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An Overview of Extinguishing Systems for Computer Equipment

Various types of automatic suppression systems are available for protecting computer equipment. This report discusses the uses and limitations of these systems and provides general information relating to property damage from their activation.

Introduction

On average there were 209 structure fires reported annually in the United States (US) from 2006 to 2010 that started in electronic equipment and/or computer rooms. These fires resulted in an annual average of $11.9 million in direct property damage, based on data from the National Fire Protection Association (NFPA) report Computer Rooms and other Electronics Equipment Areas. Of the reported fires, twenty-one percent occurred in one- and two-family dwellings (21%), followed by office buildings (13%), with schools and apartment buildings each accounting for nine percent of the fires.

Forty-eight percent of the non-home structure fires involving electronic equipment and/or computer rooms were protected by an automatic suppression system, with seventy-two percent of those systems being automatic sprinklers. According to the report, "When the extinguishing equipment reported was not sprinklers, halogen systems accounted for 49% of the equipment, compared to 43% for carbon dioxide systems and 8% for other, unspecified special hazard systems." Additionally, fire detection systems were present in seventy-seven percent of the non-home structure fires involving electronic equipment and/or computer rooms.

There are a number of automatic suppression systems, including automatic sprinkler systems, water mist systems, clean agent systems, and carbon dioxide systems, that may be used to protect electronic and other computer equipment. Each type of system has inherent advantages and disadvantages. The following is a summary of these systems, their basic operational concepts, and property damage concerns.

Automatic Sprinkler Systems

Automatic sprinkler systems are the most widely used suppression system. These systems function by discharging water as a cooling agent to suppress fires in the early stages of fire growth. The design of automatic sprinkler systems can vary based on the property protected and the available water sources. Typical systems used to protect computer equipment areas include wet pipe and pre-action systems.

Wet Pipe Systems

In these systems, water is present in the system piping at all times and is discharged, above the fire, through a sprinkler head with a fusible link. When a fire causes the room temperature to reach a preset point, the sprinkler head link will melt, allowing water to be dis-

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charged in a coarsely divided water spray over the fire. These systems provide the best protection because water has high heat absorption ability and is capable of penetrating deep-seated fires. However, unless the computer equipment is de-energized prior to activation of the sprinkler system, the water may enter energized equipment, causing a short circuit. The degree of water damage to uninvolved equipment will depend on the sprinkler destiny, the spacing of the equipment, and the number of sprinkler heads activated.

Another concern is the temperature rating of the sprinkler head. Tests have shown that room temperatures over 120°F (49°C) can damage magnetic media. Data from the referenced NFPA report indicate that, of the fires occurring in properties protected by automatic sprinklers, fifty-six percent were too small to activate the suppression system. As such, when a sprinkler system is used to protect a computer facility, attention should be given to the temperature ratings of the sprinkler heads to ensure they activate below the point that computer media could be damaged, but above the maximum ambient room temperature. However, lowering the temperature rating of the sprinkler head can also present challenges. Depending on the equipment protected, a computer room's ambient ceiling temperature could approach 100°F (38°C). Computer equipment usually operates most efficiently at approximately 70°F (21°C). To maintain this temperature, computer rooms are usually equipped with air conditioning systems that maintain constant temperature and humidity, which will allow the use of a lower temperature rating of the sprinkler head.

Pre-Action Systems

These systems are similar to dry pipe systems in that water is discharged through a sprinkler head as a cooling agent; however, a pre-action system's piping is not filled with water, but uses air to maintain the system pressure. The protected area is provided with smoke and heat detectors set below the melting point of the sprinkler link. When conditions in the protected area activate a detector, a valve is released allowing water to fill the piping in the exposed area. If the temperature in the area exceeds the melting point of the sprinkler link, water is then discharged onto the fire.

This type of system is preferred for high value equipment because it requires two events to initiate water flow. Typically, the detector activation causes a local alarm to sound that should bring personnel to investigate. Additionally, the alarm circuitry can be interfaced with computer equipment to shut down critical equipment before water is discharged. By initiating an alarm earlier than the application of water, on-site personnel can often extinguish the fire using fire extinguishers, thus limiting water damage. Further, when the alarm is interfaced to shut down the equipment power, damage from short-circuiting of equipment is eliminated.

See Fire Protection Report FP-22-06, *Sprinklers and Their Applications*, for additional information on this topic.

Water Mist Systems

While water mist suppression systems are not new, they have gained popularity in recent years as fire suppression system for computer facilities. Water mist systems are similar to automatic sprinklers in that water is used as the suppression agent; however, in a water mist system, the water droplets are generally not discharged with sufficient momentum to easily penetrate the rising fire gases and reach the surface of the fire. When the water droplets are converted from a liquid into steam, however, the volume increases significantly. The steam displaces available oxygen in the fire compartment, thereby reducing the oxygen available for combustion, contributing to the suppression of the fire.

Water mist systems are effective at controlling surface fires, but limited in their ability to extinguish deep-seated fires. The concern with water mist systems is the amount of heat required to convert the water to steam, typically 212°F (100°C), well above the temperature at which magnetic media is damaged. Systems that are provided with detection equipment interfaced with power shutdown controls should be used to prevent short-circuiting of sensitive equipment. Water mist systems can be designed in three different configurations:

Local Application Systems

These systems are designed and installed to provide complete distribution of mist around the hazard or object to be protected. They can be designed to protect an object in an enclosed, unenclosed, or open outdoor condition and are actuated by automatic nozzles or by an independent detection system. Local application systems limit the amount of water discharged to a specific piece of equipment, thus reducing the damage to other equipment.

Total Compartment Application Systems

These systems are designed and installed to provide complete protection of an enclosure or space. The complete protection of the enclosure or space can be achieved by the simultaneous operation of all nozzles in the space by manual or automatic means. This type of system will limit damage to only the items contained within the space. If individual electronic systems are isolated and protected in this manner, the damage can be restricted to equipment clusters.

Zoned Application Systems

This design approach is a subset of the total compartment application system. These systems are designed and installed to provide complete mist distribution throughout a pre-determined portion of an enclosure or space. This can be achieved by simultaneous operation of a selected group of nozzles by manual or automatic means. These systems typically are used to protect process applications and are controlled by logic circuits that determine which areas require water application, limiting water damage to only those areas.

See Fire Protection Report FP-23-05, *Water Mist Systems*, for additional information on this topic.

Clean Agent Systems

A clean agent, formerly known as a "halon alternative," is an electrically non-conducting, gaseous extinguishing agent that does not leave a residue upon evaporation. A clean agent extinguishing system is an extinguishing system that allows a clean agent to be distributed through a series of pipes and nozzles into a suitable enclosure, where the concentration is maintained for a specified time to extinguish a fire in the enclosure. Clean agent extinguishing systems are loosely classified as "pre-engineered" or custom "engineered" systems, based on the equipment and area protected.

A pre-engineered system has a predetermined flow rate, nozzle pressure, and quantity of clean agent. These systems have specific pipe size, maximum and minimum pipe lengths, flexible hose specifications, number of fittings, and number and types of nozzles prescribed by a testing laboratory. Pre-engineered systems are turnkey packages designed for common equipment arrangements.

An engineered system requires individual design and calibration to determine flow rates, nozzle pressures, and pipe size based on the area or volume protected. Engineered systems are designed so that each nozzle provides a specific quantity of clean agent, and design criteria will include the quantity and types of nozzles and their placement in a specific system.

While clean agent systems create the least property damage, there are other concerns, including environmental issues, toxicological issues, and economic issues.

Environmental Issues

Clean agents have been developed primarily as a replacement for Halon 1301. When a clean agent is used, enclosure integrity must be adequate to ensure the extinguishing concentration is maintained for the required time. Some clean agents require a large quantity of agent to extinguish a fire. Material properties that are frequently referenced in discussing a clean agent include its Ozone Depletion Potential (ODP), the Global Warming Potential (GWP), and the Atmospheric Lifetime. The Montreal Protocol requires the ODP of fire protection agents to be zero. This requirement essentially eliminated the use of halon. Although sometimes inappropriately coupled, the ODP and GWP are two distinctly different concepts. The ODP addresses the alleged depletion of the ozone layer that filters out some of the harmful ultraviolet rays of the sun, while the GWP addresses global warming.

Toxicological Issue

The EPA restricts the use of clean agents based on whether the agent is approved for use in "manned spaces." The agents that the EPA restricts for use in "unmanned spaces" should only be considered for use in truly inaccessible areas, such as under computer room floors and in electrical equipment cabinets. Unmanned spaces that are large enough may become manned during repairs. Considerations should also be given to employees possibly being trapped in unmanned spaces, employees attempting rescue efforts in unmanned spaces, and fire-fighters who may have to extinguish the fire.

If the clean agent is approved for an occupied space, the EPA places further restrictions based on expected egress time from the space.

Economic Issues

The extinguishing concentration directly affects the storage requirements. Storage requirements affect both the economy of the system and the practicality of the system. A gas that is cheaper per pound, but requires a tremendous quantity of agent for extinguishment, may result in a more expensive system than one with a higher price per pound. This cost difference would be primarily due to the added cost of more storage cylinders and additional agent.

See Fire Protection Report FP-23-02, *Clean Agent Extinguishing Systems*, and FP-23-01, *Halon and Alternate Agents*, for additional information on this topic.

Carbon Dioxide (CO_2) Systems

A CO_2 extinguishing system is a non-conducting, gaseous extinguishing agent that does not leave a residue upon evaporation. CO_2 systems operate much like a clean agent system, but extinguish fires by completely filling the protected space, thus excluding oxygen. While the temperature involved in a CO_2 system is extremely low, -110°F (-79°C), the heat capacity of CO_2 is very limited. CO_2 is effective in fire control by cooling only when applied directly to a burning surface. Additionally, CO_2 is limited in its ability to penetrate deep-seated fires, such as trashcans and stacks of paper. CO_2 requires a much longer hold time than clean agents in order to obtain complete extinguishment.

Total flooding CO_2 systems should not be used in occupied areas unless the area is provided with an alarm system and delay circuits that allow for occupant evacuation before system discharge. Once the CO_2 is discharged into a space, the occupants may have trouble in finding escape routes due to obscured vision and lack of oxygen. Ultimately, the CO_2 will cause a loss of consciousness and suffocation. Additionally, because CO_2 is heavier than air, high concentrations can spread to lower levels and confined spaces.

Summary

Automatic suppression systems for computer equipment have distinct advantages and disadvantages that should be closely evaluated in order to select the most appropriate protection for the equipment in use. Property damage caused by the suppression system itself is difficult to estimate due to the unknown variables of each fire and the variety of systems currently available. In general, assuming proper installation, the additional property damage from fire suppression systems activation is minimal in comparison to the losses without such protection.

References

1. National Fire Protection Association (NFPA). Fire Protection Handbook. 20th ed. Quincy, MA: NFPA, 2007.

2. Computer Rooms and Other Electronics Equipment Areas. Quincy, MA: NFPA, 2012.

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