CHAPTER 33

FIRE PROTECTION

33-1. General fire protection systems

The fire protection system consists of basic fire suppression systems, such as automatic sprinklers and carbon dioxide systems, as well as fire detection and alarm systems. Halon systems are no longer used. The purpose of the system is to protect property and life from the consequences of a fire and to provide fire control until professional fire fighters arrive. Whether the combustion is controlled or extinguished by the suppression system depends on the hazard being protected against; the type of system selected to protect the hazard; the type of suppression agent selected; and of utmost importance, the design of the suppression system. It is imperative that the National Fire Protection Association (NFPA) Fire Code standards and manufacturer's recommendations relative to each suppression, detection, and alarm system be consulted before any operation or maintenance is performed on any of these systems.

33-2. Fire detection systems

The concept of defense in depth is applied in fire protection when an early warning fire detection system is used to communicate plant or equipment status to a central location or assigned staff. The first line of defense is the early warning fire detection system designed to detect the particles of combustion formed before overt signs of fire appear, followed by systems designed to detect fire and release extinguishing agents. The system's purpose is to provide the earliest possible warning of a potential fire hazard, principally by the extensive use of ionization smoke detectors.

a. Type of detectors. The three basic types of detectors can detect smoke, heat, and flame.

(1) Two types of smoke detectors are used: ionization and photoelectric. Ionization smoke detectors contain a small amount of radioactive material which ionizes the air in the sensing chamber, thus rendering it conductive and permitting a current flow through the air between two charged electrodes. When smoke particles enter the ionization area, the detector circuit responds with an alarm or buzzing. Photoelectric spot type detectors contain a chamber that has either overlapping or porous covers of light that allows the entry of smoke. The unit contains a light source and a special photosensitive cell in the darkened chamber. The cell is either placed in the darkened chamber at an angle different from the light path or has the light blocked from it by a light stop or shield placed between the light source and the cell. With the admission of smoke particles, light strikes the particles and is scattered and reflected into the photosensitive cell. This causes the photosensing circuit to respond to the presence of smoke particles in the smoke chamber.

(2) Heat detectors can be configured as spot type or line type. In spot type detectors the sensing element is concentrated at a particular location. Line type detectors sense temperature changes along the length of a metal wire. When heat above a predetermined level reaches the lines strung throughout an area to be protected, an alarm or alarm and fire-suppression system is triggered. Heat detectors are fixed-temperature, rate-compensated, or rate-of-rise types. A fixed-temperature detector is a device that responds when its operating element becomes heated to a predetermined level or higher. A rate-compensated detector is a device that responds when the temperature of the air surrounding the device reaches a predetermined level, regardless of the rate of temperature rise. A rate-of-rise detector is a device that responds when the temperature rises at a rate exceeding a predetermined amount.

(3) A flame detector is a device that responds to the appearance of radiant energy visible to the human eye or to radiant energy outside the range of human vision.

(a) A photoelectric flame detector is a device that the sensing element is a photocell that either changes its electrical conductivity or produces an electrical potential when exposed to radiant energy.

(b) A flame flicker detector is a photoelectric flame detector with means to prevent response to visible light unless the observed light is modulated at a frequency characteristic of the flicker of a flame.

(c) An infrared detector is a device with a sensing element that is responsive to radiant energy outside the range of human vision.

(d) An ultraviolet detector is a device with a sensing element that is responsive to radiant energy outside the range of human vision.

b. Signaling systems. One of the major advantages of using a remote multiplexing system for fire detection is the ease of adding alarm detectors without the requirement of long conduit and multiple cable runs throughout the plant. The early warning fire detection system may be a Class A proprietary protective signaling system that meets the requirements of NFPA 72, National Fire Alarm Code. Class A fire detection means a fire alarm can be received and displayed at the central alarm station in the abnormal presence of a single break of a single ground fault in any signaling circuit. A Class B system does not include this emergency operating feature.

33-3. Fire suppression systems

Many types of fire suppression or extinguishing systems are available. Water spray provides cooling action, CO_2 reduces the oxygen concentration, isolation removes the fuel from the fire, and dry chemicals disrupt the unrestrained chemical chain reaction needed for combustion. However, not all extinguishing agents are equally effective and cost efficient in certain types of fires. Water used on electrical control equipment and terminal cabinets can cause damage by shorting. CO_2 is not cost effective in large volume areas, and the area is not immediately habitable after application. Another factor to consider is whether the suppression system should be activated by automatic or manual means. The consequences of a false trip of an automatic system can be as bad as a fire in that operations personnel may deactivate the system to preclude further trips.

a. Water systems. Protecting facilities from fire frequently requires the installation of a sprinkler system. Equipment consisting of overhead piping and attached sprinklers connected to an automatic water supply protects defined spaces and a variety of hazards. There are four major types of sprinkler systems: wet pipe, dry pipe, deluge, and pre-action.

(1) The wet pipe system is the simplest and most common. The wet pipe system utilizes a water-filled piping system connected to a water supply and is equipped with sprinklers having fixed temperature elements which each open individually when exposed to a high temperature due to a fire. The areas where wet pipe sprinkler systems will be used are heated shops, garages, warehouses, laboratories, offices, record rooms, locker rooms, lunch rooms, and toilets.

(2) The dry pipe type of system has heat operated sprinklers attached to a piping system containing air under pressure. When a sprinkler head operates, the air pressure is reduced, a “dry pipe” valve is opened by water pressure, and water flows to any opened sprinkler heads.

(3) The deluge type of system consists of open-type sprinkler heads attached to a network of dry (not water-filled) piping which is automatically controlled by a fully supervised fire detection system which also serves as a fire alarm system. When a fire is detected, an automatic deluge valve is tripped open, admitting water to the system to discharge through all of the sprinkler heads. The system may be subdivided into separately controlled headers, depending on the area to be covered and the number of sprinkler heads required. The usual pressure required at the sprinkler heads is about 175 psi and the piping should be properly sized accordingly. Water spray deluge sprinkler systems are provided where required in open areas and areas requiring the protection of the piping from freezing. Water deluge systems are provided for outdoor transformers, when the transformers are installed on or adjacent to the structure to help prevent the spread of fire and to limit damage to the structure and other close-by transformers and equipment.

(4) The pre-action type of system is similar to the above water spray deluge system, except that it contains closed type sprinkler heads which only discharge water through those sprinklers whose fixed temperature elements have been opened by the heat from a fire.

b. Carbon dioxide. This type of system usually consists of a truck filled low pressure refrigerated liquid carbon dioxide storage tank with temperature sensing controls to permit the automatic injection of permanently piped carbon dioxide into areas to be protected. The system usually includes warning alarms to alert personnel whenever carbon dioxide is being injected into an actuated area. Carbon dioxide extinguishing systems of this total flooding type will be utilized to extinguish coal bunker fires and for electrical hazard areas such as in battery rooms, electrical relay rooms, switchgear rooms, computer rooms, and within electrical cabinets.

c. Foam extinguishing systems. Foam fire extinguishing systems utilize a foam producing solution which is distributed by pipes equipped with spray nozzles or a fuel tank foam entry chamber for discharging the foam and spreading it over the area to be protected. It is principally used to form a coherent floating blanket over flammable and combustible liquids which extinguish (or prevent) a fire by excluding air and cooling the fuel. The foam is usually generated by mixing proportionate amounts of 3 percent double strength, low expansion standard foam concentrate using either a suitably arranged induction device with (or without) a foam storage-proportioning tank to mix the foam concentrate with a water stream from a fire water header. A tank foam chamber or open sprinklers aspirate the air to form the foam to blanket the area to be protected. The deluge water entry valve to the system may be manually or automatically opened. Foam systems will be installed in power plants to protect fuel oil areas, lubricating oil systems, and hydrogen seal oil systems.

d. Portable fire extinguishers. Portable hand held CO_2 fire extinguishers should be provided and located throughout the facility in accordance with the NFPA. The use of dry chemical fire extinguishers is not recommended, primarily due to cleanup problems.