ISFSI

INSTRUCT-O-GRAM

THE HANDS-ON TRAINING GUIDE FOR THE FIRE INSTRUCTOR

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FIXED EXTINGUISHING SYSTEMS

TIME REQUIRED **2 hours**

INTRODUCTION

Fire fighters are encountering fixed extinguishing systems with increasing frequency. Property owners install fixed systems to protect sensitive or valuable material that may be damaged by traditional fire fighting methods. Some businesses are required, by code or ordinance, to install a fixed extinguishing system to protect all or part of their occupancy. Still other systems are installed at the request of the insurance company.

Regardless of the reason for the system being installed, a fire fighter should understand how it works. Some systems can leave hazardous or toxic vapors even after extinguishing the fire. Fire fighters unaware of this could enter an area with improper personal protective equipment.

Fixed systems, unlike sprinkler systems, are designed to extinguish the fire. Fire fighters should be extremely cautious when responding to a protected structure with smoke showing, as the system has probably not work as designed. Sprinklers have an effectively limitless supply of extinguishing agent (water). Fixed systems have a finite amount of agent, usually contained in a small tank or cylinder. Once that agent is expelled there is no further action taken to control the fire until the arrival of fire fighters. Given the types of occupancies usually protected by fixed systems a fire that was not extinguished has the potential to become devastating.

OBJECTIVES

1. Given a lecture and reading assignments, the student will list five types of fixed fire extinguishing systems, with 100% accuracy and state their intended applications.
2. Given a lecture and reading assignments, the student will list three occupancies that would require fixed fire extinguishing systems, with 100% accuracy.
3. Given a lecture and reading assignments, the student will list four types of foam systems, with 100% accuracy.

MOTIVATION

Fixed extinguishing systems help lower the possibility that the fire department will be called to certain high risk areas. Have the class discuss good and bad aspects of that. Examples may include: Pros — fires are extinguished in the incipient stage, fire fighter and public safety are increased by reduced responses, property damage is reduced by early application of extinguishing agents; cons — occupants or employees may get a feeling of overconfidence, fires controlled but not extinguished may not be reported in a timely fashion, property damage may be increased by accidental discharge of the agent.

actuated by a product of combustion detector.

3. Semi-fixed system type A
A semi-fixed system type A has discharge piping permanently in place, but not connected to a permanent foam supply. Typically a mobile foam solution apparatus (usually a fire truck) supplies the foam concentrate. This system is often used for subsurface injection of foam into a tank farm fire. It is similar to a dry standpipe system.

4. Semi-fixed system type B
A semi-fixed system type B provides a foam solution pre-piped throughout a facility, usually via foam hydrants. Foam must be applied manually to a fire from these supplies.

5. High expansion foam system
In a high expansion foam system an automatic detection device or manual pull station releases foam to cover entire buildings to a depth of several feet. They utilize a powered foam generator and deliver the foam through fixed piping. Ventilation is usually needed ahead of the progression of the foam to ensure proper movement through the protected area.

6. Foam/water system
A foam/water system is essentially a deluge sprinkler system with foam added to the water.

ACTIVITY

Divide the class into small groups. Give each group an occupancy type and ask them to determine whether and what type of fixed system would be appropriate. The instructor should serve merely as a facilitator unless incorrect information is being given unchallenged by anyone else in the class. Each group should report to the class.

Possible Occupancy types:

1. A warehouse with rolled paper storage (Foam — sprinklers with AFFF)
2. A restaurant with several deep-fat fryers (Dry chemical system or wet chemical system)
3. A manufacturer using a fuming acid as an ingredient in processes (High expansion foam)
4. A high tech computerized X-ray room at a hospital (Halon, Carbon Dioxide or water sprinklers)

REFERENCES

IFSTA Manuals: *Private Fire Protection, Fire Inspection and Code Enforcement*; Course Guide for NFA/OLFSP class, *Fire Protection Structures and Systems Design*, NFPA 1001, 1031, 12, 12A, 12B, 16, 16A, 17.

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V. Foam

Foam is used in applications where water alone may not be an effective agent. This includes areas such as flammable liquid processing or storage areas, aircraft hangars and rolled paper or textile storage areas. Foam systems are covered in NFPA 11 and 11A.

A. How foam works

Foam works by:

- Smothering prevents air and flammable vapors from combining
- Separating intervenes between the fuel and the fire
- Cooling lowers the temperature of the fuel and adjacent surfaces
- Suppressing prevents the release of flammable vapors

B. How foam is generated

- Foam Concentrate is the raw liquid foam prior to the introduction of water and air
- Foam Proportioner is a device that introduces the proper amount of foam concentrate into water
- Foam Solution is a foam, water mix before introduction of air
- Foam (finished foam) is the final product after the introduction of air

Four elements are necessary to produce effective fire fighting foam: Foam concentrate, water, air and mechanical agitation. They must be blended in the proper ratios to produce high quality foam. Usually, proportioners and foam nozzles are designed to work together to create foam. Using unmatched elements can lead to low quality foam.

C. Proportioning rates

Fire Fighting foam is 94% to 99.5% water. Foams are designed to be used in ½, 1, 3 or 6 percent solutions. High expansion foams are used at ½, 2 or 3 percent. Foams for polar solvent fuels require 3 or 6 percent solutions. Foams should only be used at the percentage they were designed to be used at.

D. Expansion rates

1. Low Expansion

   Low expansion foam (such as AFFF or FFFP) has a small air/solution ratio (about 1:7 to 1:20). It is most effective where the temperature of the fuel does not exceed 212°F

2. High and Medium Expansion

   Medium Expansion Foam has an air/solution ratio between 1:20 and 1:200. High Expansion Foam has an air/solution ratio between 1:200 and 1:1000. High and medium expansion foams are effective as space fillers in confined or hard to reach areas. High expansion foams used as an additive in sprinkler systems assist in penetration of tight bulk storage.

E. Foam nozzles and sprinklers

Foam nozzles and sprinklers (foam makers) are the delivery system for the foam solution. It is best to use nozzles and sprinklers that are specifically designed for foam.

Foam/water sprinklers are the most common method of delivering foam to an automatic foam system. These systems are designed for AFFF foam. They are usually designed to inject air by using the venturi effect. However, sometime a normal sprinkler head is used for a lower quality foam that aerates simply through the water falling through the air.

F. System descriptions

1. Self-contained system

   A self contained system contains everything necessary to produce foam within the system. Water and foam concentrate (or a premixed solution) are in a tank under pressure.

2. Fixed system

   A fixed foam extinguishing system is piped from a central foam station. The foam is delivered through fixed outlets such as sprinklers, usually deluge type. These systems may be either local application or total flooding. Most are design to Halon systems. Both are available in local application or total flooding varieties. A local application system reduces the oxygen content in the air to less than 15%. Total flooding systems require that an area be sealed off completely through closed doors and windows and air ducts. But while Halon systems interrupt the chain reaction of fire, Carbon Dioxide systems extinguish the fire by the removal of oxygen. Since Carbon Dioxide has a vapor density of about 2.5 it is heavier than air. The gas is stored at about -110° F. This extreme cold is what causes the cloud that is visible when a CO_2 extinguisher is discharged. After activation of a Carbon Dioxide system, the atmosphere will be as much as 34% CO_2. Concentrations this high essentially remove oxygen from the fire. Of course, the removal of oxygen from a fire also removes it from living things. Nine percent Carbon Dioxide in air is considered the maximum concentration for people to tolerate without quickly losing consciousness. People have been killed from Carbon Dioxide systems discharging before they were able to exit the area. Due to its electrical conductive ability and its tendency to produce static electricity, Carbon Dioxide is not a viable substitute for Halon agents in sensitive computer areas. The static electricity can erase data stored on computer disks. Therefore, property owners must decide whether their hardware or their data is more valuable and make fire protection decisions accordingly. If hardware is the primary asset then a Carbon Dioxide system may be preferable. If data is the primary asset, then a simple water sprinkler system may be the best choice. Carbon Dioxide systems are covered in NFPA 12.

B. Components

In the past heat detectors, either fixed or rate of rise, were used as actuation devices for Carbon Dioxide systems. Recently, however, smoke and even flame detectors are being used. The three means of actuation are: Automatic, triggered by a product of combustion detector and preceded by an alarm; Normal Manual, triggered by a pull station and activating an alarm; Emergency Manual, used only when the other two methods fail, causing a discharge of agent with no pre-alarm. Carbon Dioxide can be stored in either high pressure (850 psi) or low pressure (large tanks at 300 psi at 0° F) tanks. The tanks are connected to the nozzles through fixed piping.

C. Inspecting and testing

Carbon Dioxide systems need to be checked annually by properly trained individuals, preferably licensed by the manufacturer. Agent cylinders should be checked semiannually and replaced if 5% of weight or 10% of pressure is lost. Cylinders must be hydrostatically tested every 12 years.

V. Other Gaseous Agents

Newer gaseous agents that do not contain halocarbons are also covered under NFPA 2001.

A. Inergen (IG-541)

Inergen was the first and is the most popular Halon alternative. Inergen is 40% Argon, 52% Nitrogen and 8% Carbon Dioxide. The carbon dioxide in Inergen increases respirations and allows people to work in the environment after a release for up to 30 minutes even where the oxygen level is well below that necessary to support combustion. Inergen has no adverse effect on the environment because the gasses are all naturally occurring and not manufactured. It has a design concentration of 35% in air. It is toxic at 43% to 52% in air.

B. Argonite (IG-55)

Argonite is a mixture of 50% Argon and 50% Nitrogen. It works by reducing oxygen below the level required to support combustion. Argonite has no adverse effect on the environment because the gasses are naturally occurring and not manufactured. It has a design concentration of 36% in air. It is toxic at 43% to 52% in air.

C. Argon (IG-01)

Argon, an inert gas, is used to reduce the level of oxygen. Argon has no adverse effect on the environment because is naturally occurring and not manufactured. It has a design concentration of 36% in air. It is toxic at 33% to 43% in air.

extremely valuable where a "clean" agent is required. Their use has declined in recent years due to their impact on the ozone layer. Their manufacture and installation has been severely curtailed for several years, but existing systems may stay in place. All manufacture of CFC's will be banned in 2000 by the Montreal Protocol treaty signed in 1990. Halons are specifically exempt due to their irreplaceability. However, their use will most certainly by phased out over the next few years. Many companies, including the US Navy, are searching for an effective replacement for Halon systems.

1. Halon 1301

   Halon 1301 does not pose much of a health hazard at concentrations below 10%. Between 10% and 15% applications all occupants must be evacuated within 30 seconds. Above 15% concentrations, SCBA must be supplied. 1301 is stored and discharged as a liquid but vaporizes immediately. Halon 1301 decomposes at about 950° into Hydrogen Fluoride, Hydrogen Bromide, Bromine and other compounds. These products are toxic. SCBA must be worn in an area where Halon 1301 has extinguished a fire. Halon 1301 systems are covered in NFPA 12A.

2. Halon 1211

   Halon 1211 has a higher boiling point than 1301, allowing it to be projected in a liquid stream over greater distances. Halon is used in portable extinguishers and local application fixed systems, but is only approved for total flooding systems in areas that are not intended for human occupancy. 1211 decomposes at about the same temperature as 1301, leaving similar toxic products. Halon 1211 systems are covered in NFPA 12B.

3. Carbon Tetrachloride

   Carbon Tetrachloride (Halon 104) was widely used as an extinguishing agent until its toxic properties were discovered. Many simple fixed systems were in use. Typically, the system consisted of a glass bulb filled with Carbon Tetrachloride. The bulb was suspended in air, held in place by a wire with a fusible link or sometimes even wax. When the fusible material melted the bulb would drop onto a sharp, usually metal, spike, which broke the bulb and released the agent. "Carbon Tet" is still sometimes encountered, but these systems should be removed.

4. Other Halogenated Agents

   Many other halogenated agents are or have been used for fire control including:

   - Halon 1011 (Chlorobromomethane)
   - Halon 1202 (Dibromodifluoromethane)
   - Halon 2402 (Dibromotetrafluoroethane)
   - Halon 1001 (Methyl Bromide)

5. New Halon Replacements

   New Clean Agent systems are covered under NFPA 2001. They are coming into more common use as Halon systems discharge or are replaced or upgraded.

   a. CEA 614 — C_6H_{14}, Used for local application
   b. CEA 410 — C_4H_{10}, Used for total flooding application
   c. HFC 23 (FE-13) CHF_3 is Trifluoromethane
   d. HCFC-124 — $CHClFCF_3$ Chlorotetrafluoraethane
   e. FM 200
   f. Triodide FIC-13I1 — CF_3I
   g. Halotron 1

B. Inspecting and testing

Halon and other halogenated systems should only be tested by qualified individuals. They should be inspected semi-annually. All tanks which have lost 5% of weight or 10% of pressure should be replaced. All spaces equipped with Halon systems are required to have warning signs.

IV. Carbon Dioxide

A. Description

Carbon Dioxide systems are similar in

PRESENTATION

Interactive Lecture

Fixed extinguishing systems are usually used where sprinklers would be impractical or ineffective. One disadvantage of fixed systems is that they only contain a finite amount of extinguishing agent, unlike sprinklers which can have a virtually limitless water supply. Additionally, sprinklers are considered effective when they control a fire, while special extinguishing systems need to actually extinguish the fire to be effective.

I. Dry Chemical

Dry chemical systems are used where rapid knockdown is required. Agents include Sodium Bicarbonate ($NaHCO3$) and Potassium Bicarbonate ($KHCO3$) [BC fires] and Monoammonium Phosphate ($NH5PO4$) [ABC fires]. They are used for:

- Quenching operations
- Dip tanks
- Paint Spray Booths* Kitchen Cooking areas
- Exhaust duct systems

Systems may be set up as either local application or total flooding. In either case, clean up is difficult due to water resistance and small particle size. Dry Chem systems are not considered "clean" agents and not recommended for areas with sensitive electrical equipment.

A. Description

Dry Chemical systems contain: A storage tank for expellant and agent, Piping to carry the gas and agent, Nozzles to disperse the agent and an Actuating mechanism. Expellant can be either nitrogen or carbon dioxide. Containers can be of any size or shape, though most are in the 30 to 100 pound range. Nozzles can be either One-position or two position. One position nozzles project a straight stream of agent onto a specific surface while two position nozzles project a fan shaped stream of agent to protect a larger area. Actuation is generally a fusible link or a manual pull station. Occasionally actuation is done manually only. On systems with automatic actuation a warning device is needed to ensure evacuation of the affected area. Dry Chemical systems work by interrupting the chain reaction of fire. They are covered in NFPA 17.

B. Inspecting and testing

Dry Chem systems should be inspected monthly to ensure readiness. The inspection should include: Checking pressure gauges to ensure proper operating pressure, Checking for obvious damage, checking for obstructions to manual actuators, checking tamper seals to ensure that they are intact. In addition to this monthly inspection, systems should be inspected every six months to ensure that system requirements have not changed and that the system is entirely intact. Fusible links should be changed every year.

II. Wet Chemical

Wet chemical systems are typically a solution of water and either potassium carbonate or potassium acetate. These systems are particularly effective on fires involving wood, paper, cooking oils, grease and flammable liquids. They are not recommended for electrical fires because of the conductive properties of the solutions. A wet chemical system has the same components of a dry system. Fires are controlled by: removal of fuel, smothering, cooling and inhibition of the chain reaction. They are covered in NFPA 17A.

III. Halogenated Agents

A. Description

Halogenated agents are Alkyl Halides, combinations of Carbon and members of the Halogen family of elements. They are named by the number of Carbon, Fluorine, Chlorine, Bromine and Iodine atoms in the molecule. Halon 1211 and 1301 were developed to replace Carbon Tetrachloride (Halon 104) when it was discovered that it was highly toxic. Halon 1211 (Bromochlorodifluoromethane) and 1301 (bromotrifluoromethane) are widely used in fixed extinguishing systems. Halon 1211 is typically used as a local application system while Halon 1301 is used in a total flooding system. Halons are very effective in class B and C fires and also have limited application in A fires. They work by interrupting the uninhibited chain reaction. Bromine is the active agent in Halon systems. They are