

Fire and Extinguishing Tests on Computer Equipment

Introduction

Background

In many industries, the idea of operating a firm without electronic data processing is just about inconceivable. Whereas a few years ago computers were mainly used in such fields as administration, accounting, and personnel; they are now becoming increasingly important in the factory production area. The computer system is becoming the central feature of the entire company. Failure of the computer system directly affects all aspects of the company and can lead to an interruption of production. Protective measures, therefore, must be given high priority.

A number of measures are necessary to provide computer security, and fire protection is an important factor contributing to the reliability of computer operations. Other factors are protection from burglary and sabotage, data security, reliability of air conditioning, and a secure electrical supply including protection from overvoltage. Particular attention must be paid to fire protection, however, because the effects of fire damage are often catastrophic.

In the field of defensive fire protection, area protection installations more frequently include residue-free extinguishing agents. It is possible to protect either the computer hazard (above-ceiling area, room, and underfloor), or the underfloor only. Carbon dioxide and halon are the residue-free extinguishing agents that have generally been chosen. Water sprinklers have also been installed.

Because of the need to detect and extinguish fires as quickly as possible to avoid long interruptions in production, individual cabinet extinguishing systems have also been used. This involves equipment designed to detect and extinguish a fire in a computer cabinet with minimal delay. There are differences of opinion among fire protection specialists about the effectiveness of such installations.

Because of these differing opinions, the Allianz Loss Control Service and TELA-Versicherung investigated the effectiveness of various extinguishing systems. These tests used the most realistic fire scenarios possible so that specific recommendations for practical use could be derived from the knowledge gained.

Fire Hazards

In terms of fire load and ignition danger, computer areas can be sub-divided into several risk areas:

Space Under Raised Floor, also known as False Floor and Underfloor

Relatively high fire loads in the form of energy supply and data cables are present in every computer installation. The main ignition hazards are faulty contacts, loose connections, and cable installations unrelated to the computer itself.

Computer Room

High fire loads exist here in the form of computer equipment in cabinets, wall finishing and combustibles such as paper. It should be noted that the main ignition hazard comes from the actions of personnel.

Technical Equipment

Computer equipment, power distribution panels, and air conditioning units represent a fire load that must not be underestimated, especially because of the use of plastics. Possible ignition hazards are overvoltage, failed components, overloaded circuits, faulty contacts and connections, and failure of overload protection equipment.

Neighboring Areas

The areas surrounding a computer room must be considered additional hazards to the computer. However, this investigation did not explore these hazards. This aspect must, however, be considered when developing the fire protection concept for a given computer installation since a major source of damage can be the spread of fire and smoke from adjacent areas.

Objectives

The three primary danger areas described make it clear that fire and extinguishing tests should be carried out in the under-floor, the computer room, and individual cabinets. The following test objectives were defined:

The main items to be investigated during the fire tests in the false floor are:

- How does an underfloor fire develop with time and what areas are affected?
- Can an underfloor fire spread to computer cabinets?
- Which extinguishing agents are most effective (water, halon, or CO₂)?

Test Program

Given the objectives listed above, the decision was made to carry out the following series of fire tests:

Underfloor

- Fire extinguishing using halon, CO₂, deluge, and sprinklers
- Burn-out test without automatic extinguishing

Two false floors of different heights, 11.8 in. (300 mm) and 19.7 in. (500 mm), were used in this series of tests to determine if the height of the false floor had any influence on the effectiveness of the different systems.

Computer Room

- Fire extinguishing by area flooding with Halon 1301

Computer cabinets

- Cabinet extinguishing tests with Halon 1301, Halon 1211, and CO₂ – Preliminary tests on individual units – Cold test on fully functioning computer – Fire test on fully functioning computer – Burn-out test

Fire protection is an important factor contributing to the reliability of computer operations.

Test Arrangements

First Test Area

The tests were carried out in the fire test room of the Allianz Centre for Technology in Ismaning near Munich, Germany. The room measures 19.68 ft x 32.8 ft (6 x 10 m) and has a clear height of 13.45 ft (4.1 m). In order to produce environmental conditions in the fire test room similar to those in a computer center, a false floor and suspended ceiling were installed.

False Floor System

A false floor of the type usual for computer areas was built on an area of 15.75 ft x 25.6 ft = 3.2 ft² (4.8 m x 7.8 m = 37.5 m²). The height was 11.8 in. (300 mm) for the first five tests and 19.7 in. (500 mm) during the subsequent tests. The support structure was of galvanized steel. It had been found during earlier tests that aluminum structures became unstable after being subjected to fire for a short time so that the load carrying capability of the false floor could no longer be guaranteed. The boards for the false floor were fire-resistant electrical pressboard.

Ceiling System

The suspension depth of the ceiling was 33.5 in. (850 mm). The boards of the suspended ceiling also were fire resistant.

Ventilation and Air Conditioning

The underfloor was ventilated by means of two circulation units that changed the air about 20 times per hour. The air emerged from the underfloor into the room through the nine ventilation plates. There were four extraction openings in the ceiling area. The ventilation flaps were attached to a control unit.

Since the heat released by the fully functioning computer systems created temperatures high enough for adverse effects on equipment function, it was necessary to install an air conditioning plant in the test room. A water-cooled air conditioning cabinet with a cooling power of 18 kW was used. The cooled air was fed directly into the underfloor.

Fire Detection System

Four smoke detectors, connected in two groups, were installed below the suspended ceiling in the test room. Two ionization and two optical smoke detectors were used. The installation conformed to the guidelines given in Form 3006 of the Association of Property Insurers (Verband der Sachversicherer – VdS). The ionization and optical smoke detectors installed in the false floor were also connected in two groups. The control unit controlled the air circulation units, the closing of ceiling flaps, and the electrical supply to the computer units.

Ignition Source

It was considered important to have the fire occur in a way that was as realistic as possible. Current practice in most fire tests is to ignite the fire by using gas/oil burners or combustible fluids (such as n-hexane). This does not correspond to any realistic fire source in a computer center.

For this reason, the ignition source used was a 3.3 ft (1 m) long resistance wire which was connected to a controllable 220 VAC source with a 10 A fuse. The wire was wound around a combustible board, 2.4 in. x 1.2 in. (60 x 30 mm), and installed in a thermoplastic junction box. In order to increase the fire load, the junction box was placed in kerosene-soaked fiber rods, approximately 1 oz (25 g). The resistance wire was heated by increasing the voltage until it was red hot and the junction box was thus set on fire. By this means, it was possible to be sure that a fire would really occur in the computer units; it was also closer to actual practice than if ignition was obtained by using combustible fluids.

Test Execution and Results

Fire and Extinguishing Tests in the False Floor

For these extinguishing tests, cables typical of those generally used in computer rooms were laid in the false floor. In some cases, the cables were laid in cable trays 11.8 in. (300 mm) wide and in others they were laid in an unordered manner. In order to have the same fire load for each fire test, the floor always contained the same number and type of cables. The length of the cables was approximately 14.8 ft (4.5 m). The temperature was measured at 15 points during the fire tests in the false floor. Interface cables were laid, via a 0.66 ft x 0.66 ft (0.2 m x 0.2 m) cutout in the floor, into a disk store installed on the false floor in the center of the fire test room. This was intended to permit observation of the spread of the fire from the false floor into the machine. Temperature sensors were also installed at this location. Ignition took place in the false floor between measuring stations 1 and 6 approximately 11.8 in. (300 mm) from the machine.

Halon Extinguishing Equipment

Extinguishing tests were carried out in both the 11.8 in. (300 mm) and 19.7 in. (500 mm) high false floors. The extinguishing system was put into operation by the fire detection equipment which was connected in two groups in the false floor. The results from both tests were approximately the same.

Extinguishing Test with Area Flooding Equipment

The extinguishing test with a halon area flooding system was intended to permit conclusions on whether incipient fires in computer cabinets could be extinguished with certainty by area flooding systems.

When a computer unit burns, a positive pressure builds up within the unit because of the increase in the volume of the air and combustion gases associated with the combustion process. Because of the compact and encapsulated design of computer cabinets, it is conceivable that the halon pressure may not be high enough to penetrate into the unit when area flooding is used. It will then be impossible for a concentration capable of extinguishing the fire to build up within the unit.

During the area flooding test with Halon 1301, a defective door opened in a disk storage unit when the fire was ignited. For this reason, the test could not be included in the analysis. It was not possible to carry out further tests for reasons associated with environmental protection. The combustion gas washer in the fire test room was not large enough to prevent the permissible maximum workplace figure for fluorine constituents (5 mg/cubic meter) from being exceeded.

Cold Tests on Fully Functional Computer

A second series of tests was carried out on a fully functional computer. No fire was ignited in these cold tests. The intention was to investigate whether the functioning of the computer system is adversely affected by the introduction of the extinguishing agent (if, for example, an accidental discharge occurs). During the tests, the temperature in the computers was measured at 23 different points, the concentration of extinguishing agent at eight points, and the relative humidity at two points.

The series of tests was planned in such a way that the tests for which little adverse effect on function was expected were carried out first. The tests where severe "cold shock" was expected were placed at the end of the series. Halon 1301, Halon 1211, and CO₂ were all used. Tests were carried out with the computer equipment both de-energized and live.

In order to achieve the objectives described, the following test series was carried out:

- Flooding with Halon 1301 with computer switched off
- Flooding with Halon 1301 with computer switched on
- Flooding with Halon 1211 with computer switched off
- Flooding with CO₂ with computer switched off
- Flooding with CO₂ with computer switched on

In all the tests, the floor ventilation was in operation. After each test, the computer system was checked by a maintenance technician for functional capability by the use of test programs. All the command and storage functions of the central unit, along with data transfer to and from disk storage, were tested.

The most important information derived from this series of tests was that the functional capability of the computers was not affected by the direct introduction of extinguishing agent into the computers.

Summary of Results

Fire and Extinguishing Tests in the False Floor

In all of the false floor tests, the periods between ignition and fire recognition was less than one minute.

Extinguishing Tests Using Water as the Extinguishing Agent

All the extinguishing tests using sprinkler and deluge extinguishing systems had negative results. The thermal convective current present in the false floor during the initial phase of the fire was sufficient to open a sprinkler in one case only. In all the tests, the smoke was so thick that it was no longer possible to see and it became impossible to remain in the room without breathing apparatus. In all the tests of this series, the fire spread from the false floor into the computer cabinets. Sprinklers were therefore found to be unsuitable for fighting fires in false floors.

Extinguishing Tests Using Gaseous Extinguishing Agent

The extinguishing tests using gaseous extinguishing agents had positive results. Once the fire had been detected, the incipient fire was reliably extinguished in every case by switching off the air conditioning and flooding the false floor. The distribution of the extinguishing agent in the false floor was uniform. Cable ducts, enclosures, and ventilation outlets do not represent obstructions in this respect. Although extinguishing gas did emerge into the room and, via cable outlets, into the computer cabinets during flooding, there was no evidence of agent concentration buildup in the cabinets to the extent necessary to extinguish a fire. Smoke in the room was minimal. After the extinguishing procedure was finished in each test, traces of fire could be identified only in the immediate vicinity of the ignition location. There was never any danger of the fire spreading into the computer units.

Conclusion

It is possible to conclude from the test results that only gaseous extinguishing systems, either halon or CO₂, can reliably combat fires in false floors.

High reliability must be set for computer systems and other electronic controls because firms are largely dependent on their correct functioning. Fire protection is one of the most important parts of the overall security concept. The fire tests described have demonstrated ways of effectively combating incipient fires in the vicinity of and inside computers.

These tests have shown quite clearly that sprinkler systems are not suitable for false floor protection. This result could be extended to the computer room itself. It is not possible to protect electronic equipment by means of automatic water extinguishing systems. Their value for protecting buildings, however, remains undisputed. If building protection by the sprinkler system comes into action, it must be assumed that the computer units already have been destroyed.

Reprinted with permission of National Association of Fire Equipment Distributors.