door assemblies where the fire escape stairs connects 3 stories or less. - The fire escape staircases shall have not less than a 2-hour fire resistance rating and 1-hour 30 minutes fire protection-rated door assemblies where the fire escape stairs connects 4 or more stories
Ch.2 Part 4 Cl. 29	NFPA 101 2000 edition	7.2.2.6.3	A fire escape stairs outside the building shall be separated from the interior of the building by fire resistance wall having 1-hour fire resistance rating and 1-hour fire protection-rated door assemblies if the outside stair served not more than 3 stairs or 1 hour 30 minutes fire resistance rating and 1-hour 30 minutes fire protection-rated door assemblies if the outside stair served more than 3 stories.
Ch.2 Part 4 Cl. 30	NFPA 101 2000 edition	1)7.1.3.2.1 (e) 2)7.2.2.2.1 3)7.8.1.3	1) Penetrations into and openings through an fire escape staircases shall be prohibited except for the following: (1) Electrical conduit serving the stairway (2) Required exit doors (3) Ductwork and equipment necessary for independent stair pressurization (4) Sprinkler piping (5) Standpipes 2) Stair Dimension Min. Clear width of the stair = 112 cm Where total occupant load of All stories served by stair is fewer than 50 min. clear width = 91 cm Max. height of risers = 17.8 cm Min. height of risers = 10.2 cm Min. thread depth = 28 cm Min. headroom = 203 cm Max. height between landing = 3.7 m 3) The floors an other walking surface within an fire escape route shall be illuminated to values of at least 10 lux measured at the floor.

Note:
1) Ch: Chapter
2) Cl: Clause

C ON-SITE SURVEY AND CASE STUDY OF IMPROVEMENT OF EXISTING BUILDINGS

C. ON SITE SURVEY AND CASE STUDY OF IMPROVEMENT ON EXISTING BUILDING

C.1 ON SITE SURVEY ON EXISTING BUILDINGS

In the course of the first field survey in Thailand, the survey on the existing buildings has been conducted in BMA and other local province. The result and findings on the fire prevention system of the existing buildings are compiled in the following sections.

In BMA, questionnaire survey was conducted on 125 existing buildings. Among them, the Study Team explored some buildings

The Study Team also visited the following local authorities and observed the existing buildings as listed in the following tables.

- Phuket during 30-31 September 2001,
- Pattaya on12 September 2001, and
- Hatyai and Songkhlar during 18-19 September 2001.

List of the Observed Buildings

No.	Building Use	Location of building
1	Hotel	Three hotels in Phuket
		Pattaya
		Songkhla
2	Hospital	Phuket
3	Commercial	Phuket
4	Theater	Pattaya
5	Cinema Complex	Phuket
6	Office	Songkhla
7	School	Songkhla

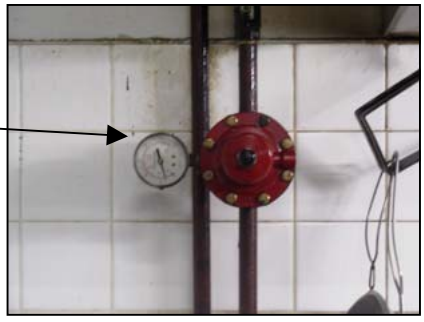
The observed problems are categorized into the following seven stages. The problems by each stage are shown in the subsequent subchapters.

1) Outbreak Prevention
2) Initial Fire Spread Prevention
3) Safety Evacuation
4) Fire Spreading Prevention
5) Full-Scale Fire Fighting and Rescue
6) Prevention for Fire Spreading to other Buildings
7) Management System for Fire Prevention

(1) Outbreak Prevention

Most kitchens use direct gas cylinders for cooking in medium-size buildings, such as offices, schools and so on. Sometimes these cylinders are located inside buildings, and some big hotels use a gas pipe system.

In a high school, about 10 kinds of cooking stalls are located behind canteens. Most of them have gas cylinders inside and plastic doors are installed between the canteen and stalls. Some gas burners use plastic shields as a windbreaker.



The layout of gas pipes is very dangerous, because some pipes lye directly on the floor, and carts pass over the pipes many times every day.

Some kinds of chemicals are stored in a high school. Many of them are in bottles kept on wood shelves with no doors. There are two plastic doors connected to the classrooms.

Regarding the installation of sprinklers, there are long distances of sprinklers and high ceiling spaces in places such as big entrance halls and restaurants.

Generally speaking, automatic fire alarm equipment is properly installed in buildings, but some equipment is not periodically inspected, and is not repaired when needed. A smoke detector watch board is placed on the wall beside the hotel check-in counter. There are sometimes troubles on alarms.

The smoke detector is installed on the center of the ceiling in the electrical room. This detector is located in front of the air grill of the air conditioning.

(2) Initial Fire Spread Prevention

Combustible interior finishing materials are used in an elevator hall, which is connected to the corridor to the guestrooms. The wall material in the corridor also looks combustible.

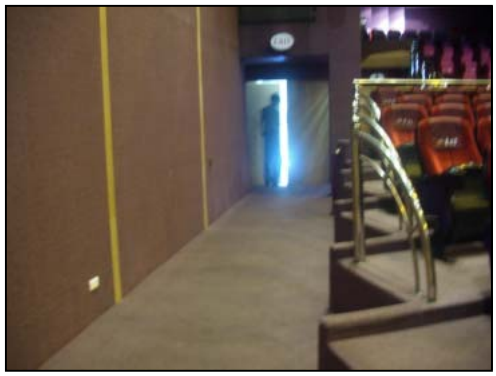
A big hall is located at the top of an office building. The ceiling is more than 6 meters high, and the wall finishing material looks combustible.

(3) Safety Evacuation

The outside stair is facilitated from the forth floor to the ground. The exit to this steel stair is located in the landing of the staircase on the forth floor and accessed by a ladder on the landing. The exit opening is an aluminum frame window and the height of the handrail is very low.

The evacuation signboard is made of wood without illumination. Some signboards have several icons such as for the elevator, toilet, and the fire hose. There are many kinds of icons for exit signs.

There are no lights for evacuation in a 400-seat theatre, and there are only four exits in the back.



The dust chute is located on the landing of the evacuation staircase. There is a big clearance surrounding the dust chute pipe without any filling materials.

There is a wood door for maintenance of the pipe shaft facing the landing of the evacuation staircase.

An evacuation stair from the ground floor to the upper floors is suddenly connected to a steep slope to the outside.

There is a big kitchen connected to a evacuation staircase with a wood door.

There are many combustible subjects in the evacuation corridor, and the height from ground level to the exit is more than 1 meter.

The fire door to the fire exit has more than 10cm clearance between the floor and the bottom of the door, and the finishing material in the elevator hall is made of wood.

(4) Fire Spreading Prevention

The water supply and the drainage pipes are located under the beams, and many pipes penetrate the upper floor's slab without any filling material. Also, these pipes, as well as electric conduits (sometimes wires), air conditioning ducts and telephone lines also penetrate the space between the walls and the slab.

There are many buildings with unsafe vertical partitions. There are many medium and high-rise buildings with vertically unsealed pipe shafts and wooden inspection doors.

This is a machine room for elevators in a hospital under construction. The elevator shaft is not yet enclosed by a fireproof structure.

The pipe shaft room has a wood inspection door, which opens to the restroom.

The exhaust fan is located at the top of wall, and exhaust air directory into this pipe shaft.

There are big openings of the vertical shaft, facing a big kitchen in a hotel. This pipe shaft is perilously used to ventilate the kitchen.

The staircase has big windows at the top. This means that the staircase is actually a ventilation chimney.

There are many pipes in this shaft which has a wood door and faces the guest room corridor.

A big supermarket has a big void in the center of the building. At the bottom of this void, there are a lot of clothes. A corridor, enclosing the void, has a chain of retail shops. This void has no fire shutters.

(5) Full-Scale Fire Fighting and Rescue

There is an entry door with an aluminum frame.

There is a fire hydrant cabinet in which a hose is obstructively banded for the use in an emergency

(6) Prevention for Fire Spreading to other Buildings

The exterior wall of this entertainment facility is badly not connected to the roof structure.

(7) Management System for Fire Prevention

A fire command center is located close to a big kitchen and have an air duct, which penetrates the wall of this room, and is connected to the corridor and to the kitchen.