April 2012
Interim Revision April 2025

TELECOMMUNICATIONS

Table of Contents

Page

List of Figures

List of Tables

1.0 SCOPE

This document gives property protection recommendations for telephone central offices (TCOs), mobiletelephone switching offices (MTSOs), and facilities that process audio, video, and data signals.

This data sheet does not cover facilities that use Voice Over Internet Protocols (VOIP) electronic equipment; refer to FM Property Loss Prevention Data Sheet 5-32, *Data Centers and Related Facilities*.

1.1 Changes

April 2025. Interim revision. Significant changes include the following:

A. Revised the Section 1, Scope, to clarify the intent for facilities with direct current (DC) power equipment that use switches and relays. Facilities that use Voice Over Internet Protocols (VOIP) electronic equipment should refer to OS/DS 5-32, *Data Centers and Related Facilities*.

B. Revised Section 2.1.4, Wind, to remove the reference to OS/DS 1-8, *Antenna Tower and Signs*. This OS/DS is obsolete, effective April 2025.

1.3.1 Reevaluations

April 2025. No reevaluations are required at this time.

2.0 LOSS PREVENTION RECOMMENDATIONS

2.1 Construction and Location

2.1.1 General

2.1.1.1 Locate telecommunications offices in buildings of noncombustible construction.

2.1.1.2 Protect telecommunications offices against external fire exposures. Do not allow combustible materials to expose the building or the air intake(s) for the building.

2.1.1.3 Provide two-hour fire-resistance rated interior walls, partitions, and floors for communications equipment rooms, and power rooms (stand by generator, ac power, and battery) designed in accordance with Data Sheet 1-21, *Fire Resistance of Building Assemblies*.

2.1.1.4 Provide FM Approved 1½ hr rated fire doors. Provide an electromechanical or electromagnetic holding mechanism interlocked to close the door on smoke detector actuation if the door is open intermittently or permanently.

2.1.1.5 Provide tempered or wired glass in windows of control rooms facing communication equipment rooms where the room is protected by an automatic sprinkler system. Ordinary glass is acceptable where an automatic gaseous agent system is used. Ordinary glass is also acceptable between control rooms and equipment rooms protected by an automatic sprinkler system if combustibles in the vicinity are limited or kept in metal cabinets. ″Limited combustibles″, in this case, should not exceed some seating and a few books or manuals.

2.1.1.6 Seal openings in fire-rated floors and walls through which pipes, wires, and cables pass with an FM Approved or Listed penetration seal with a fire resistance rating equivalent to the rating of the wall or floor. Provide leakage rated penetration seal with a rating as low as possible but not exceeding 7 $ft^3/min/ft^2$ (2.1 $m^3/min/m^2$) in addition to the fire resistance rating for equipment room penetrations (see Figure 1). When new construction or modifications are in progress, install temporary closures for protection when work is stopped at night and during weekends (see Figure 2).

2.1.1.7 Construct suspended ceilings of Class I materials; see Data Sheet 1-12, *Ceilings and Concealed Spaces*.

2.1.1.8 Ensure HVAC system filters are of noncombustible materials. Clean filters on a regular schedule to prevent accumulation of combustible dust; see Data Sheet 1-45, *Air Conditioning and Ventilating Systems*.

2.1.1.9 Construct raised floors of noncombustible materials.

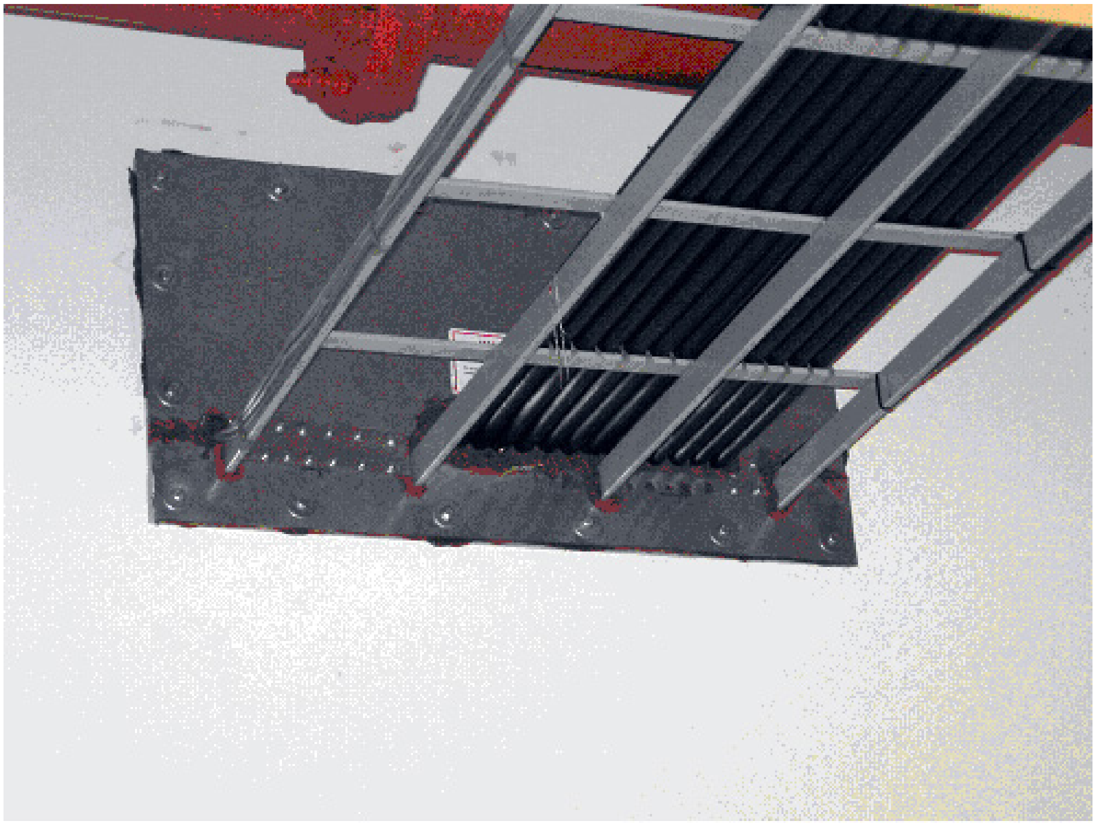

Fig. 1. Properly maintained cable penetration seal

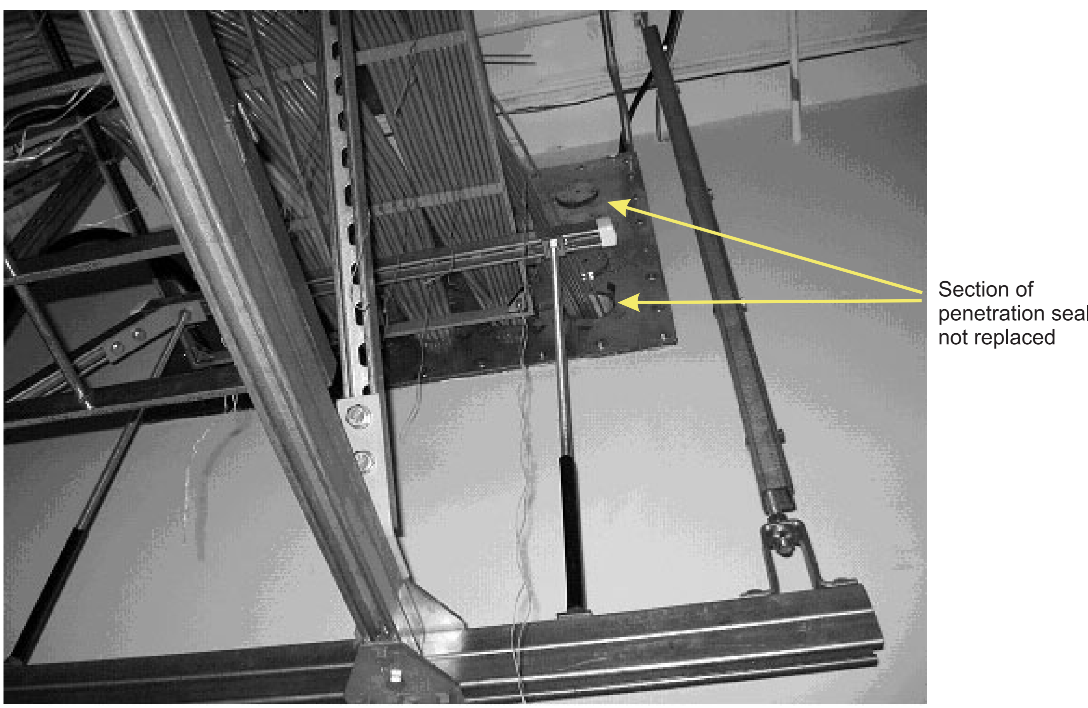

Fig. 2. Improperly maintained penetration seal

2.1.1.10 To prevent water damage to telecommunications equipment, do not locate roof drains or domestic water lines that are not needed for operations in the room. If such piping is located in the room, provide leak detection.

2.1.2 Flood

2.1.2.1 Locate new facilities outside of the 500-year flood exposure.

2.1.2.2 Develop a powerdown procedure to reduce damage to communications equipment.

2.1.2.3 Protect telephone offices against surface water runoff in accordance with FM data sheets on flooding.

2.1.2.4 Provide water-removal capability for all below-grade vaults subject to flooding from surface water runoff or sewer backup.

a) Use automatic-starting sump pumps with an alarm to a constantly attended area.

b) Natural sumps may be acceptable where the soil is an absorbent sand.

c) Portable pumps are satisfactory where there is (a) an adequate advance warning, (b) a good flood emergency response plan, and (c) adequate personnel on site to implement the plan. Ensure electric-powered sump pumps are capable of being powered by the emergency power supply.

2.1.3 Earthquake

2.1.3.1 Design buildings and equipment in accordance with Data Sheet, 1-2 *Earthquakes*.

2.1.3.2 Design fire protection systems in accordance with Data Sheet 2-8, *Earthquake Protection for Water-Based Fire Protection Systems*.

2.1.3.3 Anchor the following items to resist earthquake forces in accordance with provisions of Data Sheet 1-2, *Earthquakes,* and the additional requirements.

1. Provide shims between batteries and between batteries and racks if necessary to prevent shifting of batteries. Properly anchor diesel generator batteries and fuel tanks to resist a seismic design load for a minimum horizontal acceleration (G factor), based on Allowable Stress Design (ASD) of $0.5*S_{DS}*I_p$ unless a different value is justified per Data Sheet 1-2, Section 2.2.2.1.

2. Provide earthquake bracing for water piping in or above telecommunication equipment areas. Design bracing to resist a seismic design load for a minimum horizontal acceleration (G factor), based on Allowable Stress Design (ASD) of $0.5*S_{DS}*I_p$ unless a different value is justified per Data Sheet 1-2, Section 2.2.2.1.

3. Protect automatic sprinkler piping in accordance with DS 2-8, *Earthquake Protection*.

4. Design raised floors to resist a seismic design load for a minimum horizontal acceleration (G factor), based on Allowable Stress Design (ASD) of $0.5*S_{DS}*I_p$ unless a different value is justified per Data Sheet 1-2, Section 2.2.2.1. Anchor with bolts to pedestals in active seismic areas. Do not simply glue to concrete substrate.

2.1.3.4 Provide seismic shut-off valves to safely shut down ignitable liquid and flammable gas systems in the event of strong ground movement that can cause systems to fail.

2.1.4 Wind

Design buildings for wind forces in accordance with Data Sheet 1-28, *Wind Design*.

2.2 Occupancy

2.2.1 Locate new equipment awaiting installation in storage and staging areas where a fire involving the storage will not expose critical equipment.

2.2.2 Limit in-process storage to two pallet loads in telecommunications equipment rooms and locate so they do not expose batteries, power cable or telecommunications equipment, where storage and staging areas are not available.

2.2.3 Remove waste materials from areas exposing critical equipment at the end of each shift.

2.2.4 Do not store combustible materials in HVAC rooms and cable vaults.

2.2.5 Do not locate plant utilities, such as power cable, water pipe, and natural gas piping, in cable vaults.

2.3 Protection

2.3.1 General Building

2.3.1.1 Provide automatic sprinkler protection throughout buildings made of combustible construction or that contain combustibles.

2.3.1.2 Provide portable extinguishers suitable for Class A and Class C fires. The minimum rating is 2-A, the maximum floor area per A is 1,500 ft^2 (140 m^2) with a maximum travel distance of 25 ft (7.6 m). Do not use dry chemical extinguishers in communication equipment areas.

2.3.1.3 Notify the fire service immediately when the network operations center (NOC) receives a fire alarm. In addition, send a technician to investigate if the office is not manned.

2.3.2 Communication Equipment Areas

2.3.2.1. Provide very early warning fire detection (VEWFD) as specified in Section 2.3.9.

2.3.2.2 Provide one of the following protection systems:

a) An FM Approved clean agent fire extinguishing system designed and installed in accordance with the manufacturer's installation instructions and Data Sheet 4-9, *Halocarbon and Inert Gas (Clean Agent) Fire Extinguishing Systems*. The concentration depends on the agent selected (see Data Sheet 4-9).

b) An automatic sprinkler system. Provide automatic sprinklers with a temperature rating of 165°F (74°C) and 130 ft^2 (57 m^2) spacing. Provide a density of 0.15 gpm/ft^2 (6 mm/min) over an area of 2,500 ft^2 (230 m^2), with a hose stream demand of 250 gpm (950 lpm) for a duration of 60 minutes.

2.3.3 Cable Vaults

2.3.3.1 Provide automatic sprinkler protection designed to deliver a density of 0.15 gpm/ft^2 (6 mm/min) over an area of 2,500 ft^2 (230 m^2) plus a hose stream demand of 250 gpm (950 lpm) for a duration of 60 minutes. Use automatic sprinklers with a temperature rating of 165°F (74°C).

2.3.3.2 Provide combustible gas detection for cable vaults with an alarm to a constantly attended area at 25% of the lower flammable limit (LFL). Where vaults can be exposed by a gasoline spill (i.e., entrance to the vault is from the street), calibrate for gasoline; otherwise, calibrate for methane.

2.3.4 Sub-floor/Above-ceiling Areas Containing Cable

2.3.4.1 Provide smoke detection and a ready means of access.

Exception: If VEWFD detection is provided in the room and air is re-circulated from the sub-floor into the room, detection is not needed for underfloor areas.

2.3.4.2 Provide an automatic fire protection system for cables present in noncombustible spaces, such as under raised floors and above suspended ceilings. Actuate the system by smoke detection. The fire protection system may be one of the following (see exception below):

a) A CO_2 system designed and installed in accordance with Data Sheet 4-11N, *Carbon Dioxide Extinguishing Systems,* to achieve a concentration of 50% with a 20 minute hold-time.

b) An FM Approved clean agent fire extinguishing system designed and installed in accordance with the manufacturer's installation instructions and Data Sheet 4-9, *Halocarbon and Inert Gas (Clean Agent) Fire Extinguishing Systems*. The concentration depends on the agent selected (see Data Sheet 4-9).

c) Water mist systems may be used for under-floor protection if they can be designed to meet the FM Approvals listing. The listing requires the system to be designed and installed in accordance with Data Sheet 4-2, *Water Mist Systems,* and the manufacturers'. A system is presently FM Approved for subfloor areas of computer rooms. The system is designed as a basic unit that can protect an area 16.4 by 32.8 ft (5 by 10 m) in area and 20 in. (0.5 m) high. For larger areas, basic units can be installed next to each other along the long side of the unit. The system is FM Approved based on the following:

1) Openings in the subfloor do not exceed 1% of the floor area for floor areas 540 ft^2 (50 m^2) and less, and 0.75% for larger floor areas,

2) the width of the computer room does not exceed 33 ft (10 m),

3) ventilation is automatically shutoff, and

4) equipment shutdown begins on system actuation. The system provides 10 minutes of protection.

2.3.4.3 Provide one of the following for combustible spaces:

a) Replace the combustible floors/ceilings with noncombustible material, or

b) Provide automatic sprinkler protection designed to deliver a density of 0.15 gpm/ft^2 (6 mm/min) over 2500 ft^2 (232 m^2) the underfloor space. Use automatic sprinklers with a temperature rating of 165°F (74°C), or

c) Provide a clean agent fire extinguishing system designed and installed in accordance with Data Sheet 4-9, *Halocarbon and Inert Gas (Clean Agent) Fire Extinguishing Systems,* for Class A surface fire hazards. The concentration depends on the agent selected. A 10-minute hold-time is acceptable.

2.3.5 Standby Diesel Generators

2.3.5.1 Single Occupant of the Building

Where the telecommunications facility is the only occupant of the building, and the fuel storage tank is located outside the building, and day tank(s) in the diesel generator room contain 250 gal (0.95 m^3) or less, the quantity of diesel fuel involved in a fire is expected to be limited and the recommendations below apply:

1. Provide one of the following fire protection systems for protection of diesel generator rooms:

a) An automatic sprinkler protection system designed to deliver a density of 0.25 gpm/ft^2 (10 mm/min) over the generator room area plus 500 gpm (1900 L/min) for hose streams.

b) A water mist system FM Approved for protection of machinery spaces (see Data Sheet 4-2, *Water Mist Systems*).

c) A clean agent fire extinguishing system designed and installed in accordance with manufacturer's instructions and Data Sheet 4-9, *Halocarbon and Inert Gas (Clean Agent) Fire Extinguishing Systems.*

2. Provide the following for the day tank:

a) Locate the tank in a diked area to contain fuel spills. Double wall tanks are acceptable with leak detection in the space between provided piping enters and exits the tank through the top. A dike around the tank is required when there are pipe connections in the bottom of the tank.

b) Vent the day tank to the outside.

3. Ensure fuel transfer pumps are curbed to contain leakage. Locate the fuel transfer pumps outside for new installations.

4. Provide a thermally actuated valve or equivalent in the fuel line to the diesel generator to isolate the day tank from generator in event of fire.

5. Isolate the main fuel storage tank from the day tank by interlocking the fuel transfer pump with the fire protection system and leak detection system in the diesel generator room.

2.3.5.2 Multi-tenanted Buildings

2.3.5.2.1 Where the telecom office is located in a multi-tenanted building, comply with recommendations for fuel storage, fuel piping, and diesel generator protection contained in DS 5-23, *Design and Protection for Emergency and Standby Power Systems*.

2.3.6 Battery Rooms

2.3.6.1 Provide one of the following protection systems:

1) A clean agent fire extinguishing system designed and installed in accordance with manufacturer's instructions and Data Sheet 4-9, *Halocarbon and Inert Gas (Clean Agent) Fire Extinguishing Systems.*

2) An automatic sprinkler system designed to deliver a density of 0.15 gpm/ft^2 (6 mm/min) over an area of 2,500 ft^2 (230 m^2)with a hose stream demand of 250 gpm (950 lpm) for a duration of 60 minutes. Automatic sprinklers should have a temperature rating of 165°F (74°C.

2.3.7 Control rooms

2.3.7.1 Provide one of the following protection systems:

a) A clean agent fire extinguishing system designed and installed in accordance with manufacturer's instructions and Data Sheet 4-9, *Halocarbon and Inert Gas (Clean Agent) Fire Extinguishing Systems.*

b) An automatic sprinkler system designed to deliver a density of 0.15 gpm/ft^2 (6 mm/min) over an area of 2,500 ft^2 (230 m^2) with a hose stream demand of 250 gpm (950 lpm) for a duration of 60 minutes. Automatic sprinklers should have a temperature rating of 165°F (74°C).

2.3.8 Offices/Storage Rooms

2.3.8.1 Provide automatic sprinkler protection in these areas designed per the applicable data sheet.

2.3.9 Detection

Very early warning fire detection (VEWFD) systems detect smoldering or off-gassing typically generated from an overheating condition or from low-energy fires. VEWFD systems detect incipient fires in critical areas before flame or even noticeable smoke develops. VEWFD may use aspirating (air-sampling detectors) or high-sensitivity, intelligent, spot sensor/detectors.

2.3.9.1 Provide FM Approved VEWFD systems installed in accordance with manufacturer's criteria in telecommunication equipment areas. Install detection in the communication equipment room and return air systems. Figure 3 is a sample illustration of one type of VEWFD system installation. Refer to the manufacturer's installation guide for installation of these systems.

2.3.9.1.1 Install a sensor or port in an area no greater than 200 ft^2 (18.6 m^2) where one level of sensors are used. The sensors or ports do not need to be located in the center of the bay. Do not locate them within 3 ft (0.9 m) of supply duct registers.

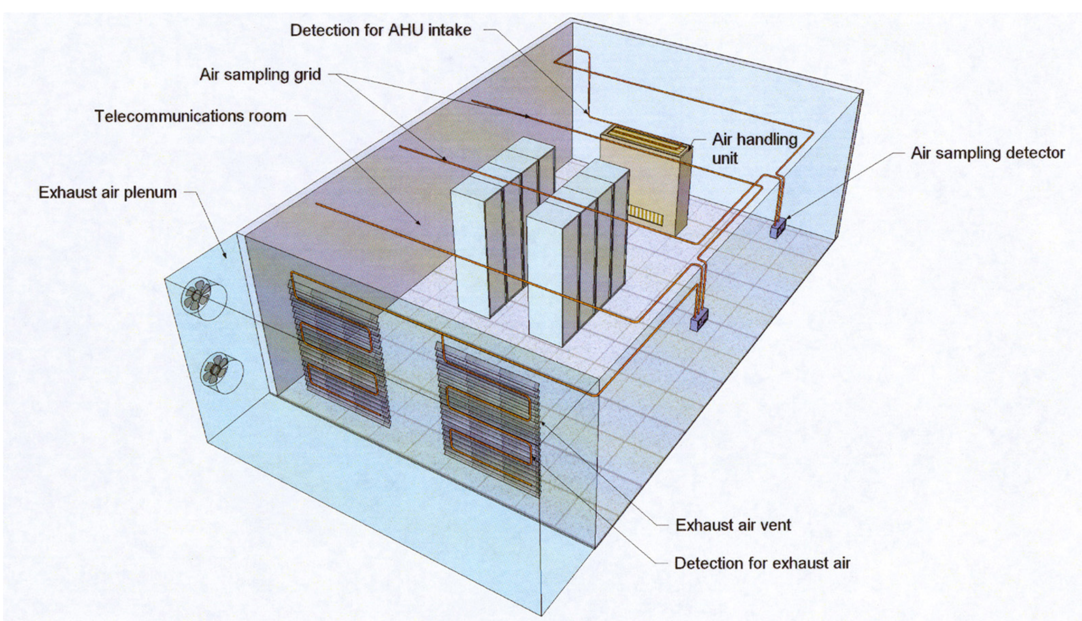

Fig. 3. Very early warning detection system

2.3.9.1.2 Install a sensor or port in an area no greater than 400 ft^2 (37.2 m^2) where two levels of detection are used. Two levels of detection may be used where cable trays would be expected to obstruct the flow of smoke to the ceiling. In this case locate one level of detection below the cable trays and one level at the ceiling. Stagger the sensors or ports between each level.

2.3.9.1.3 Install sensors or ports to monitor return air.

a) Locate sensors or ports where return air enters the unit for stand-alone HVAC units.

b) Locate sensors or ports so each covers an area no greater than 4 ft^2 (0.4 m^2) of the return opening.

2.3.9.1.4 Set minimum sensitivity settings above ambient airborne levels for alert and alarm condition.

2.3.9.1.5 Do not allow transport time to exceed 60 seconds from the most remote port to the detection unit for air sampling systems.

2.3.9.2 Conduct smoke tests when the VEWFD system is installed to verify smoke detectors are properly located with regard to air flow within the protected area. Give special attention to ventilation and stratification within the protected area. Since dilution of smoke can occur within a large room, do not exceed the recommended spacing.

2.3.9.3 Test the VEWFD system once every two years to verify proper operation. One test method is described in Appendix C.

2.3.9.4 Install fire detection in adjacent areas (offices, storage rooms, cable tunnels) that present an exposure to telecommunications equipment. Monitoring the waterflow alarm is an acceptable alternative where these areas are protected by automatic sprinkler systems. Install fire detection in accordance with Data Sheet 5-48, *Automatic Fire Detection*, and NFPA 72.

2.3.9.5 Transmit fire alarms to a constantly attended central supervisory station or to a constantly attended location staffed by trained personnel.

2.3.10 Gaseous Extinguishing Systems

2.3.10.1 Design, install and maintain FM Approved clean agent (halon alternative) fire extinguishing systems in accordance with criteria in NFPA 2001, *Clean Agent Fire Extinguishing Systems*.

2.3.10.2 Actuate the protection system either by VEWFD or by an FM Approved cross-zoned smoke detection system as follows:

1. For VEWFD, actuate an alert condition in a constantly attended location when the alert setting for the VEWFD has activated at the facility. At the pre-alarm setting, the control system should automatically shut off air conditioning and close fire dampers. At the alarm setting, it should discharge the extinguishing agent after a time delay not exceeding 30s. Ensure the alarm setting is comparable to the alarm setting for conventional smoke detectors, or

2. For cross-zoned smoke detection, actuate an alarm in a constantly attended location. Shut off air conditioning and close fire dampers on actuation of the second detector. Discharge extinguishing agent after a time delay not exceeding 30s.

Exception: Air conditioning units that take air from the room and recirculate air back to the room do not need to be shut off.

2.3.10.3 Ensure a reserve supply of clean agent equal to at least the largest system in use is available within a 24-hour period.

2.3.11 Smoke Control and Smoke Removal

If a smoke control and smoke removal system is to be installed, follow these guidelines.

2.3.11.1 Shut down the HVAC system in the event of fire unless it is designed to remove smoke.

2.3.11.2 Follow smoke control and smoke removal recommendations in Data Sheet 1-45, *Air Conditioning and Ventilating Systems,* for a non-dedicated system,

2.3.11.3 Arrange the smoke control and removal system to be powered by both normal and emergency power sources.

2.3.11.4 Protect the power supply cable for the smoke control and removal system against fire exposure if located in the fire area.

2.3.11.5 Design the smoke removal system to exhaust smoke as near to the ceiling as possible. Provide exhaust flow rates of 4,000 ft^3/min (113.3 m^3/min) plus cooling air flow through the equipment. Introduce make-up air as close to floor level as possible. Ensure air velocity from the make-up air plenum does not exceed 180 ft/min (54 m/min).

2.3.11.6 Actuate the system automatically by smoke detectors located within the fire area.

2.3.11.7 Provide barriers below raised floors between switches where more than one switch is located in the same fire area. This to prevent smoke exhausted from a fire on one switch from damaging an adjacent switch. Smoke control is not expected to reduce the loss where there is one switch located in the fire area with cable below the raised flooring.

2.3.11.8 Conduct tests to verify pressure drop is being maintained between the fire area and adjacent areas. The pressure drops in Table 1 are recommended.

a) Conduct tests annually to verify the pressure drop between the fire area and adjacent areas.

b) Conduct operational tests semiannually on all components of a dedicated system and on any component of a non-dedicated system not in operation during normal use of the HVAC system.

2.3.11.9 Provide exhaust risers with a fire and smoke damper, at each floor penetration. Arrange the damper to close on detection.

Table 1. Suggested Minimum Design Pressure Difference Across Smoke Barriers

Ceiling Height	*Design Pressure Difference (in/mm Water Gauge)**
9 ft (2.7 m)	0.10 in. (2.5 mm)
15 ft (4.6 m)	0.14 in. (3.6 mm)
21 ft (6.4 m)	0.18 in. (4.6 mm)

* When automatic sprinkler protection is provided, the minimum design pressure is 0.05 in. (1.3 mm) w.g. for any ceiling height

2.3.12 Security

2.3.12.1 Establish a procedure, such as card access, to verify that an individual entering the facility is an authorized employee.

2.3.12.2 Protect data base files against unauthorized computer access by means of a computer security system (firewall). Information to be protected includes billing, routing, customer information, security codes, authorization codes, etc.

2.3.12.3 Protect electronic components, such as circuit boards, from theft (see Data Sheet 9-16, *Burglary and Theft)*.

2.4 Operations and Maintenance

2.4.1 Gaseous Agent Fire Extinguishing System

2.4.1.1 Inspect and test clean agent systems in accordance with Data Sheet 4-9 *Halocarbon and Inert Gas (Clean Agent) Extinguishing Systems*.

2.4.1.2 Conduct a door fan test:

a) During system installation to verify agent concentration will be maintained.

b) Following an annual inspection if uncertainty exists with regard to the enclosure integrity.

2.4.2 Diesel Generators

2.4.2.1 Use lockout tagout procedures on fuel pumps supplying fuel to diesel generator day tanks when work is performed on fuel lines or fuel filters to prevent accidental starting of pump and discharge of fuel while the area is not attended.

2.4.2.1 To prevent accidental use, lock or weld shut old fuel lines to diesel fuel tanks if not connected to tank.

2.5 Emergency Response

Many fires are power-related equipment fires. In many cases, circuit protection operates properly and fire damage is limited to the equipment. In some cases the fire may involve power cable. In these events the power must be isolated to the cable.

2.5.1 Provide emergency response teams (ERTs) for locations that are normally attended. Include the following:

a) Personnel designated to notify the fire service and operate extinguishing equipment.

b) Individuals who can isolate all sources of power, including commercial power, rectifiers, batteries, and generators, to the fire area.

c) Annual drills to be sure ERT members are familiar with the steps to take.

2.5.2 Have a procedure in place that allows fire service access and the ability to shut off power to the affected area. Include the following:

a) Fire service access: Telecoms have controlled access using door locks or card control. Firefighters need access to the building. Use a lock box to facilitate access to the building.

b) Reflective markings on the floor and on the equipment (see Figure 4). Start the markings from the point of entry of firefighters. The intent is that when the fire area is located and determined to be of electrical origin, they can follow floor markings back to the power area and to circuit breakers and disconnect equipment that will allow them to isolate power to the fire area. Figure 5 shows the location of power disconnect points.

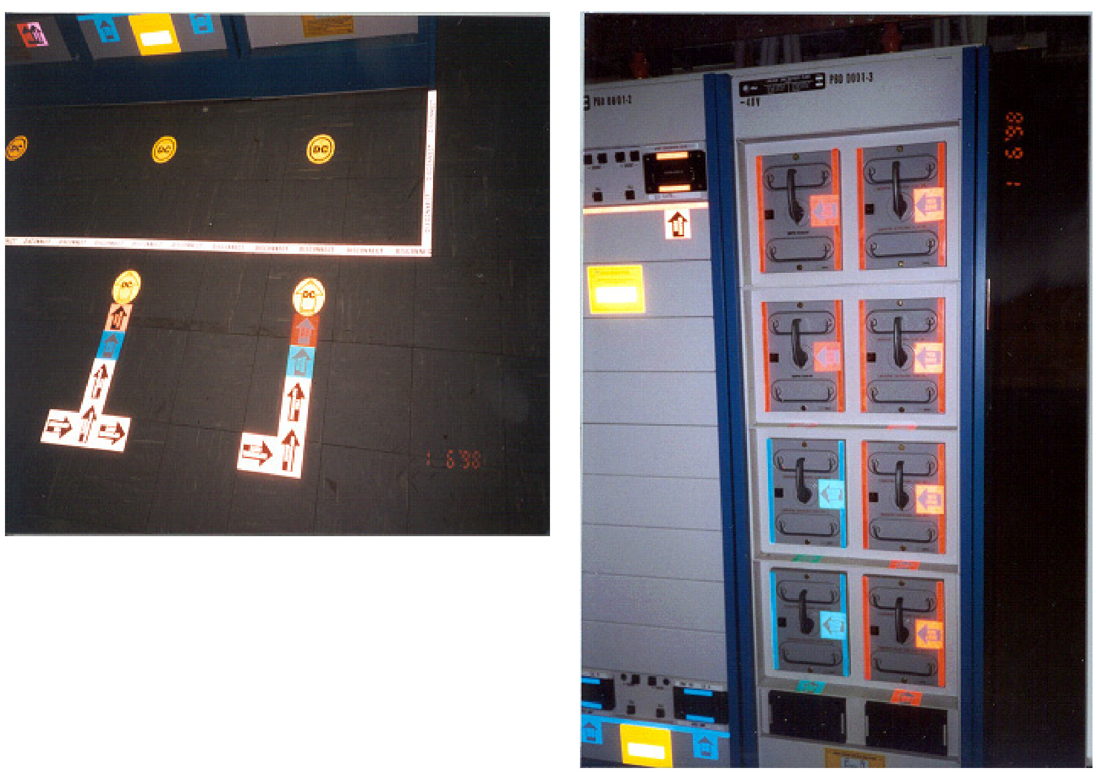

Fig. 4. Reflective markings on both the floor and power disconnect equipment.
Reflective markings allow firefighters to follow power feeds from the source of the fire to disconnect locations so power can be isolated for the affected area

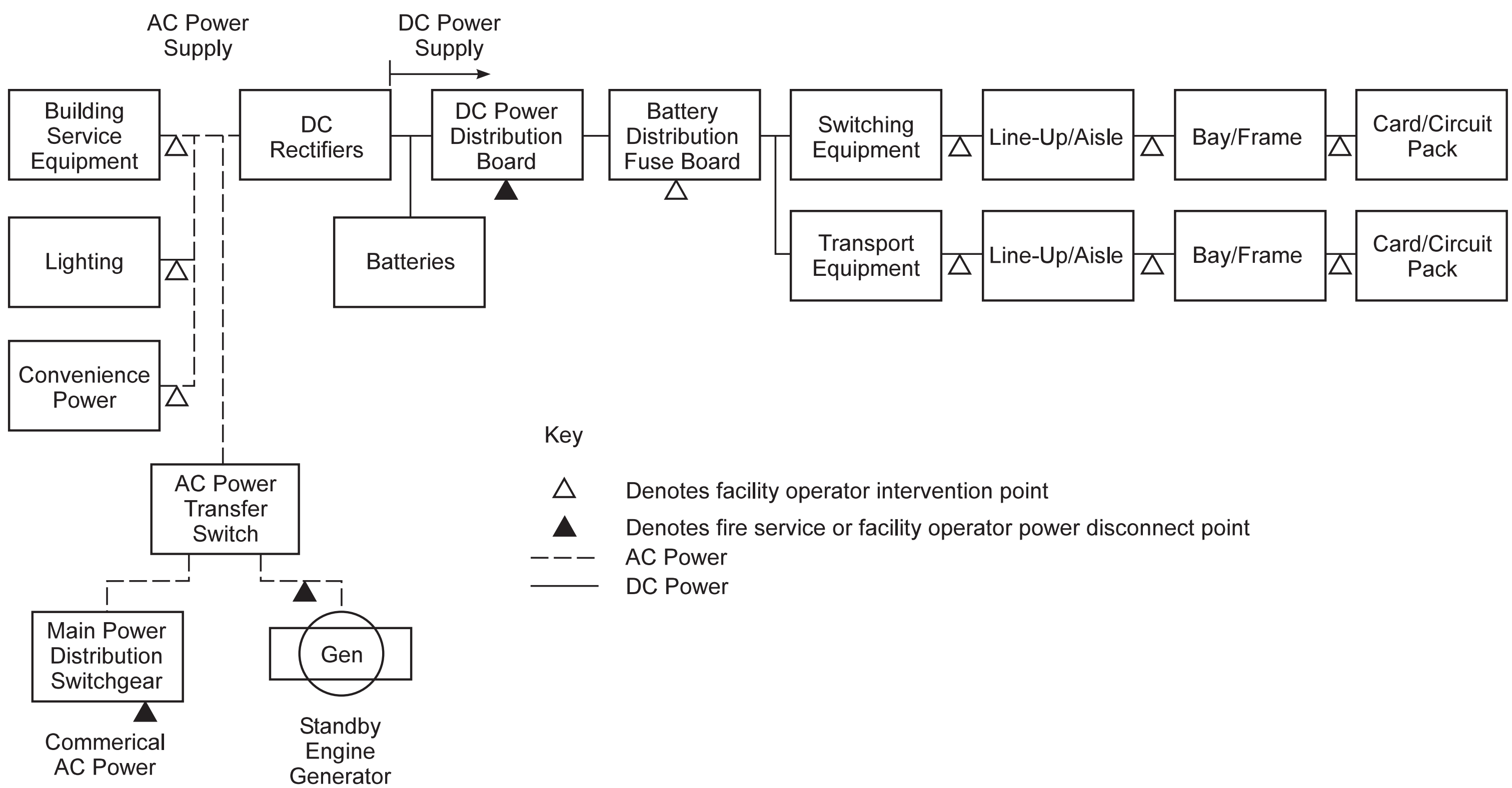

Fig 5. Telecommunications facility power sources showing selective disconnect points

c) Training in how to properly operate circuit breakers and disconnect equipment (i.e., do not pull partially out. Pull all the way out and put on the floor in front of the equipment. When operating a circuit breaker pull the breaker down all the way without pause).

d) Documentation: A binder available to the fire service inside the building entrance with the following information:

1. Floor plans
2. Contact names and phone numbers of telco personnel responsible for the site
3. Location of emergency power shutdown switches

2.5.3 Notify the fire service immediately. Notification can be direct, through the NOC, or through an appropriate constantly attended location

2.5.4 Annual exercise and review:

a) Physical arrangement of the facility and depowering program

b) A walk-through drill in which power shutdown is simulated

2.6 Electrical

2.6.1 General

2.6.1.1 Protect electrical distribution and communication equipment against over voltage by providing surge protection at the power supply origin and equipment terminals.

2.6.1.2 Provide suitable over-current protective devices to protect communication equipment. Install ac power circuits in accordance with the National Electrical Code (NEC). Install dc power circuits in accordance with *ANSI T1.311-1998, DC Power Systems-Telecommunications Environment Protection.*

2.6.1.3 Separate power cable from communication cable by running power cable in separate trays.

2.6.2 Commercial Power

Install, protect, test, and maintain transformers in accordance with Data Sheet 5-4, *Transformers*.

2.6.3 Diesel Generators

2.6.3.1. Use lockout tagout procedures on fuel pumps supplying fuel to diesel generator day tanks when work is performed on fuel lines or fuel filters to prevent accidental starting of the pump and discharge of fuel while the area is not attended.

2.6.4 DC Power Plant Equipment

2.6.4.1 Locate centralized dc power plants in two-hour-rated rooms with ventilation systems separate from telecommunications equipment areas.

a) Design battery rooms in accordance with Article 480 of the NEC.

b) Provide adequate ventilation to prevent hydrogen buildup. Install a hydrogen detection system to alarm at a constantly attended area in event of ventilation failure.

c) Maintain and test battery systems in accordance with Data Sheet 5-19, *Switchgear and Circuit Breakers*.

2.6.4.2 Do not use battery acid absorbent bags unless they are required by the local government authorities, in which case, use FM Approved battery acid absorbent bags.

A battery failure could ignite the fabric of battery acid absorbent bags that are not FM Approved, and result in fire spread across the surface of the bags, directly exposing the batteries. Depending on the material of construction, a multiple number of batteries may be involved.

2.6.4.3 Provide the following protection for valve-regulated lead acid (VRLA) batteries to reduce the possibility of thermal runaway.

a) Provide an automatic battery-monitoring system, with alarm transmitted to a constantly attended location, to warn of thermal runaway. Monitor two of the following:

1) Battery temperature

2) Battery voltage

3) Float current

4) Conductance

b) Do one of the following if there are indications of conditions leading to a thermal runaway:

1) For constant voltage float operation, reduce the voltage below the threshold that will sustain thermal runaway

2) For constant current float operation, reduce the current below the threshold value

3) Disconnect battery from charger or rectifier

4) Turn off the rectifiers or chargers

2.6.4.4 Use noncombustible construction. Ventilate battery enclosures, where provided, to control ambient temperature and prevent hydrogen buildup. Base ventilation on the failure or extreme overcharge conditions. For both types of batteries hydrogen can be evolved at a maximum rate of 4.5×10^{-6} ft^3/s (1.27×10^{-7} m^3/s) per ampere per cell at 77°F (25°C). The above information is from IEEE 484 and IEEE 1187.

2.7 Ignition Source Control

2.7.1 Use the FM *Hot Work Permit System* where hot work cannot be avoided.

2.7.2 Provide Maintenance Operations Protocols (MOP) to contractors.

a) Describe proper procedures for cable mining.

b) Require closing wall penetrations with temporary penetration seals when penetration seals must be left open overnight or over the week end. Also, require closing penetration seals with FM Approved or Listed materials on completion of work.

2.7.3 Store ignitable liquids in FM Approved containers.

2.7.4 Do not permit smoking in the central office.

3.0 SUPPORT FOR RECOMMENDATIONS

3.1 Support Information

3.1.1 General

Central offices generally have the following areas: cable entrance facility, main distribution frame, switch equipment, fiber optic equipment, battery room, emergency diesel generator, and support areas. Cable entrance facilities may be below grade (cable vault). Cable enters through wall penetrations and runs parallel to one of the walls for the length of the wall. Depending on the size of the office the vault could be 50 ft (15.2 m) to one city block long. Figure 6 shows a cable vault in a small end office. Figure 7 is a large cable vault for an office located in a major city containing 98,000 local lines and 2,700 trunks. Newer offices use cable entrance facilities where cable is brought in above grade. The cable then goes to the main distribution frame (MDF), which serves as the termination point for outside cable (see Figure 8). Telephone lines from the outside are connected to one side of the frame, internal lines from the office are on the other side of the frame. The cable then goes to the switch, which consists of control modules containing computer(s) and line modules containing circuit boards, which allow the call to be routed to the correct destination. The office may also contain fiber optic cable and related equipment. In addition, batteries are used for emergency power. Diesel engine or combustion turbine-driven generators are also provided to supply power to the office in the event of loss of off-site power. In older installations this equipment was in separate rooms in the office. In new installations all of the above except diesel or combustion turbine generators and support areas may be in the same room.

In addition, there are support areas, which may consist of offices, cafeterias, small storage areas, and craft areas. These areas are located in separate rooms outside the communication equipment areas.

Fig. 6. Cable tunnel for an end office

There are a range of offices, from end offices that provide service to the customer, to large central offices that route calls on trunks between central offices, to toll offices that handle calls outside the local area, to gateway offices that handle calls between countries. Value and importance to the telephone company increase as the number of lines or trunks increases. The function of the exchange is of importance in determining the revenue received. Long distance (toll) and data transmission are higher value than local calls.

Some telephone companies have little new construction. New equipment installation in major cities is largely in leased spaces. Former Bell company buildings presently in use have large floor areas. This is largely due to continued development of switching equipment. New generations of telephone equipment have a smaller footprint than earlier generations. Thus the equipment needed may be on 3 or 4 floors of a several story building and may only occupy 25% to 50% of the area of these floors. The rest of the floor may be used for storage of miscellaneous materials, which increases the fire exposure to the switch. It is advisable to provide fire barrier separation between these areas and switch equipment.

Other telephone companies are expanding by leasing space in buildings and constructing new buildings for their major facilities.

Fig. 7. Cable vault located in a large metropolitan switching center

3.1.2 Fire Alarm Response

Telephone equipment is automated and self-diagnostic. Small central offices are not manned. Intermediate and large offices may be occupied during the normal business day by personnel doing maintenance, repair, circuit installation, or system monitoring. During off-hours, weekends, and holidays the building is typically not occupied. Employees are assigned standby duty and can be called to go to the facility if needed. One major telephone company has approximately 800 central offices. Most offices are under 5,000 lines and many are less than 1,000. There are 35 that handle 50,000 lines or more. Only four of these buildings are occupied at all times. In these installations a security officer is assigned and may be the only person on duty during off-hours.

Response to a fire alarm will most likely be from outside the office. Notification will be from the NOC that receives alarms from a number of central offices. The fire alarm is one of many alarms monitored. The NOC may attempt to call the office if the alarm is during working hours. If not they would contact an on-call technician to check. Most companies instruct their telephone office personnel to call the fire service when a fire alarm is received during an off-duty period.

Some telephone companies have a policy of preplanning fire response with the local fire service. Where this is done the effectiveness of fire response should be substantially improved. Some companies have

Fig. 8. Main distribution frame (MDF)

color-coded communication equipment areas, the routes to power supplies, and the power supplies for these areas. This enables firefighters to identify the power supplies to the fire area and allows isolation of the power supply to the area involved.

Rapid, effective response can be a major factor in limiting damage. An effective response includes personnel with knowledge of how to isolate power to the fire area, and personnel trained to fight fires.

The allowable time for effective emergency response is based on the time needed for 200 micrograms/in^2 (30 micrograms/cm^2) of smoke to be deposited on exposed surfaces. It has been determined that if soot concentrations reach this level there can be corrosion damage to electrical components. The time needed to reach this concentration depends on the burning rate of the material. The basis for the determination was the burning rate of horizontally and vertically arranged PVC-jacketed, polyethylene-insulated cable. This is a common cable construction in the telephone industry.

Horizontal cable tray fire tests were conducted following a major central office fire. Power was applied to some of the cable under test. The test configuration consisted of a horizontal tray with a cross tray above. Both trays contained PE/PVC cable. The tray lengths were 6 ft (1.8 m). A maximum heat release rate of 500 kW occurred 15 minutes into the test. This is comparable to the burning rate of a chair with polyurethane foam cushions. The maximum generation rate of HCl at 1,000 ppm occurred at the same time.

3.1.3 Smoke Control and Smoke Removal

The purpose of a smoke control system is to exhaust smoke from the fire area and maintain adjacent areas at a higher pressure than the fire area to prevent leakage of smoke into these areas. The purpose of a smoke removal system is to remove smoke from the fire area.

The objective of a smoke removal system is to keep the smoke layer above the telecommunication equipment. The exhaust rate needed should be based on the products of combustion generated by the fire, and the cooling air flow through the equipment. This air enters the smoke layer, dilutes the smoke but also brings the smoke layer down closer to the equipment. The heat release rate from a large cable fire in a switch room may be 500 kW. The exhaust ventilation needed to control smoke from a 500 kW fire in a cable tray above the switch is approximately 1,000 ft^3/min (28.3 m^3/min). The heat release rate from a fire in switch equipment may be 150 kW. The exhaust ventilation needed to control smoke from a 150 kW fire near the floor is 3,000 ft^3/min (85 m^3/min). A value of 4,000 ft^3/min (113.3 ft^3/min) was used to provide a safety factor. Additional exhaust ventilation is needed to remove equipment-cooling air that enters the hot gas layer. The ventilation needed to remove heat from the equipment is the controlling factor in determining exhaust ventilation needed. Typically this would have to be determined by ventilation measurements made at the equipment. A fire involving storage and packaging materials would be expected to have a substantially higher heat release rate, and may result in ignition of the cable, but it would not be expected to cause as much smoke damage as a fire in equipment or cable.

The design, installation, testing, and maintenance of smoke control and smoke removal systems should be treated in the same manner as fixed fire protection systems. The two principle methods of smoke management involve either a dedicated smoke control system or a nondedicated system, such as one using the building HVAC system.

Dedicated smoke control and removal systems are independent of the building HVAC system. This system uses a riser or shaft that extends vertically through the building. The shaft has exhaust openings on each equipment floor. The exhaust openings are normally closed by dampers. In the event of fire: (a) the exhaust fan for the smoke shaft starts, (b) the exhaust damper for the fire floor opens, (c) the supply air fan for the fire floor stops, (d) the supply air fans for the other floors go to 100% outside air and the relief dampers close. This results in a condition in which all floors except the fire floor are at positive pressure. The fire floor is at a negative pressure and smoke is exhausted through the shaft

The advantages of a dedicated system are: (a) operation and control are generally simpler than other types, (b) they are less likely to be affected by modification of other building systems, (c) they are designed specifically for smoke removal, (d) contamination of the system is less likely. The disadvantages are they are expensive and require more building space.

This system can be arranged to operate automatically, or be remotely operated from a constantly attended area, or manually from the fire floor after verification of fire.

Nondedicated systems share components with the building HVAC system. On detection of smoke the supply air fans of the other floors go to 100% outside air. The advantages are that the equipment costs may be lower and deficiencies with the system are more likely to be detected since it is part of the building HVAC system. The disadvantages are that (a) the system is more complicated, (b) controls may accidentally be modified during HVAC system modification, and (c) modifications may result in the system being out of service.

3.1.4 Detection

3.1.4.1 General

Many companies are now using VEWFD systems. These systems can be expected to result in a substantial decrease in detection time for slow developing fires compared to conventional smoke detection.

3.1.4.2 Fire Detector Testing

A series of tests was carried out by one of the leading telephone companies to compare the effectiveness of various types of fire detection systems in communication equipment areas. The tests were conducted in a 16 × 26 ft (4.9 × 7.9 m) test area corresponding to a typical 20 × 20 ft (6.1 × 6.1 m) building bay of a central office. The equipment within the test area consisted of four lineups of 9 frames each. The aisle space between the frames varied from the 3 ft (0.9 m) wide maintenance aisles to the 2 ft (0.6 m) wide wiring aisles.

Resistance heaters were located in each frame to simulate heat loading within the equipment. Each frame had six 115 ft^3/min (3.2 m^3/min) fans, switched in two groups of three fans each.

Fire detection devices: The following detectors were tested: (a) spot-type: six types of spot detectors were tested. They were in four clusters between the beams without the suspended ceiling. They were mounted on the underside of the suspended ceiling when the ceiling was installed. The detectors were set to their maximum sensitivity and optional time delay features were bypassed; (b) projected beam detectors: there were two transmitters mounted on the short wall 6 in. (15.2 cm) below the ceiling and two were mounted on the long wall 12 in. (30.5 cm) below the underside of the suspended ceiling; (c) VEWFD-air sampling type detectors were used. The detector tubes were located 6 in. (15.2 cm) above the full length of one of the four equipment lineups. The sensitivity range was 0.003 to 0.03% obscuration per ft (0.010 to 0.10%/m).

Combustible materials: Four combustible materials were selected as typical of the combustible material found in a central office. The combustion products given off by these materials was simulated by heating them on a hot plate. The materials tested were: (a) polycarbonate- this material is used as line drawer material, (b) wood, (c) circuit board, (d) polyvinyl chloride. Approximately 110 gms of conductor insulation material was placed on the hot plate to simulate overheated wiring.

Location of the samples burned: The printed circuit board tests were conducted in the aisle space and in the frame. Other combustibles were tested with samples located in the aisle space.

Tests were conducted in two phases. The first phase involved no air flow. This test series was intended as a benchmark to be used to compare to the results obtained in the ventilated test series. The second phase was conducted with ventilation using the following air flow patterns: a) overhead air supply to the test area with air exhausted at a low level, b) overhead air supply with air exhausted at a high level, and c) underfloor air supply to the maintenance aisle with exhaust at a high level. The overhead air distribution was through diffusers located 8 ft (2.4 m) above the floor of the maintenance aisles.

It was found that the VEWFD system detected all of the materials burned, including tests in which material was burned within the frame. The latter could not be detected by any other detector used. The projected beam detector was able to detect all fires outside of the equipment frames. The time to detection was roughly comparable to the most sensitive spot type smoke detector. The lack of one feature was considered important for spot type detectors. This feature was the ability to set the detector at more than one alarm point; for example, a VEWFD detector can be set for a multiple number of pre-alarm points before the detector actually alarms. The one photoelectric spot detector tested alarmed in still air and under all of the air flow conditions tested for all of the materials tested. Some types of ionization detectors performed better than others. The ionization detectors did not detect some plastics fires. They also did not detect some fires where the air flow was from below the floor or when air flow was from ceiling-mounted diffusers to a low exit point.

3.1.5 DC Power Plants

3.1.5.1 General

DC power supplies may use flooded (also called vented) cell (see Figure 9) or valve-regulated lead acid (VRLA) batteries (see Figure 10).

VRLA cells are designed to minimize gas emissions and eliminate electrolyte maintenance throughout the life of the cell. This is accomplished by recombination of internally generated oxygen and hydrogen to conserve water in the electrolyte, since water is not expected to be replaced. A resealable valve is intended to vent gases not recombined, hence the term ‘‘valve-regulated’’. The electrolyte in a VRLA cell is ‘‘immobilized’’. The two most common methods are (1) use of a highly porous fibrous mat, which holds the electrolyte while separating and electrically insulating the plates (glass mat, and (2) use of a gelling agent to thicken the electrolyte that is between and around the cell plates and separators (gell cell). The intent of both methods is to immobilize the electrolyte and create voids that increase the rate of oxygen recombination. The products and the reactants in a VRLA cell are the same as those of a flooded-cell battery. The major difference is the rate of diffusion. The rate of diffusion in a VRLA cell is several times that of a flooded cell.

VRLA batteries are smaller than a flooded-cell battery. Flooded-cell batteries are typically of clear polypropylene plastic construction, and are usually mounted two high in open metal racks. A battery 16 × 16 × 24 in. (40.6 × 40.6 × 61 cm) high may contain from 10 to 15 gal (38 to 57 l) of acid. A VRLA glass mat battery is also of plastic construction. They may be mounted either vertically or horizontally. Each battery is usually within a five-sided metal enclosure with the top open. The metal sides add to the strength of the battery case. The cell may operate at pressures up to 7 psi.

Fig. 9. Flooded-cell battery room

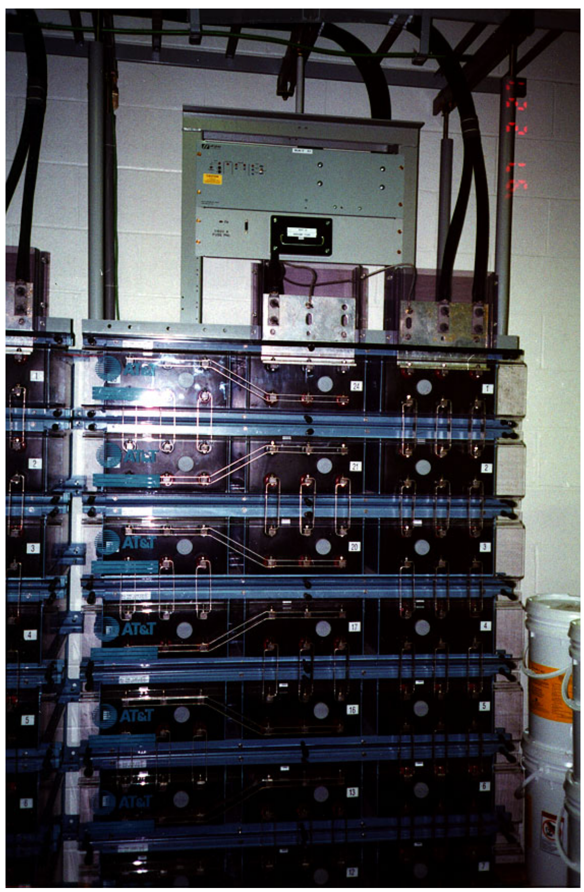

Fig. 10. Valve-regulated lead acid batteries

3.1.5.2 Cause of Thermal Runaway

Thermal runaway occurs when a battery generates more heat than can be dissipated. This may result in an explosion of the battery in extreme cases but is more likely to rupture the battery case. One or a combination of the following could cause thermal runaway:

1) Charger failure. The batteries are subjected to an excessive over voltage condition resulting in excessive battery charge current.

2) Cell internal shorts.

3) High ambient temperatures. This could be caused by failure of the power plant ventilation system.

4) Inadequate thermal management of surrounding heat sources, cell/battery design, and cabinet design.

5) Electrolyte loss. This could be caused by vent valve failure, post seal or jar/cover seal leaks; water or hydrogen loss through the plastic jar or cover.

3.1.5.3 Detection

The following methods are used to detect thermal runaway conditions:

1. Float current. Measurement of float current is believed to give the earliest warning of thermal runaway. One of the major telcos uses this method as an indication of thermal runaway. They were able to detect four strings of batteries in danger of thermal runaway in a four month period using this method. Measurements are made by technicians using hand held ammeters. FM recommends automatic battery monitoring systems.

They compare float current readings taken during three to six month intervals. If float current increases to one and one half to two times normal, the frequency of readings is increased. If float current continues to increase precautions are taken, which can include the use of catalyst caps or removal of the battery string from service.

2. Temperature. Battery temperature is reportedly the least-sensitive method. Battery temperature can be determined by measuring the temperature of the battery negative/positive post or by measuring the temperature of the wall of the battery case. There is a temperature lag over the internal battery temperature. This can be done manually at predetermined time intervals but is best done by an automatic monitoring system.

3. Conductance measurements. Conductance measurements can identify conditions that can lead to thermal runaway. These conditions will also result in a decrease in battery life. Conditions leading to battery runaway, such as cell dry-out, grid corrosion and loss of contact to the active material, internal corrosion, and loss of contact between the post/strap/plate lugs, result in a decrease in cell conductance.

4. Battery voltage. If the battery voltage of one battery in a string drops, the voltage of other batteries increases to maintain bus voltage. One company has developed battery monitoring equipment designed to read the voltage of each cell in a battery string. Information is available that gives the voltage needed at a specific battery temperature before the battery begins gassing. When this voltage is reached the rate of hydrogen gas generation is high enough to result in an exothermic reaction.

4.0 REFERENCES

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Data Sheet 1-28, *Wind Design*
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Data Sheet 2-8, *Earthquake Protection for Water-Based Fire Protection Systems*
Data Sheet 5-4, *Transformers*
Data Sheet 5-20, *Electrical Testing*
Data Sheet 5-23, *Design and Protection for Emergency and Standby Power Systems*
Data Sheet 5-31, *Cables and Bus Bars*
Data Sheet 5-48, *Automatic Fire Detection*
Data Sheet 7-32, *Ignitable Liquid Operations*
Data Sheet 7-83, *Drainage Systems for Ignitable Liquids*

Data Sheet 7-88, *Ignitable Liquid Storage Tanks*
Data Sheet 9-13, *Evaluation of Flood Exposure*
Data Sheet 9-16, *Burglary and Theft*
Data Sheet 10-1, *Pre-Incident Planning*

4.2 Other

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ANSI T1.307-2003, Fire Resistance Criteria-Ignitability Requirements for Equipment Assemblies and Fire Spread Requirements for Wire and Cable.

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UL 1581, Reference Standard for Electrical Wires, Cables and Flexible Cords.

UL 1666, Test Method for Flame Propagation Heights of Electrical and Optical-Fiber Cables Installed Vertically in Shafts.

APPENDIX A GLOSSARY OF TERMS

Analog transmission: A way of transmitting voice, video, and data in which the transmitted signal is similar to the original signal. If you spoke into a microphone and saw your voice on an oscilloscope, then did the same with your voice as transmitted on the phone line, the signals would look essentially the same. The only difference is that the electrically transmitted signal would be at a higher frequency.

Cable vault: A below-grade structure, usually constructed of concrete, through which telephone cables are routed from subscribers' lines outside the building to a main distribution frame inside the building. The cables are usually in bundles on racks or in trays (see Figs. 6 and 7).

Central Office (CO): A telephone company facility exchange where subscriber lines and private branch exchange lines are joined to switching equipment for connecting other subscribers to each other, locally and long distance. In Europe it may be called a ''public exchange''.

Constantly attended: Facility is attended 24 hrs per day 7 days per week.

End office: A central office to which a telephone subscriber is connected. Frequently referred to as a ''Class 5 office''. The last central office before the subscriber's phone equipment. The central office that actually delivers the dial tone to the subscriber.

FM Approved: References to ''FM Approved'' in this data sheet mean the product or service has satisfied the criteria for FM Approval. Refer to the *Approval Guide*, an online resource of FM Approvals, for a complete listing of products and services that are FM Approved.

Tandem office: A major phone company switching center for the switched telephone network. It serves to connect central offices when direct interoffice trunks are not available.

Toll office: A central office used primarily for supervising and switching calls to locations outside the local service area.

Gateway office: The entrance or exit into a major communications network. Examples are offices that receive and transmit international calls.

Cellular mobile telephone system (CMTS): A low-powered, duplex radio/telephone that uses multiple transceiver sites linked to a central computer for coordination. The sites, or ''cells'', cover a range of one to six or more miles (1.7 to 10 km) in each direction. They overlap one another and operate at different transmitting and receiving frequencies to eliminate crosstalk when transmitting from cell to cell. Each cellular phone has an identification number, which allows the mobile telephone switching office (MTSO) (see Fig. 12) to track and coordinate mobile phones in its service area.

Cell site: A transmitter/receiver location operated by a wireless service provider (WSP), through which radio links are established between the wireless system and the wireless unit. The area served by the cell site is referred to as a ''cell''. Depending on the volume of calls and the area (hills or buildings that may obstruct transmission) the area served could be from one to ten miles in diameter. Cells overlap. In major cities they would be located on the roofs of buildings. Two enclosures are usually provided. One enclosure is the power cabinet. The other enclosure is the minicell and contains transmission equipment. The power cabinet contains batteries and rectifiers that convert 120 V ac to 48 V dc. The cabinets are of heavy-gauge steel construction. They have their own cooling systems (by fan) and heating (by heat strips). Rural cells handle about 20 to 30 calls at a time during peak periods. Metropolitan cells handle 200 to 300 calls at a time. The approximate cost of a cell site is US$250,000. Replacement time for one cell is about 1 day.

Co-location: The ability of an end-user or another local or long distance telecommunications company to put their equipment in a local telephone company's offices and join their equipment to the phone company's equipment. Their equipment is usually enclosed and separated from local phone company equipment by a wire fence or wall. The other local or long distance company is usually required to supply their own batteries but with few exceptions the building owner will provide the standby diesel generator.

Controlled environment vault (CEV): A low maintenance, water-tight concrete, metal, or fiberglass container typically buried in the ground that provides permanent housing for remote switches, remote line concentrators, pair gain and fiber transmission systems. It is maintained under controlled temperature and humidity conditions.

Communications equipment areas: These areas are the cable entrance facility, main distribution frame and switch equipment areas.

Central processor: The main element within an exchange that establishes switching connections to the telephone network. In electronic exchanges, it monitors the system and performs test functions. It is usually arranged to record subscriber activity for billing purposes.

COW (cellular office on wheels): Can be used as a temporary cell site.

Centrex: A business telephone service offered by the local telephone company from a central office. It is a single line service delivered to individual desks. Each person has their own telephone number. No switching equipment is required at the business site as all switching is done at the central office.

DECT (digital european cordless telecommunication): The pan-European standard based on the time division multiple access (TDMA) used for limited-range wireless services. It is used primarily for wireless PBX systems, telepoint and residential cordless telephony.

Digital telephony: A digital telephone system transmits specific voltage values of ''1'' and ''0'' to transmit information.

Distribution frame: A metal structure used to connect wiring from outside the central office with wiring inside. On the other side wires come from the CO or PBX. Both sides are connected with a ''jumper'' wire. By pulling off one end of the jumper wire and moving it to another location a phone number can be changed. In big central offices, distribution frames can be a city block long. Surge protection may be provided within this frame or in a separate protector frame.

DMS (digital multiplex system): Also the name of a family of digital central office switches manufactured by Northern Telecom.

DMS Series 10 supports 200,000 busy hour call attempts, the series 20 supports 440,000 busy hour call attempts, the series 30 supports 660,000 busy hour call attempts, the series 40 supports 800,000 busy hour call attempts, the series 50 supports 1,200,000 busy hour call attempts, the series 60 supports 1,440,000 busy hour call attempts for plain old telephone service (POTS).

DMS-100 is an end office switch that handles traffic from subscriber lines and traffic from trunks from other offices. It is economical for from 2,000 lines to 100,000 lines.

DMS-200 is a tandem office switch. It can provide operator service and is a long distance switch for from several hundred to 60,000 trunks.

DMS-100/200 is a switch that combines end office functions of the DMS-100 and the tandem office functions of the DMS-200.

DMS-250 is a long distance switch designed for interexchange carrier networks. It can be configured to handle from 480 to more than 80,000 trunks. It can be arranged for multi-functional applications such as international switching and international direct dialing.

DMS-300 is an international gateway switch. It can support up to 45,000 trunks. It can support more than 20 different national and international trunk signaling systems.

DMS-MTX is a cellular mobile telephone switching system serving as point of access to the public switched network. It controls all subsystems required for an operational cellular system, including radio channel units and cell site equipment. It can support up to 512,000 subscribers.

Double-Interlock Preaction System: A sprinkler system that is located downstream of a preaction valve and is equipped with closed-type sprinklers. The preaction valve is arranged to open only after the actuation of both a sprinkler and a detection system that is supervising the area being protected by the preaction sprinkler system. Most double-interlock sprinkler systems have either an electric or a pneumatic means of accomplishing these two activating conditions.

DS-N: A hierarchy of digital signal speeds used to classify capacities of lines and trunks. (See Table 2). The fundamental speed level is DS-0. The digital signal hierarchy is used in North America.

Table 2. Digital Signal Transmission Rates

Designation	*Equivalent To*	*Digital Service Level*	*No. of Channels*	*Transmission Capacity*
DS-0*		0	1	64,000 bps
DS-1	T-1	1	24	1.544 Mb/s
DS-1C	2 T-1s	1C	48	3.152 Mb/s
DS-2	4 T-1s	2	96	6.312 Mb/s
DS-3	28 T-1s	3	672	44.736 Mb/s
DS-4	168 T-1s	4	4,032	274.176 Mb/s

* DS-0: Digital Service, level 0. It is 64,000 bps, the worldwide standard speed for digitizing one-voice conversation using pulse code modulation (PCM).

DWDM (dense wave division multiplexing): A means of increasing the capacity of fiber-optic transmission systems through the multiplexing of multiple wavelengths of light. Each wavelength channel typically supports OC-48 transmission at 2.5 Gbps or 10 Gbps. A 32 channel system will support an aggregate of 80 Gbps.

End office: See central office

ESS (electronic switching systems): Originally a designation for the switching equipment in Bell System central offices but has more general use now. Lucent Technologies Network Systems now develops and manufactures switches and related systems. Their switches have the following designations:

1A ESS switch is capable of handling 10,000 to 15,000 lines.

4ESS is a tandem switch with a capacity of 20,000 to 100,000 trunks.

5ESS switch handles both line and trunk applications. It is a modular unit that can be increased in size to handle a wide range. It can serve from 20,000 to 140,000 lines. It can also serve 100,000 trunks.

Fiber optics: The transmission of signals by light waves over fiber. A single cable containing 96 fibers is less than 1 in. (2.5 cm) in diameter and can support approximately 384,000 voice channels. Repeater stations are needed to regenerate and amplify signals every 28 mi (47 km).

Gateway office switch: See central office.

ISDN (integrated services digital network): Uses digital technology to deliver voice, circuit data, and packet service data over standard telephone lines.

IXCs: IntereXchange (long distance) carriers as opposed to local exchange carriers (LEC).

LAN (local area network): A short-distance data communications network (typically within a building or campus) used to link computers and peripheral devices under some form of standard control.

LATA (local access and transport areas): One of 196 local geographical areas in the U.S. within which a local telephone company may offer telecommunications services (local or long distance).

LEC: Local exchange carrier.

Microcells: Used to relay cellular telephone calls made within buildings, tunnels, etc. to cell sites or to a mobile telephone switching office. The calls would otherwise be shielded by the structure.

Microwave radio transport: A network of transmitters and receivers that are in line of sight of each other. This is used to transmit signals over long distances.

MOP: Maintenance operations protocol are procedures developed by telecommunications companies to describe how work should be conducted by telco technicians or contractors.

MTSO: A mobile telephone switching office. This central office houses the field-monitoring and relay stations for switching calls between the cellular and wire-based (land-line) central office. The MTSO controls the entire operation of a cellular system. It contains equipment that monitors all cellular calls, keeps track of the location of all cellular-equipped vehicles traveling in the system, arranges handoffs, keeps track of billing information, etc.

NEBS (network equipment building standards): A set of performance, quality, environmental, and safety (including fire testing) requirements developed by Telcordia, the R&D and standards organization owned by the seven regional Bell operating companies (RBOCs). NEBS compliance is often required for telecommunications equipment service providers for equipment installed in their switching offices. Telephone equipment should pass the ANSI T1 flamespread test or the network equipment-building system (NEBS) fire test. Equipment is not labeled; telephone company personnel are unlikely to be familiar with this test.

NOC (network operations center): A group responsible for the day-to-day operations of a network. Each service provider has an NOC.

Non-Interlock Preaction System: A sprinkler system that is located downstream of a preaction valve and is equipped with closed-type sprinklers. The preaction valve is arranged to open upon either the operation of a sprinkler or the actuation of a detection system that is supervising the area being protected by the preaction sprinkler system.

Nonpropagating or Group 1 cable:

a) Cable with a fire propagation index (FPI) of less than 10 when tested in the FM fire propagation apparatus.

b) Cable that when tested in accordance with the FM 3972 Vertical Tray Test does not have flame spread more than 5 ft (1.5 m) beyond the 60 kW fire exposure.

c) Cable that has passed the UL-910 or the NFPA 262 tests.

OC-N: Optical carrier level N. OC-1 with a basic transmission rate of 51.840 Mb/s, on which Sonet is based. All higher levels are direct multiples of OC-1. (See Table 3).

Table 3. Optical Signal Transmission Rates

Optical Carrier Designation	*Level*	*Sonet Channel Transmission Rate*
OC-1	1	51.840 Mb/s
OC-3	3	155.52 Mb/s
OC-12	12	622.08 Mb/s
OC-48	48	2.5 Gb/s
OC-192	192	10 Gb/s
OC-768	768	40 Gb/s

PBX (private branch exchange): The switch equipment is located at subscribers' premises rather than the telephone company central office.

PCN (personnel communication network): A type of personnel communication system that uses pocket telephones. These telephones allow communication with other individuals through both wireless and wireline.

PCS (personnel communication system): A generic term describing mobile or portable radio communication services. The communication system can be integrated with other connecting networks such as land line.

Preaction Sprinkler System: A sprinkler system that is located downstream of a preaction valve and is equipped with closed-type sprinklers (i.e., sprinklers equipped with a thermal sensing element and an orifice cap).

Propagating cable:

a) Cable with a fire propagation index (FPI) of more than 10 when tested in the FM fire propagation apparatus.

b) Cable that when tested in accordance with the FM 3972 Vertical Tray Test has a flame spread greater than 5 ft (1.5 m) beyond the 60 kW fire exposure.

c) Cable that has not been tested or has not passed UL-910 or the NFPA 262 test.

RBOC: regional bell operating company

Signal processing equipment: The electronic equipment that performs signal-processing operations such as switch or transport for audio, video, and data signals.

Single-Interlock Preaction System: A sprinkler system that is located downstream of a preaction valve and is equipped with closed-type sprinklers. The preaction valve is arranged to open upon the actuation of a detection system that is supervising the area being protected by the preaction sprinkler system.

SONET (synchronous optical network): An international communications standard for fiber-optic transmission rates from 51.84 Mb/s to 13.22 Gb/s, created to provide the flexibility needed to transport many digital signals with different capacities, and to provide a design standard for manufacturers.

Support areas: Areas used for battery rooms, emergency generator rooms, office(s), storage rooms or cafeterias.

T-1: A digital transmission link with a capacity of 1.544 Mb/s. T-1 uses two pairs of normal twisted wires. T-1 can handle 24 voice conversations, each one digitized at 64 Kbps.

Telco hotel: A multi-tenanted building containing signal processing equipment from more than one telecommunications company. Each telecommunications company and any other tenant in the building needing emergency power will have its own emergency generator(s) and fuel supplies.

Toll office: A central office used primarily for supervising and switching toll traffic.

Trunk: A communication line between two switching systems.

Valve-Regulated lead acid batteries (VRLA): Are designed to minimize gas emissions and eliminate electrolyte maintenance by recombination of internally generated oxygen and hydrogen to conserve water. A resealable valve is intended to vent gases not recombined, hence the term ''valve-regulated''. The electrolyte in a VRLA cell is ''immobilized'' by the use of a highly porous fibrous mat between the plates or by the use of a gelling agent to thicken the electrolyte.

Very early warning fire detection (VEWFD): Detectors used to accomplish VEWFD are listed as being capable of providing alarm initiation at threshold levels that are more sensitive than conventional smoke detectors. Conventional (or standard) smoke detectors commonly have a default setting from 2.5% to 2.8% per foot obscuration. Listing allows them a range of between .5% and 4.0% per foot obscuration. Smoke detection that detects products of combustion below .5% per foot obscuration (generally from .003% to 0.2% per foot obscuration) are considered as providing VEWFD. The object is to detect smoldering or off-gassing typically generated from an overheating condition or from low-energy fires. VEWFD can be accomplished using air sampling or spot-detection equipment. It is sometimes necessary to decrease the spacing of the sensing elements. In addition to area detection, sensing elements should monitor return air from the space protected.

APPENDIX B DOCUMENT REVISION HISTORY

The purpose of this appendix is to capture the changes that were made to this document each time it was published. Please note that section numbers refer specifically to those in the version published on the date shown (i.e., the section numbers are not always the same from version to version).

April 2025. Interim revision. Significant changes include the following:

A. Revised the Section 1, Scope, to clarify the intent for facilities with direct current (DC) power equipment that use switches and relays. Facilities that use Voice Over Internet Protocols (VOIP) electronic equipment should refer to OS/DS 5-32, *Data Centers and Related Facilities*.

B. Revised Section 2.1.4, Wind, to remove the reference to OS/DS 1-8, *Antenna Tower and Signs*. This OS/DS is obsolete, effective April 2025.

April 2012. Terminology related to ignitable liquids has been revised to provide increased clarity and consistency with regard to FM Global's loss prevention recommendations for ignitable liquid hazards.

January 2010. The following changes were made:

1. Revised recommendation regarding the use of ordinary glass between control rooms and equipment rooms (Section 2.1.1)

2. Added recommendation regarding the use of FM Approved battery acid-absorbent bags (Section 2.6.4).

3. Added definitions of types of preaction sprinkler systems to Appendix A, *Glossary of Terms*.

September 2007. Clarification was made to the recommendation 2.2.1.

January 2007. The following changes were made:

1. Two-hour fire walls are recommended for telecommunications equipment areas. The exposure of telecommunications equipment rooms varies from light (office areas) to moderate to heavy (storage and diesel generators). It is more practical to recommend a two-hour-rated wall rather than a one-hour-rated wall since the wall may be exposed to various fire load.

2. Penetration seals having both a leakage rating and a fire resistance rating are recommended for telecommunications equipment areas. Penetration seals in the previous publication had fire resistance ratings only. Many types of fire-rated seals do not seal tightly until exposed to heat.

3. Primary detection for signal processing equipment will be very early warning fire detection (VEWFD). Primary protection will be gaseous agent suppression or automatic sprinkler protection system.

4. Information concerning spacing and alarm settings for VEWFD systems has been included.

5. Testing VEWFD detection on installation and at two-year intervals after installation is recommended.

6. Automatic monitoring for thermal runaway of valve-regulated lead acid (VRLA) batteries with alarm to a constantly attended area is recommended.

7. Where telecom offices are located in multi-tenanted buildings, a recommendation has been added to comply with recommendations for fuel storage, fuel piping, and diesel generator protection contained in FM Global Loss Prevention Data Sheet 5-23, *Design and Protection for Emergency and Standby Power Systems*. Where in a building not containing other systems and where the day tank is no larger than 250 gal (0.95 m^3), the room can be protected using detection, automatic fire protection, and fire-resistive construction. Also, fire and leak detection in the diesel generator room interlocked to shut off fuel transfer from the main supply tank to the day tank and from day tank to generator.

8. Protection is recommended for battery rooms, control rooms and cable vaults.

9. Recommendation added for hydrogen detection for battery rooms with alarm to a constantly attended area.

10. Recommendation for maintenance operating procedure (MOP) added for operations that could result in a fire (cable mining) or could increase damage following a fire (replacement of penetration seals).

September 2000. This revision of the document was reorganized to provide a consistent format.

September 1998. The following major changes were made:

1. Fire protection recommendations for the switch room are based on value of equipment in the room. This includes replacement cost of the switch and fiber optic equipment and loss of revenue over a four week period.

2. Effective emergency response has been given equal credit to automatic sprinkler protection. For effective emergency response a very early warning fire detection (VEWFD) system must be provided, fire response must be l0 minutes or less, and the response must include the ability to fight fire and isolate power to the fire area.

3. Smoke control and smoke removal recommendations have been included for communication equipment areas.

4. VEWFD systems have been recommended for new construction and when major changes are made to existing construction. Many offices are unmanned and VEWFD has been proven to substantially reduce time to detect a fire.

5. Natural catastrophe recommendations regarding flood, earthquake, and wind have been included.

6. Data Sheet 9-16, *Burglary and Theft,* is referenced regarding security precautions for circuit board theft.

APPENDIX C ADDITIONAL INFORMATION

C.1 Performance Test Procedures for VEWFD Systems

C.1.1 These performance tests are intended to simulate the small amounts of smoke that would be created in the early stages of a fire in an telecommunications equipment area. If an actual fire were to produce the amounts of smoke produced by these tests, telecommunications companies would want to be alerted by the fire alarm system. The tests represent a good balance between the desire to use smoke sources that are representative of the types of fires that have occurred in telecommunications equipment areas and the desire to minimize the introduction of smoke that can cause damage to operating telecommunications equipment in the area.

C.1.2 Objectives

These tests are also intended to meet the general objectives listed below:

a) The tests are intended to be repeatable. A consistent quantity, temperature, and color of smoke is produced each time the test is performed.

b) The test equipment can be quickly set up in actual telecommunications facilities.

c) Testing is intended to prevent or minimize the potential for smoke damage to telecommunications equipment in the room, (little or no corrosive products of combustion should be produced).

C.1.3 Heated Wire Test

C.1.3.1 This test uses an electrically overloaded PVC-coated wire to simulate the early stages of a fire. Although a PVC wire is used, hydrogen chloride vapor is unlikely to be produced in quantities significant enough to be of concern, due to the relatively low temperatures reached. If the current is applied for a longer time, or if the wire sample is shorter than stated, small quantities of hydrogen chloride can be generated. In either event, a clearly perceptible odor that should dissipate in a short time is produced by the test. Table 4 describes two heated wire tests.

Table 4. Heated-Wire Test Parameters

Parameter	*Modified BS 6266 Test: Two 1 m Wires in Parallel*	*North American Wire Test:*
Wire Specs	Wire is very flexible due to stranded construction and highly plasticized insulation.	A single strand of 22 AWG copper wire, insulated with PVC to a radial thickness of 1.1 mm (0.041 in.). This wire is stiffer than the BSI wire due to the single-strand construction and the minimally plasticized PVC insulation.
Smoke Characterization	More visible smoke than the 2 m test or the single wire 1 m test but still very light smoke. Due to the higher temperature in the wires, a small amount of HCI vapor will be produced.	More visible smoke than the BSI wire tests but still very light. A minor amount of HCI is produced but for a shorter duration than the BSI wire tests.
Test Period	60 seconds	30 seconds
Electrical Load	Constant voltage -6.0 volts dc, current varies from 0 to 30 amperes during the test due to changing resistance in the wire.	Constant current of 28 amperes. Voltage varies from 0 to 18 volts dc during test due to changing resistance in the wire.
Pass/Fail Criteria	‘‘Alert’’ or ‘‘pre-alarm’’ signal within 120 seconds of the end of the period.	

C.1.4 Test Apparatus

The test apparatus consists of the items listed below:

a) Wire. Table C.1 lists options for wire selection and test parameters for the users to select. Test wire should be cut cleanly to the length specified in Table C.1.

b) Wire Mounting.The wire should be arranged by placing it on a noncombustible, nonconductive board, or suspending it on a noncombustible, nonconductive support. The wire should be arranged so that there are no kinks or crossovers where localized higher temperature heating can occur.

c) Power Supply and Leads.A regulated dc power supply should be capable of supplying a current of 0 to 30 amperes at 0 to 18 volts dc (i.e., Kenwood Model XL6524E-D). The lead wires between the power supply and the test wire (s) should be 10AWG, 3.25 m (10.66 ft) long to avoid unacceptable voltage drop.

d) Stop Watch.A stop watch or clock accurate to 1 second should be used.

C.1.5 Test Procedure

a)The test should be performed in the room in which the detection system is installed, with all normal ventilation fans (e.g., fans internal to equipment, room ventilation fans) operating. Testing should also be performed with the fans turned off to simulate the potential for fan cycling and/or a power failure. This does not preclude testing required *by NFPA 72.*

b) Detector Programming.The detector alarm sensitivity setting (i.e., pre-alarm or alarm) used during the test should be identical to those used during normal operation of the system. Alarm verification or time delay features should be disabled during the test to permit the detector response to be annunciated immediately upon activation.

This testing is intended to verify that the detectors will ‘‘see’’ smoke in sufficient concentrations to reach the specified alarm levels. Because the test produces a small amount of smoke for a brief period of time (i.e., a puff of smoke), the use of the alarm verification or time delay features would likely result in the detector not reaching the specified alarm levels. In a ‘‘real world’’ fire, the smoke would continue to be produced as the fire grows, permitting the detector to reach alarm. If these features are disabled during the testing, they should be enabled at the conclusion of the testing before leaving the room.

c) Test Locations.Test locations should be selected by considering the airflow patterns in the room and choosing challenging locations for the tests (i.e., both low airflow and high airflow can be challenging). If possible, the locations and elevations of the test apparatus should be varied to simulate the range of possible fire locations in the room. Locations where the smoke will be drawn directly into the telecommunications equipment cooling ports or fans should be avoided. Locations where the smoke will be entrained into the air exhausting from an equipment cabinet are acceptable.

d) Preparation.The test wire should be prepared by carefully removing not more than 0.6 in. (12 mm) of the insulation from each end. The wire should be mounted on the insulating material so that there are no kinks or crossovers in the wire.

e) Setting.The power supply should be set to supply either a constant voltage or constant current as shown in Table C.1.

f) Connection.The ends of the test wire(s) should be connected to the power supply leads.

g) Test.When all other preparations are complete, the power supply should be switched on for a period shown in Table C.1. After the appropriate current application time, the power supply should be turned off, and the test results should be observed and recorded. To avoid burns, the wire should not be touched during the test, or for 3 minutes after turning the power supply off. If the wire is located close to HVAC registers or equipment exhaust ports, the airflow can cool the wire and result in inadequate production of smoke. In this event, either the apparatus should be repositioned or the wire should be shielded from the airflow.

h) Test Sequence.The test should be repeated at least three times for each HVAC condition, with the test apparatus placed in a different location in the room each time. If possible, the elevation of the test apparatus should be varied.

i) Pass/Fail Criteria.The pass or fail criteria for the VEWFD system should be as indicated in Table C.1.

C.2 NFPA 76 Telecommunications

This standard contains performance-and-prescriptive based requirements. Prescriptive requirements are intended to provide requirements that if completed, would result in a well-protected facility. Performance requirements give goals that need to be achieved if an alternate method of protection is used. Prescriptive-based requirements are based on the size of a facility. Requirements are based on (a) communication equipment which has passed flame spread tests, (b) very early warning fire detection systems, (c) fire-resistant construction separating support areas of the facility and communication equipment areas, and (d) credit is given where the facility is backed up by another facility or where portable equipment can be used to restore the operation of the facility within a short time.