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# Standard for Fire Protection of DOE Electronic Computer/Data Processing Systems

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Prepared for:
**U.S. Department of Energy**
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# PREFACE

Major DOE computer and control rooms contain an estimated billion dollars worth of essential electronic equipment. Thus, on a value basis alone, DOE has a vital interest in protecting these facilities. The vital control, service, and research capabilities provided by these units provide an additional incentive for insuring the highest level of protection.

Management responsible for computer facilities is well aware of its dependence on this equipment. Procedures in use prior to the widespread adoption of computers for business and research are no longer available for rapid application when the computer is out of service. Uninterrupted operation is a prime requisite and points up the necessity for making every effort to prevent damage by fire. Extensive information developed through the computer and stored on disks, tapes, film, drums, or other devices is also vulnerable to fire and demands the same consideration for fire protection.

Major research, accounting, and production operations are frequently dependent upon computers for control, data acquisition, or processing. Lost time on these operations can be more costly than fire damage to the computer itself.

In addition to the available information from the manufacturers of fire protection equipment and insurance organizations, there are a number of documents dealing with fire protection for computer facilities in the form of standards, guidelines or recommended practices. Experience and rapidly paced technological advances make it necessary to revise these documents periodically. In an effort to keep DOE and contractor personnel informed, the Office of Operational Safety initiated a project to review the fire protection of computer facilities in the DOE complex and to provide an updated standard.

The Federal Fire Council publication, "Fire Protection for Essential Electronic Equipment," Recommended practices No. 1 (RP-1), March 1962, second revision August 1978, the most comprehensive treatment of this subject and the most pertinent to DOE operations, was selected as the basic document for this effort. It has been revised, with the incorporation of other relevant material, to serve as a standard for specific application to DOE computer systems. That document, combined with field suggestions, was used to update the original version of this standard, which had been issued, as WASH 1245-1 in July, 1973. That, in turn, had been based on the second revision of RP-1, issued July 1969.

The following are the major changes from the July 1973 edition of WASH 1245-1:

1. Sprinkler protection has been emphasized as the basic protection system, with Halon as a supplement or as alternative when sprinklers are impracticable.

2. A carpet flame spread limitation has been introduced.

3. Ceiling fire resistance ratings have been clarified.

4. The value limitation per fire area has been increased to $50 million.

5. Detection system requirements have been clarified.

6. The Appendices have been updated and modified. The appendix on fires has been modified to include a list of all incidents involving computers in DOE since 1966

7. The Bibliography has been expanded.

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## CHAPTER I

# GENERAL

### 101. SCOPE

101-1. This standard applies to all essential electronic computer data processing equipment as well as the storage facilities, associated utilities, and air conditioning systems. Electronic computer/data processing equipment consists of an analog or digital computer, together with input, output, memory, and other peripheral equipment.

101-2. Essential electronic computer/data processing equipment, hereafter referred to as computer equipment, includes that which meets one or more of the following criteria:

a. Is designated as vital to the DOE mission.

b. Is required for security.

c. Performs an operation which could be performed by substitute methods but where the substitute methods would result in unacceptable delay, or would involve significant additional expenditures for personnel, facilities, and equipment.

d. Has a monetary value of $1,000,000 or more.

101-3. When a computer installation does not fall within the above criteria, this standard should be followed to the extent that is practicable.

101-4. Facilities such as control or data acquisition rooms in reactor, accelerator or production operations, while not strictly computer installations, are frequently of sufficient value or importance to warrant special protection. This standard may be used with fire protection engineering judgment in such cases.

### 102. CODES AND STANDARDS

102-1 When codes, standards or other criteria are referenced in this document, the latest revisions shall apply.

## CHAPTER II

# CONSTRUCTION AND OPERATION

### 201. SCOPE

201-1. This chapter describes the types of construction necessary for a computer building and computer rooms including location and perimeter separation. Certain operating requirements are included.

201-2. The structure in which computer equipment is housed shall be located, constructed, and/or protected to minimize the danger of fire, water, smoke, and corrosive gases to the equipment.

201-3. The following computer locations are listed in order of preference: (a) a separate one-story, fire-resistive facility; (b) the ground floor of a multistory, fire-resistive building; (c) any floor above the ground floor of a multistory fire-resistive building; (d) the basement level of a flood-protected building.

When locating computer equipment below grade level, special consideration must be given to protection from water that would tend to run to the lowest portion of a building as a result of flooding or fire-fighting efforts elsewhere in the structure.

201-4. At facilities where computer equipment may be a target for arson and sabotage, the location and housing structure should be designed to protect against potential damage from such acts.

### 202. HOUSING STRUCTURE

202-1. The requirements in Section 202 are designed to provide a safe housing structure and minimize the danger of a fire, not related to the equipment, but which may damage or destroy such equipment.

202-2. When computer equipment is housed in a portion of a structure, either new or existing, and that portion is subdivided from the remainder of the structure by firewalls, then only the portion of the structure housing the equipment is required to comply with this section.

202-3. New structures or existing structures selected to house computer equipment shall be of fire resistive or noncombustible construction. Materials used for interior finishes, insulation, vapor barriers, or acoustical treatments shall meet one of the following criteria of noncombustibility:

a. Materials no part of which will ignite and burn when subjected to fire. The American Society for Testing Materials (ASTM) Standard E-136, "Test for Noncombustibility of Elementary Materials," shall be used as the criterion for determining noncombustibility within the meaning of this paragraph. As used in this document, ASTM E-136 is applicable to composites as well as elementary building materials.

b. Materials other than as described in paragraph (a) above, having a surface flamespread of 25 or less. Flamespread ratings as used herein refer to ratings obtained according to National Fire Protection Association (NFPA) No. 255, "Test of Surface Burning Characteristics of Building Materials."

202-4. When the computer area has one or more exterior walls, protection against exterior fire exposure shall be provided in accordance with NFPA 80A, "Protection From Exposure Fires."

## 203. PERIMETER SEPARATION FOR COMPUTER AREA

203-1. The requirements in Section 203 apply to single and multistory structures and are designed to provide a fire-resistive separation between the computer area and adjoining areas. The purpose of the perimeter separation is to protect the computer equipment from the damaging effects of a fire outside of the computer area.

203-2. Fire-resistive separations shall be a noncombustible material having a fire resistance rating not less than the maximum fire potential of occupancies in adjoining areas. In no case shall the fire resistance rating be less that one hour.

203-3. Fire-resistive separations shall extend from structural floor to the underside of the structural floor above the ceiling.

203-4. Openings in fire-resistive separations shall be protected by fire doors, fire windows, or fire dampers, subject to the following limitations:

a. Fire windows meeting the requirements of paragraph 203-6 may be used for openings which are subject to light or moderate fire exposure and which are protected by automatic sprinklers.

b. Fire doors and fire dampers shall be used in ducts where required in Chapter V.

c. Fire doors meeting the fire-resistance rating prescribed in NFPA No. 80, "Fire Doors and Windows," shall be used on doors openings in the separation.

d. Fire doors serving as exit doors must swing with the exit travel except for doors on individual small rooms which may swing in.

e. Because of the potential of smoke damage, all openings in the separation, except ducts, should be protected with normally closed fire doors or fixed fire windows.

203-5. Fire protection ratings of fire doors, fire dampers and fire windows shall be as determined and listed by a nationally recognized testing agency.

203-6. Installation of fire doors and fire windows shall be in accordance with the requirements of NFPA No. 80, "Fire Doors and Windows."

203-7. Viewing windows and special architectural treatments for entrance doors may be provided in the separation provided they do not violate the fire integrity of the separation.

## 204. INTERIOR CONSTRUCTION OF COMPUTER AREA

204-1. The requirements in Section 204 are designed to produce a computer area that will not in itself provide the fuel for a fire.

204-2. When areas in an existing structure are to be converted for use as computer areas, all nonstructural combustible materials within the perimeter separations of the equipment areas shall be removed, except as permitted in paragraphs 204-3 and 204-6 below.

204-3. All materials installed within the perimeter separations of the computer areas including those used for walls, partitions, raised floors and their supporting system, wall finishes, suspended ceilings and their suspension systems, insulations or sound deadening boards, vapor barriers, acoustical treatments, furring strips, battens, ductwork, and other construction shall be noncombustible, except that minimum amounts of exposed wood moldings and trim are permitted.

204-4. When raised floor systems are used in computer areas, they shall be of concrete, steel, aluminum, or other noncombustible materials, except that minimum amounts of vinyl or rubber materials are permitted for leveling, sealing, or to prevent horizontal shifting of floor panels or decking.

a. Flooring or decking shall consist of easily removable access panels or sections provided in sufficient quantities so that power and signal cables, wiring, and all space beneath the raised flooring or decking are accessible in case of emergency.

b. Joints around floor panels or sections and openings in the flooring or decking for cables, wiring, or other uses shall be protected to minimize the entrance of debris or other combustibles beneath the flooring or decking.

c. Commonly used floor covering materials such as asphalt, rubber or vinyl floor tile or carpeting may be used on the raised floor deck.

d. Carpets shall meet flamespread rating of 25 or less (ASTM E-84) or 0.9 watts/sq. cm. (NFPA 253).

204-5. The structural floor shall be equipped with an adequate drainage system for the removal of water from inside the computer area. Provisions should be made for backwater valves if there is any danger of water backing up through the system.

204-6. When a room is to be converted for use as a computer area, combustible materials of construction should be replaced. If this cannot be economically justified, the combustible materials shall be protected by the application of a noncombustible material having a fire-resistive rating commensurate with the exposure.

204-7. Floor or roof construction above computer areas shall be made reasonably water tight. Expansion joints should be flashed and/or otherwise protected.

204-8. When the concealed space formed by a ceiling and/or raised floor is used as a supply or return air plenum chamber, the plenum chamber installation shall conform with the appropriate provisions in NFPA No. 90A, "Air Conditioning and Ventilating Systems."

204-9. In floor-ceiling assemblies or roof-ceiling assemblies, access panels shall be of a construction that does not lower the rating of the assembly.

204-10. Fire-resistant separations between independent computer systems shall have a fire-resistance rating at least equal to the greater fire potential of the two computer areas. In no case shall the fire resistance be less than one hour. This fire-resistant separation shall extend from ceiling slab to the floor slab through concealed spaces above the ceiling and below the floor.

204-11. Any openings in the fire-resistant separations between systems shall have fire-rated protection suitable to the separation. Where doors in the separation must remain open for ease of access, automatic hold-open devices acutated by smoke detectors located on both sides of the separation shall be used.

NOTE: If magnetic hold-open devices are used, they should be located so that their magnetic fields will not cause inadvertent loss of information on tapes or disk packs.

## 205. OPERATING ENVIRONMENT FOR COMPUTER AREA

205-1. The requirements of this section are designed to reduce the amount of combustibles permitted within the computer area.

205-2. Except as noted below, only the actual computer equipment and auxiliary equipment electronically interconnected with it or which must be located in close proximity to the computer equipment shall be permitted in the computer area.

205-3. Metal office furniture to the extent required for efficient operation may be located within the computer area.

205-4. Small-size supervisory offices and similar occupancies directly related to the computer operations may be located within the computer area, provided that all furnishings are metal and adequate facilities are provided for containing the necessary combustible materials. Supplies of paper or other combustible materials shall be strictly limited to that need for day to day operation.

205-5. Records may be kept in the computer area to the extent allowed in Chapter VI.

205-6. Listed waste containers shall be used to limit a fire to the contents of the container. Containers shall be emptied at the end of each shift or at least once each day.

205-7. The area under raised floors shall be inspected periodically to assure that no loose combustibles in the form of card punchings, trash, or debris have accumulated.

205-8. The following are prohibited in the computer area:

a. Any activity or occupancy not directly associated with the computer system(s) involved.

b. Bulk storage of office or computer supplies, forms, stationery, and other combustible supplies.

c. Components of the computer systems which are neither electronically interconnected to the computer system nor required in close proximity.

d. Maintenance shops and maintenance operations except for those repair and maintenance operations which must be performed directly on equipment which is impracticable to remove from the computer area.

e. Bulk storage of records (see Chapter VI).

f. Storage of combustible materials under raised floors.

g. Any other combustible materials, equipment, or operation which constitute a hazard and which can be removed.

h. Smoking (see Appendix A).

## CHAPTER III

# MACHINES AND CABLES

### 301. SCOPE

301-1. In view of the use of combustible materials, particularly plastics in wire insulation, printed circuit boards, and other components, it is evident that such equipment can burn and cause serious internal damage. Any equipment not conforming to the requirements of this chapter may present risks to itself and/or to neighboring elements greater that those which are necessary or should be tolerated.

NOTE: Underwriters' Laboratories, Inc., published UL 478, a standard for "Electronic Data-Processing Units and Systems." UL 478 represents the judgement of Underwriters' Laboratories, Inc., in defining the construction and test standards so that, when deenergized, fire is not likely to spread beyond the external housing of the unit containing the source of ignition. A unit is defined by UL as that portion of a system to which an identification number is applied. The requirements of UL 478 are incorporated in this document; however, a single unit as defined by UL frequently represents an excessive module of risk, and therefore requirements in addition to the requirements of the UL 478 are included to provide the DOE with equipment where a fire is less likely to involve an entire unit.

### 302. MACHINE CONSTRUCTION

302-1. The requirements contained in Section 302 are designed to provide equipment which to the maximum extent practicable will not sustain or propagate a fire originating from electrical defects or overheating within the equipment or from a small exposure fire outside of the equipment. When units meeting these requirements cannot be obtained on an economical or competitive basis, additional fire protection features such as in-cabinet extinguishing fire partitions between units may be required.

302-2. Except as modified below, all electronic data processing units that are part of an electronic computer shall conform to the requirements of UL 478, "Electronic Data-Processing Units and Systems."

302-3. Noncombustible material shall be used in the construction of computer equipment. All structural members; i.e., cabinets, frames, chassis, supports, partition, etc., shall be noncombustible. In addition, all nonstructural items such as shield, covers, and guards shall be noncombustible.

302-4. To the maximum extent possible, noncombustible materials shall be used for electrical insulation, electrical components, component mountings, and printed circuit boards. When it is impossible or impracticable to use noncombustible materials, the materials used should be the least combustible available that will meet the operating needs of the equipment. This also applies to sound and thermal insulation as well as any other material used in machines construction.

302-5. Bulkheads and other forms of subdivision to stop or at least impede the progress of fire shall be used to the maximum extent possible.

302-6. Filters shall comply with Underwriters' Laboratories, Inc., Class I specifications (Air Filter Units, UL 900), shall be replaceable, and shall be changed at sufficient frequency to prevent accumulations of hazardous amounts of combustible dust or lint.

302-7. If fluids are used for lubrication, hydraulic or cooling purposes, they shall have a flash point of 300°F or higher. A pressure relief device shall be required on systems with sealed construction. Oils shall not be used for any other purposes in a computer system.

302-8. When special fixed fire protection systems are necessary, they shall whenever possible be specified as part of the purchase, leasing contract, or design, and shall be installed as an integral part of the equipment.

302-9. Each computer cabinet subject to thermal overload shall be equipped with a thermal overload device that will deenergize the cabinet or the entire computer and signal the computer console.

### 303. CABLE CONSTRUCTION

303-1. Cabling is defined as being those power supply and signal conductors which connect to the units, between the units, and between major subdivisions as opposed to those conductors which are internal to the units. Specifically, a cable passing through an equipment cabinet wall shall be identified as internal wiring when it is within the cabinet.

303-2. Signal carrying cables and power conductors should be physically separate except that cable may carry both power and signal when specifically designed for this service and specifically approved by a recognized testing

laboratory for the services involved. The separation between power and signal cables should be sufficient so that a fire developing in one group shall in no way affect the operation of the other group.

303-3. In any case where cables are supported by racks, trays, or other supports, the entire support system shall be on noncombustible construction.

303-4. It should be recognized that cables may burn vigorously when in groups. Cables whose insulation and jackets have been fabricated to minimize the development and propagation of flame, and have been listed or approved by recognized testing laboratories as flame retardant, shall be used in conjunction with computer equipment. Their use will reduce, but not eliminate the hazard from grouped cables.

## CHAPTER IV

# FIRE PROTECTION SYSTEMS

### 401. SCOPE

401-1. This chapter describes fire protection systems that may be employed for computer equipment protection.

### 402. FIRE PROTECTION SYSTEMS COMPONENTS

402-1. Automatic Sprinkler Equipment:

a. Automatic sprinkler protection for computer equipment areas shall be in accordance with NFPA No. 13, "Sprinkler Systems." The sprinkler system should preferably be valved independently from the other sprinkler systems.

b. The purpose of sprinkler protection is to limit and control major fire incidents and prevent total destruction of the computer system.

402-2. Halogenated Fire Extinguishing Agent and Carbon Dioxide Systems:

a. Halogenated Fire Extinguishing Agent Systems using Halon 1301 or 1211 shall be designed and installed in accordance with NFPA No. 12A or 12B, "Halogenated Fire Extinguishing Agent Systems."

b. Carbon Dioxide Systems shall be installed in accordance with NFPA No. 12, "Carbon Dioxide Extinguishing Systems."

402-3. Automatic Fire Detection Equipment:

a. Automatic detection equipment shall be the smoke or photoelectric type per NFPA 72E.

(1) Consideration should be given to the arrangement of detection equipment to shut down power and air conditioning to the involved equipment. The decision for the specific design should be determined on the basis of facility requirements.

402-4. Local and Remote Alarms. All alarms associated with fire extinguishing and fire detection systems shall alert local personnel and shall be transmitted to a manned alarm station.

402-5. Portable Firefighting Equipment:

a. The requirements of this paragraph are designed to provide fire extinguishers which will be immediately available and capable of controlling incipient fires in the computer area. Carbon dioxide fire extinguishers or hose reel systems and Halon fire extinguishers are recommended for electrical fires. No other Class C (electrically nonconducting) extinguishing agents should be used. Clear-water type fire extinguishers are also required because of the inevitable presence of ordinary combustibles. Liquefied gas type extinguishers may be substituted for water type extinguishers, providing each unit has a UL rating of 2-A or higher.

b. Every computer area shall be provided with carbon dioxide or Halon fire extinguishers, prominently located so that no electrically powered machine is more than 75 feet travel distance from an extinguisher with a UL rating of 10-BC or higher.

c. Each computer equipment area shall be provided with Class A-rated fire extinguishers, prominently located so that no person in the area shall have to travel more than 75 feet to obtain a fire extinguisher having a UL rating of 2-A or higher.

d. Fire extinguishers shall be clearly marked to indicate the type of fire for which it is intended, shall be in compliance with NFPA No. 10, "Installation of Portable Fire Extinguishers," and shall be maintained in accordance with NFPA 10A, "Recommended Good Practice for the Maintenance and Use of Portable Fire Extinguishers."

### 403. FIRE PROTECTION SYSTEM REQUIREMENTS

403-1. This section covers the types of fire protection system required for the computer room.

a. **Automatic Protection.** The computer room shall be protected by an automatic sprinkler system. Automatic total flooding Halon may be considered in lieu of a sprinkler system if an adequate supply of water is not available. Halon 1301 may be used to supplement the automatic sprinkler system.

1. The space underfloor and above the ceiling shall be protected by an automatic sprinkler or Halon 1301 system, if required by the presence of combustible materials. An automatic carbon dioxide or Halon 1211 system may be used underfloor in place of the above. Actuation solely by manual operation is acceptable if, when the equipement is energized, it is under the supervision of an operator or other persons familiar with the equipment.

2. Halon and carbon dioxide systems shall have a reserve supply at least equal to the design supply except where onsite bulk storage is available for refilling the supply containers or the system provides protection in addition to an automatic sprinkler system.

3. Sound fire protection engineering judgement requires that in the selection of the appropriate agent, consideration must be given to the nature of the agent, potention personnel exposure, cost, and the type of combustibles present.

4. In-cabinet protection should be considered for the central processing unit and other critical computer components.

b. **Automatic Detection.** Automatic detection shall be provided for the entire computer area. When a separate automatic alarm system is provided for early warning purposes, it shall be of the ionization or photoelectric (smoke) type.

c. **Emergency Response.** Adequate personnel should be available to respond to any alarm for effective first-aid firefighting. The respondents shall be familiar with the equipment operation, utility supply lay-out, and shall be thoroughly trained in first-aid and fire suppression. The intent is to provide a fire suppression effort pending the arrival of professional fire fighting personnel and equipment.

d. **Portable Firefighting Equipment.** Portable firefighting equipment shall be provided per paragraph 402-5.

### 404. VALUE LIMITATION

404-1. This section is concerned with the limitation of computer values in any one fire area. A fire area is that area which is separated from other areas by exterior walls, firewalls, or other rated fire resistive separations.

404-2. The maximum computer value in any one fire area shall not exceed $50,000,000.* Where a division is necessary to conform to the $50,000,000 criterion, a four-hour wall is required.

404-3. When it is necessary within these limitations to locate more than one computer system in a single fire area, fire protection engineering judgement shall be exercised to provide the best possible separation of systems.

*Note: The value limitation is assumed to be the calculated replacement value in 1983 dollars. The limit may be escalated in subsequent years by the same factors used for calculating replacement values for other property as discussed in DOE Order 5480.1A Chapter VII, Fire Protection.

## CHAPTER V

# UTILITIES

### 501. SCOPE

501-1. This chapter concerns the necessary utilities required in a computer area and the emergency controls required for shutdown of these utilities.

### 502. AIR CONDITIONING SYSTEMS

502-1. Air conditioning systems shall conform to the requirements of NFPA No. 19A, "Air Conditioning and Ventilating Systems," and to the additional requirements set forth below.

502-2. When air conditioning is provided, the air distribution system for the area involved and associated rooms should be completely separate and independent from any other air distribution system. The refrigeration compressors, brine circulation system, cooling towers, or similar equipment may, however, be common to other systems if desired.

502-3. All duct insulation and linings, including vapor barriers and coatings, shall be noncombustible.

502-4. All filters shall be noncombustible (meeting the requirements for Underwriter's Laboratories, Inc., Class I or better) and shall be cleaned or replaced as necessary to prevent combustible dust or lint accumulations.

502-5. Air ducts serving other areas should not pass through the computer or records storage area. When it is impracticable to reroute such ducts, they shall be encased in a fire-resistive duct, equivalent to the fire resistance of the enclosure for the area involved or be provided with suitable fire doors or dampers as outlined in NFPA No. 90A, "Air Conditioning and Ventilating Systems."

502-6. Consideration shall be given in the design or modification of the air conditioning and ventilating systems to provide for smoke venting, taking into account the probable smoke paths in relation to exposure of computer units.

### 503. ELECTRICAL SERVICE

503-1. The requirements of this section apply to all power and service cables supplying the computer area and the equipment. The equipment and interconnected wiring requirements are set forth in Chapter III.

503-2. All wiring shall conform to NFPA No. 70, "National Electrical Code" with particular attention to Article 645 — Data Processing Systems (see Appenddix C). Insulation on cable to computer equipment shall be flame retardant and if run under raised floors, it shall also be water resistant. Bundling or stacking of cables in large groups should be avoided. Abandoned cable shall be removed from underfloor space and cable trays. Spare cables shall not be stored in underfloor spaces or cable trays.

503-3. Service transformers should not be permitted in the computer area. However, if such a transformer must be installed in this area, it shall be of the dry type or the type filled with an Underwriter's Laboratories, Inc., listed nonflammable dielectric medium. Such transformers shall be installed in accordance with the requirements of the National Electric Code.

503-4. Junction boxes under raised floor areas are to be avoided. If they must be used, they shall be metal, completely enclosed, readily accessible, grounded to the electrical equipment ground, and in compliance with the National Electrical Code requirements as to construction. They shall be securely fastened to the floor. No splices or connections shall be made in the under-floor area except within junction boxes, or by means of receptacles or connectors which incorporate grounding wires and which have positive means to prevent accidental disconnection or loosening.

503-5. Fluorescent fixtures shall be fitted with noncombustible light diffusers.

503-6. Emergency lighting, actuated by failure of normal power, shall be provided in the computer area.

### 504. EMERGENCY POWER CONTROLS

504-1. A prominently labeled master control switch shall be located at each principal exit from the computer equipment area. These master control switches shall be in addition to any emergency shutdown for individual machines or units and shall disconnect power to all computer equipment and the air conditioning system.

### 505. OTHER UTILITIES

505-1. Utility systems not required in computer operations shall not be installed in, or pass through the computer room.

## CHAPTER VI

# STORAGE AND RECORDS

### 601. SCOPE

601-1. This chapter discusses the types of storage and records and the protection required for each type.

### 602. GENERAL STORAGE

602-1. Section 602 is concerned with reducing fuel for fire by prohibiting the storage of all combustible supplies and materials not needed to accomplish day-to-day operations.

602-2. Of necessity, the operation of computer equipment involves storage of sizable quantities of combustible materials including print-out paper, stationery supplies, unused magnetic and paper tapes, packaging materials and other types of flammable supplies. If not rigorously controlled, the storage of these items may become a serious hazard. An accumulation of supplies within the computer room represents a fuel load for potential fires and shall be restricted to the minimum necessary for efficient operation. Such material within the computer room shall be kept in totally enclosed metal files or cabinets.

603-2. **Record Media.** Typical input recording media include punch cards, plastic- or metal-based electronic tapes (on metal or plastic reels and in metal, plastic, or cardboard containers), paper or plastic punch tapes, microfilm and other photographic media, magnetic disks, memory drums, memory cores, and other media usually in machine language format.

603-3. **Classification of Records.** The following method for categorizing records is adapted from NFPA No. 232, "Protection of Records." The four general classes of records are:

a. **Class 1 (Vital) Records.** Records essential to the mission which could not be reproduced or obtained elsewhere. Examples include irreplaceable program records, research data, master records, accounts receivable, specified wiring diagrams, and various types of operational data.

602-3. Storage rooms outside the computer area shall be provided for reserve stocks of supplies, including paper, unused magnetic tapes and other items required for continuing operations.

## 603. PROTECTION OF RECORDS

603-1. Section 603 details requirements for protecting various types of records involved in the use of computers and methods for protecting the different recording media used. Requirements for protection of records on paper-based materials are derived from extensive experience with paper in fire situations and long-established standards. Protection needs of records on plastic-based materials are determined by more limited experience. Plastic-based materials are more susceptible to fire damage than paper-based records. Some computer installations generate, use and store large quantities of input records as well as print-out records. These records in some instances can be more important to continuity of operations than the computer equipment itself.

b. **Class 2 (Important) Records.** Records possessing a high value to the mission but which, if lost, could be reproduced or reconstructed with difficulty or extra expense. Loss of records in this class would cause a considerable delay in execution of the mission. Examples include statistical records maintained to check operating costs, manpower and material utilization designs in process of development, research data and records of experiments in progress.

c. **Class 3 (Useful) Records.** Records which could be readily replaced without presenting a great obstacle to prompt restoration of operations. Examples might include program records contributing to accomplishment of mission but possessing less than a high value and procedural instructions for use as examples in solving special problems.

d. **Class 4 (Nonessential) Records.** Records which are unnecessary to accomplishment of the mission, and records which in accordance with prearranged plans and authorizations are eligible for destruction, or erasure of recorded data on magnetic media.

603-4. **Duplication of Records.** An effective method for safeguarding records consists of duplicating and storing copies in a separate area remote from the fire area storing the originals. This normally assures that the two sets of records will not be subject to damage from the same fire.

a. All vital and important records shall be duplicated immediately as a standard operating procedure; duplicates shall be stored in a separate fire area from that housing the originals, preferably in a separate building.

b. Whenever practicable, useful records shall be similarly duplicated.

603-5. **Records in the Computer Area.**

a. The quantity of records shall be kept to the absolute minimum required for immediate use.

b. When the quantity of records is not large enough to economically justify a separate storage room, the records may be kept in closed metal files or cabinets within the computer area.

603-6. **Records Stored Adjacent to the Computer Area.**

a. **General.** To the maximum extent consistent with efficient operations, all records shall be stored outside the computer area. An adjacent, fire resistive records or tape library opening directly into the computer area and meeting the requirements of subparagraphs b or c below is an acceptable area. The degree of fire resistance shall be commensurate with the fire exposure of the records to the computer area, but not less than two hours. Detection is required in records storage rooms in order to alert first-aid firefighting forces before the fire involves sufficient material to become a hazard to the computer.

b. **Records on Paper-Based Materials.** Records storage rooms and vaults shall be provided with automatic sprinkler and automatic detection systems.

c. **Records on Plastic or Metal Materials.** Records on plastic or on metal materials in plastic cases shall be stored in a separate room or vault equipped with automatic detection and automatic sprinkler systems. Total flooding Halon 1301 systems may be used as supplementary protection.

603-7. **Records Stored in Other Areas.** Fire protection for records in storage rooms not immediately adjacent to

the computer area and for the duplicate records shall be determined in accordance with sound fire protection engineering judgement.

603-8. **Class 4 (Nonessential) Records.** In order to reduce the fire load records in this classification shall be destroyed or erased for reuse.

## CHAPTER VII

# MOBILE EQUIPMENT

### 701. SCOPE

701-1. The term mobile equipment as used in this chapter shall mean parked or positioned trailers and similar equipment used as substitutes for traditional building structures to house computer equipment. This type of housing is permissible only when computer equipment is required to be mobile. It is not intended to suggest that trailers can be used as a substitute for permanent facilities.

701-2. To the extent applicable, the requirements in the other parts of this document shall be applied to mobile computer equipment. In particular, the requirements covering the use of only noncombustible materials for construction, insulation, and interior finish of computer equipment areas, the special protection requirements of computer equipment and the protection of records shall be followed in intent when conformance in fact is not possible. Listed below are specific requirements unique to mobile equipment.

### 702. TRACTION SOURCES

702-1. Where internal combustion engine powered tractors or similar means are used as the motive power for the movement of mobile equipment, such equipment shall be disconnected and removed a sufficient distance from the computer equipment so as not to present a fire exposure to the computer equipment.

### 703. TRAILER CONSTRUCTION

703-1 Trailer bodies or the body of other types of mobile equipment housing computer equipment shall be in conformance with DOE EV/0043 "Standard on Fire Protection for Portable Structures."

### 704. TEMPORARY CONSTRUCTION

704-1. Connecting corridors and other temporary construction used in connection with, or in close proximity to the computer equipment shall be of noncombustible materials.

### 705. SPACING

705-1. Mobile equipment shall be separated sufficiently to preclude the spread of fire from one unit to another.

705-2. The computer equipment shall be located a sufficient distance from other facilities so that the use of flammable liquids or other hazardous materials at these facilities will not present a fire exposure to the computer. This distance shall be at least 50 feet unless the natural terrain or other noncombustible barricades provide the necessary protection between the fuel and the computer equipment.

## CHAPTER VIII

# EMERGENCY OPERATIONS

### 801. SCOPE

801-1. Emergency operations include the establishment of programs for firefighting, and programs for the restoration of damaged records.

### 802. FIRE EMERGENCY ORGANIZATION

802-1. An emergency fire control organization for each computer equipment operation shall be established. The following paragraphs describe functions which should be included in such organizations but do not attempt to specify the organization. Each facility must determine the best method of providing the needed protection.

802-2. The purpose of the fire emergency plan shall be to:

a. Prevent or minimize injury to personnel.

b. Prevent or minimize danger to computer equipment.

c. Prevent or minimize danger to records.

d. Preserve the ability of the computer equipment to operate.

e. Prevent or minimize danger to other operations and equipment.

f. Prevent or minimize danger to the building housing the operations and other buildings in the area.

802-5. Emergency equipment required in the computer room will differ at various facilities; however, equipment that should generally be provided includes:

a. A floor lifter located near the main entrance and reserved exclusively for emergency use.

b. Sprinkler stoppers to stop the flow from a sprinkler head after a fire is extinguished.

c. Waterproof salvage covers used to protect equipment not involved in the fire.

802-6. Written fire emergency procedures, which assigns specific responsibilities to designated personnel, shall be prepared. This emergency plan shall be coordinated with other emergency components included in the sitewide emergency plan.

## 803. SALVAGE OPERATIONS

803-1. In the event of fire, particularly where there is either considerable smoke or use of water, prompt salvage operations can aid greatly in rapid restoration of operations and limitation of damage. Immediate action is one of the main keys to successful salvage operations with preplanning before the fire as an equally important item.

803-2. Where there is water damage potential from a source outside the computer area, protective measures will vary according to equipment design. In some instances adequate shielding can be obtained by simply taking off the side covers of the equipment and placing them on top of the exposed units. In other cases prepared covers or waterproof tarpaulins will be needed.

803-3. Whenever computer equipment has been contaminated with water, firefighting chemicals, smoke or soot, it is vital that action be taken to clean and dry it as soon as possible. If clean water is the contaminant, drying is all that is necessary. However, if the equipment is contaminated with smoke, soot, or firefighting chemicals, cleaning before drying is necessary. Failure to remove contamination promptly may greatly increase the damage.

803-4. Salvage techniques are detailed in Appendix B, Reconditioning of Flooded and Smoke-Contaminated Equipment.

803-5. The locations of salvage covers, mops, brooms, and other equipment useful in the reduction of damage should be ascertained and made readily available to the emergency teams and others who may be called on to remove water and otherwise aid in salvage operations.

803-6. With respect to records damaged by fire and water, the Federal Fire Council's Recommended Practice No. 2, "Salvaging and Restoring Records Damaged by Fire and Water" outlines certain simple first-aid actions which will increase the salvage potential of damaged records. Speed of application is often essential to successful salvage.

## 804. REESTABLISHMENT OF OPERATIONS

804-1. The prompt reestablishment of operations after a damaging fire depends on the availability of alternate equipment which can be used to perform the functions of destroyed equipment, the ability to replace the damaged equipment or records and the restoration of any damaged facility or the ability to use an alternate area for substitute equipment.

804-2. The existence of similar computer equipment or equipment capable of performing its mission does not constitute an available alternate source. The alternate equipment must be in a location which can be used, and must have available computer time to take over the functions of the disabled operation.

To the extent possible, availability of alternate operating facilities should be determined and prior arrangements established for mutual aid in case of fire.

804-3. Accurate records of the types of equipment used and particularly any modifications or changes made after installation should be kept in a separate location to aid the manufacturer in prompt replacement of any destroyed equipment.

804-4. Plans should be made for the transfer of personnel, supplies, and equipment to alternate sites and for the expedient handling of replacement equipment.

804-5. Because of the importance of the above-mentioned planning, all of the possibilities should be formalized in written emergency operation plans.

# APPENDIX A

## SMOKING RESTRICTIONS

Existing computer protection standards vary in their approach to this subject. Requirements vary from a complete ban to only "controls." Originators of various standards indicate that the complete ban is based on the sensitivity of tapes and electronic components, in addition to fire prevention considerations. Fire protection authorities generally agree as to the desirability of controls due to the high values subject to loss from small ignition sources.

The following program shall be adopted for all DOE-controlled computer facilities.

### CONTROL OF SMOKING

1. Smoking shall be prohibited in all tape and records storage vaults and computer equipment areas.

2. Smoking may be permitted in adjoining rooms such as offices, lunchrooms, lobbies, and reception areas. In permissible areas, there shall be suitable receptacles for ashes, high standards of housekeeping, and signs warning against carrying lighted smoking materials into the prohibited areas.

3. Permissive areas shall be located so that products-of-combustion (smoke) detection systems shall not be actuated by cigarette smoke.

4. Smoking controls shall apply during maintenance, modification, or building expansion operations, as well as normal operating periods.

5. Adequacy of the control program should be reviewed as part of each fire protection survey.

# APPENDIX B

## RECONDITIONING OF FLOODED AND SMOKE-CONTAMINATED EQUIPMENT

This Appendix was published in draft form in RP-1, second revision, 1978. The format below is the same document, as published in NAVSEA 59086-VD-STM-000/CH-631.

### SECTION 10 RECONDITIONING OF FLOODED AND SMOKE-CONTAMINATED EQUIPMENT

631-10.1 **GENERAL**

631-10.2 Shipboard electronic, electrical, and mechanical equipment may become flooded with freshwater, seawater, fuel, lubricating oil, or a combination of these contaminants; or may be contaminated by smoke during fire or other casualty. The replacement or repair of this equipment is important to the ship's operation; therfore, it is imperative that equipment be restored to operational condition.

631-10.3 Since reliability of the equipment is important, the equipment shall be restored as nearly as possible to new condition. Experience shows that most equipment can be successfull reconditioned, but it must be thoroughly done to minimize the possibility of subsequent failure.

631-10.4 This section covers reconditioning methods applicable to electronic, electrical, and mechanical equipment such as:

1. Digital computers.

2. Radar transmitters, receivers, and consoles.

3. Fire control equipment.

4. Radio transmitters and receivers.

5. Amplifiers and power supplies.

6. Teletypewriters.

7. Switchboards.

8. Motors, 5-horsepower and under.

9. Electronic test equipment.

631-10.5 The following equipment is not reconditioned at the shipboard level:

1. Electric motors larger than 5-horsepower or too heavy to be place in an oven for drying (chapter 302, Electric Motors and Controllers).

2. Motors having taped windings as the primary insulation system (chapter 302, Electric Motors and Controllers).

3. Radio equipment, infrared sensors, and sonar transducers (chapter 400, Electronics).

## 631-10.6 RECONDITIONING EQUIPMENT

631-10.7 The equipment used in reconditioning flooded or smoke-contaminated equipment is described in paragraphs 631-10.8 through 631-10.11.

631-10.8 **ULTRASONIC TANKS.** Two stainless steel ultrasonic tanks large enough to immerse the equipment to be cleaned are needed. Each tank should be equipped with drains and steam or electric heaters. The transducers (preferably magnetostrictive) should be side-mounted, immersible units. For small tanks, bottom-mounted transducers are suitable. The energy input should be 6 to 10 watts per square inch over the entire side or bottom of the tank. Use one tank for cleaning and the other for rinsing. A third tank (without the transducer) may be used for presoaking smoke-contaminated items.

631-10.9 **SPRAY EQUIPMENT.** Pressure-atomizing (airless) spray guns, such as those used for aircraft washing, are preferred. Compressed-air guns are also suitable.

631-10.10 **COMPRESSED AIR.** Oil-free air at about 80 lb./in$^2$ is needed for spraying equipment. Air for blowing off bulk water before drying must be clean, dry, oil-free, and reduced to 10 to 20 lb/in$^2$.

631-10.11 **DRYING EQUIPMENT.** Vacuum or forced-draft ovens with the temperature reliably controlled at 48.9 °C to 71 °C (120 °F to 160 °F) are preferable for drying the cleaned items. A room equipped with heaters or dehumidifiers can also be used. Warm-air blowers are useful, but high-temperature heat guns may cause damage.

## 631-10.12 RECONDITIONING MATERIALS.

631-10.13 The materials needed in the reconditioning of flooded or smoke-contaminated equipment are:

1. Precleaners for smoke and soot deposits.

2. Detergents for cleaning.

3. Cleaning emulsions for oily contamination, preservatives, and salts

4. Water-displacing fluids for temporary preservation and drying electronic and electrical equipment.

631-10.14 **PRECLEANER.** Use alkaline cleaning agent to clean the smoke and soot deposits from smoke-damaged equipment. Use 2 to 3 ounces of trisodium phosphate (technical grade, NSN 6810-00-664-7487) per gallon of water (1 to 1½ pounds per cubic foot) at 48.9 °C to 71.1 °C (120 °F to 160 °F). Workers shall wear rubber gloves to minimize contact with the alkaline solution. In an emergency, an alkaline cleaning agent such as a dishwashing compound may be used.

631-10.15 If trisodium phosphate is not available through normal channels, it can be obtained from the following sources:

1. Ashland Chemical Company
   Box 2219
   Columbus, Ohio 43216

2. Fisher Scientific Company
   585 Alpha Drive
   Pittsburgh, PA 15238

3. Olin Corporation
   120 Long Ridge Road
   Stamford, CT 06904

631-10.16 **DETERGENT.** For cleaning equipment with little or no oily contamination, use a general-purpose water-soluble detergent (MIL-D-16791 Type I). Mix 1 ounce per gallon of freshwater (1 gallon per 125 gallons or 17 cubic feet). Detergent MIL-D-16791 is available in 1- and 5-gallon cans. (See table 631-17 for NSN's.)

631-10.17 **CLEANING EMULSION.** Cleaning emulsion is used for removing oily contamination preservatives, and salts from flooded equipment. The emulsion concentration (table 631-17) comprises the following:

1. Dry cleaning solvent, Fed. Spec. P-D-680, Type II.

2. Fuel oil, diesel marine, MIL-F-16884, Type I.

3. Surfactant, polyethylene glycol 400 dioleate.

631-10.18 The mixing formula for the emulsion concentrate is 94 parts of dry cleaning solvent to 5 parts fuel oil to 1 part surfacant. The surfactant is available from the following sources:

1. Armak Chemicals Division
   Box 1805
   Chicago, IL 60609
   Order: polyethylene glycol 400 dioleate

2. Emery Industries, Inc.
   Carew Tower
   Cincinnati, OH 45202
   Order: Emerest 2648

3. Glyco Chemicals, Inc.
   P.O. Box 700
   Greenwich, CT 06830
   Order: Pegosperse 400 DO

631-10.19 Fill the clean tank 20 to 50 percent with cleaning emulsion concentrate and then add freshwater. The mixing formula for emulsion concentrate is given in table 631-45. The water shall have a hardness of less than 10 p/m. Upon mixing, the emulsion will readily form and should begin to separate after standing for about 30 minutes. Rapid separation indicates excessive water hardness.

**TABLE 631-45. EMERGENCY CLEANING EMULSION CONCENTRATE FORMULA**

| Ingredients | Small Batch (5.32 gal.) | Large Batch (58.5 gal.) |
|---|---|---|
| Solvent (P-D-680, Type I) | 5 gal. | 55 gal. |
| Diesel fuel oil (MIL-F-16884 Type I) | 1.1 qt (1 L) | 2.9 gal. (11 L) |
| Surfactant | 6.8 fl. oz. (200 mL) | 75 fl. oz (2200 mL) |

**TABLE 631-46. WATER-DISPLACING FLUID FORMULAS**

| Components | Formula No. 1 (by parts) | Formula No. 2 (by parts) |
|---|---|---|
| N-Butyl alcohol | 93.75 | 98.75 |
| Basic barium dinonylnaph-thalene sulfonate (50% concentrate in naphtha) | 6.0 | 1.0 |
| Antioxidant BHT | 0.25 | 0.25 |

631-10.20 In an emergency, general-purpose oil-soluble detergent (MIL-D-16791 Type II) may be used for the surfactant, even though the emulsion concentrate will not have the optimum properties.

631-10.21 **WATER-DISPLACING FLUIDS.** Water-displacing fluid (Formula No. 1) is used for the temporary preservation of any equipment pending cleaning, and for drying mechanical and electrical equipment, except for electrical contacts. Water-displacing fluid (Formula No. 2) is used for drying electronic equipment and electrical equipment having open contacts. These fluids, packaged in aerosol spray cans, may be obtained as Spra-Dri, Formula No. 1 or No. 2 from:

Orb Industries
P.O. Box 1067
Upland, PA 19015

**CAUTION**

These fluids are flammable and moderately toxic. They must be used in well-ventilated areas away from open flames or other ignition sources. Personnel shall wear rubber gloves to prevent skin contact.

631-10.22 Water-displacing fluids may also be locally prepared for application with paint-spraying equipment (table 631-46).

631-10.23 The components that make up the water-displacing fluid are available from the following sources:

1. N-Butyl alcohol, technical grade (1-butanol), NSN 6810-00-281-2685 (5 gal.)

   a. Fisher Scientific Company
      585 Alpha Drive
      Pittsburgh, PA 15238

   b. Gallard-Schlesinger Chemical
      Manufacturing Company
      584 Mineola Avenue
      Carle Place, New York 11514

2. Basic barium dinonylnaphthalene sulfonate (50 percent concentration in naphtha). Specify as Na-Sul BSB in naptha.

3. Antioxidant BHT, available from R. Vanderbilt Company as Vanlube PC.

631-10.24 **RECONDITIONING PROCEDURE**

631-10.25 The reconditioning procedure consists of five steps described in paragraphs 631-10.26 through 631-10.36.

631-10.26 **PREPARATION.** Unprotected ferrous metals in submerged equipment will rust rapidly when exposed to air (chapter 300, Electric Plant General). Arrangements should be made to immediately proceed with the reconditioning operation after dewatering or recovery of the equipment. Complete disassembly of contaminated equipment is unnecessary. It must be opened to allow the cleaning solution to reach all contaminated areas, and to allow complete draining, rinsing, and drying. Remove covers and access panels, cut large wire bundles, and loosen cable connected boots. Remove fuses and panel lights, unless complete access is required for superficial contamination as caused by light smoke or by a brief, light spray of seawater.

631-10.27 **PRECLEANING AND TEMPORARY PRESERVATION.** Equipment flooded with seawater should be flushed with or immersed in freshwater as soon as possible. If cleaning cannot be completed within a few days after flooding a preservative should be applied to prevent corrosion. Water-displacing fluid (Formula No. 1) is preferred. If unavailable, corrosion-preventive Grade 3 of MIL-C-16173 or some other readily removable preservative may be used.

631-10.28 **CLEANING AND RINSING.** Immersion in an ultrasonic tank is the most effective means of cleaning. It is essential for complex electronic equipment and large electric motors. Air dissolved in the cleaning solution reduces the scrubbing action, so freshly filled tanks should be deaerated by allowing the tank to run for 15-30 minutes before use. The temperature should be between 37.8 °C and 57. °C (100 °F and 135 °F).

631-10.29 **ITEMS BEING CLEANED SHOULD BE SUSPENDED IN THE TANK AND TURNED OCCASIONALLY.** Small parts and hardware may be cleaned in cans suspended or floating in the tank. Immersion for 2-3 minutes is usually adequate for circuit boards, 5-10 minutes for complete chassis, and 10-20 minutes for motors. After cleaning, the item should be briefly flushed with freshwater, then rinsed in the purest available water in an ultransonic tank in the same manner. Spray-cleaning equipment may be used on racks, cabinets, switchboards, and similar equipment that cannot be moved or that is too large for the ultrasonic tanks. Rinsing can be done with the same equipment or a small freshwater hose.

631-10.31 **FIRE AND SMOKE.** Heavy, adherent contamination may require presoaking in a tank of trisodium phosphate solution (paragraph 631-10.14) at 48.9 °C to 7.1. °C (120 °F to 160 °F) for 2 to 5 minutes. Presoaked items or those with only light contamination, are then cleaned as described in paragraph 631-10.32. Items with moderate or oily contamination or with preservatives are present are cleaned as described in paragraph 631-10.31.

631-10.31 **OIL OR OIL AND SEAWATER.** The cleaning emulsion specified in paragraph 631-10.19 removes

oily contaminants and salts. The concentrate is mixed with freshwater to form the emulsion. Depending upon the amount of oily contaminant, use 20 to 50 percent of the concentrate. After cleaning (preferably ultrasonically), flush and rinse thoroughly using the same procedure. If spraying occasionally stir the emulsion to prevent separation, then proceed as described in paragraph 631-10.34.

631-10.32 **SEAWATER.** If little or no oily contamination is present, a detergent solution (paragraph 631-10.16) prepared with freshwater is used for cleaning. Flush and rinse thoroughly and proceed as described in paragraph 631-10.34.

631-10.33 **FRESHWATER.** If the flooding water was of potable quality or purer and carried no other contaminants into the equipment, flush with pure freshwater and proceed as described in paragraph 631-10.34. If mud, oil, salts, or dirt are present, proceed as described in paragraphs 631-10.31 or 631.10.32.

631-10.34 **DRYING.** Drying may be done by blowing the water off the equipment with oil-free, low-pressure air (10 to 20 lb/in$^2$). Place the equipment in a warm oven [48.9 °C to 71.1 °C (120 °F to 160 °F)] until dry (8 to 24 hours).

**CAUTION**

Do not use oily moisture-displacing sprays on electronic equipment.

631-10.35 For large items or if an oven is not available, the water-displacing fluid (Formula No. 2) may be used to speed-dry and prevent corrosion.

631-10.36 **CHECKOUT.** Electronic and electrical equipment shall be checked for proper operation, defective components, and high insulation resistance. Adjustment and realignment may be necessary before returning the equipment to service.

631-10.37 **RECONDITIONING EQUIPMENT REQUIREMENTS**

631-10.38 Some guidelines that may be helpful when reconditioning flooded or smoke-contaminated equipment are given in paragraphs 631-10.39 through 631-10.42.

631-10.39 **UNSEALED VOIDS.** Some components, such as panel meters and synchro and servo motors, have cases which are not hermetically sealed, but are tight enough to prevent adequate cleaning, rinsing, and drying. Sometimes these can be opened and the contents cleaned, but replacement is often cheaper. If the contamination is superficial, remove such items in the preparation procedure and manually clean as necessary.

631-10.40 **LUBRICATED PARTS.** Discard oil wicks before cleaning equipment and replace with new ones. Replace sealed bearings after cleaning. Relubricate gears, cams, and other components.

631-10.41 **MOTORS AND GENERATORS.** Spray cleaning is adequate only for fractional-horsepower AC units. For larger units and all DC equipment use ultrasonic agitation. Disassemble the unit, discarding cabon brushes, sealed bearings, oil wicks, and packing. Clean the rotor and stator separately. After drying, reassemble and relubricate as necessary. Operations shall not be attempted until the circuit-to-ground resistance exceeds 8,000 ohms as measured by null balance methods. High potential insulation resistance measurements shall never be made while insulating systems are wet or damp. Equipment may be started at reduced voltage and operated for several hours under no load or very light load to produce gentle internal heating to complete the drying until the resistance between the circuit and ground exceeds the following:

1. One megohm for equipment rated at 450 volts or less.

2. A value in megohms equal to rated voltage divided by 500 for equipment rated over 450 volts.

631-10.42 Failure to reach a satisfactory insulation resistance level, or a decline in resistance afterward, is an indication that salts are still present and a more thorough (longer) cleaning is required.

# APPENDIX C

## NATIONAL ELECTRICAL CODE NFPA-70 ARTICLE 645—DATA PROCESSING SYSTEMS (1981 EDITION)

### ARTICLE 645—DATA PROCESSING SYSTEMS

645-1. **Scope.** This article covers equipment, power-supply wiring, equipment interconnecting wiring, and grounding of data processing systems, including data communications equipment used as a terminal unit in a data processing room.

645-2. **Supply Circuits and Interconnecting Cables.**

**(a) Branch-Circuit Conductors.** The branch-circuit conductors to which one or more units of a data processing system are connected to a source of supply shall have an ampacity not less than 125 percent of the total connected load.

**(b) Connecting Cables.** The data processing system shall be permitted to be connected by means of computer cable or flexible cord and an attachment plug cap or cord-set assembly specifically approved as a part of the data processing system. Separate units shall be permitted to be interconnected by means of flexible cords and cable specifically approved as part of the data processing system. When run on the surface of the floor, they shall be protected against physical damage.

**(c) Under Raised Floors.** The power and communications supply cables and interconnecting cables shall be permitted under a raised floor provided:

**(1)** The raised floor is of suitable construction.

**See Electronic Computer/Data Processing Equipment, NFPA 75-1976 (ANSI).**

**(2)** The branch-circuit supply conductors to receptacles are in rigid metal conduit, intermediate metal conduit, electrical metallic tubing, metal wireway, metal surface raceway with metal cover, flexible metal conduit, liquid-tight flexible metal conduit, mineral-ionsulated, metal-sheathed cable, metal clad cable, or Type AC cable.

**(3)** Ventilation in the underfloor area is used for the data processing equipment and data processing area only.

645-3. **Disconnecting Means.** A disconnecting means shall be provided to disconnect the power to all electronic equipment in the computer room. This disconnecting means shall be controlled from locations readily accessible to the operator at the principal exit doors. There shall also be a similar disconnecting means to disconnect the air-conditioning system serving this area.

645-4. **Grounding.** All exposed noncurrent-carrying metal parts of a data processing system shall be grounded in accordance with Article 250.

645-5. **Marking.** Each unit of a data processing system that is intended to be supplied by a branch circuit shall be provided with a manufacturer's nameplate, which shall also include the rating in volts, the operating frequency, and the total load in amperes.

# APPENDIX D

## ELECTRONIC EQUIPMENT LOSSES IN AEC/ERDA/DOE

The following losses in computer facilities are abstracted from DOE property loss and annual summary reports since 1966:

12-20-66 A defective calculating machine ignited and damaged a bench and chair in addition to the machine. One sprinkler head controlled the loss while a dry chemical extinguisher completed extinguishment. Loss was $2,125. Potential loss was over $1 million in this woodframe building.

3-4-67 A fire occurred in the assembly shop area of a university developing a pattern-recognition computer for the AEC. Four months delay and $23,000 loss to the government, plus $155,700 other loss. The fire department extinguished the fire in this unprotected, unoccupied area.

3-12-67 An unprotected, unoccupied electronics trailer burned at a remote test site when a ceiling heater shorted. Loss was $6,500.

3-2-67 A smoking materials fire originating inside the wood-walled rest room spread up a pipe duct to a key punch mezzanine. Two sprinklers and the fire department hose streams extinguished the fire. Loss was $250. Potential loss was $1.5 million.

6-1-67 An underfloor smoke detector sounded the alarm when smoke from a motor-bearing fire spread to the area. The loss was limited to the motor and 45 min. downtime. Three years of memory work in process was saved.

12-9-67 An instrument trailer heater failed and ignited duct insulation. An automatic fire alarm shorted out but a guard observed the fire and sounded the alarm. Damage was $10,563.

6-20-68 A fire in a commercial truck carrying AEC computer equipment on the open highway resulted in $55,673 loss.

8-6-68 A flash flood flowed into an underground bunker, damaging electronic equipment to the extent of $9,300.

12-19-68 Electronic diagnostic equipment in a test firing bunker was damaged when a fire erupted from a fault in an induction coil and switch gear. Portable extinguishers limited the loss to $4,500, mostly from smoke.

3-18-69 An electric short in the wiring of an unprotected trailer ignited the combustible ceiling tile. Two AEC offices suffered a combined loss of $67,900. The base fire department extinguished the fire.

1969 The same site had another fire in another electronics trailer. This time the fire occurred less than one month after an automatic Halon 1301 system had been installed. The loss in the $350,000 trailer was held to $92.

11-7-69 An internal fire in a calculator was extinguished by the operator for a loss of $37.50.

11-12-69 A computer printed circuit card shorted and burned 11 other cards before the operators extinguished the fire with a portable extinguisher. Loss was $250.

1974 An electronic plotter was damaged by an internal short generated fire. The $8,208 loss was absorbed under the vendor's warranty.

1976 Another internal fire from a rectifier fault in a computer circuit resulted in a $45 loss. Prompt operator action kept the fire from spreading beyond the card of origin.

6-28-76 A computer tape console fell off a forklift when being moved. Loss was $2,000.

3-13-77 An electrical internal fault destroyed an analyzer, oscilloscope, and power supplies. Fire was extinguished by a dry chemical portable unit and 1½'' hose line. Loss was $10,000.

7-26-77 Welding vapors tripped an underfloor Halon system for a $1,400 loss.

1-4-78 A Halon system was accidentally discharged when dismantling a pull box alarm actuator. Loss was $2,941.

1-20-78 A small desk calculator was damaged by an internal power card failure. Loss was $1,050.

11-30-78 A computer memory box shorted out and burned. A single sprinkler extinguished the fire and prevented spread to other, immediately adjacent equipment. Loss was $9,000.

12-10-78 A dry pipe sprinkler system was flooded, froze, and discharged on thawing to damage computer components for a $13,000 loss.

1-2-79 Electronic components were damaged when a sprinkler pipe was broken for a $2,000 loss.

2-28-80 A trash can fire in an electronics trailer was successfully extinguished by an automatic Halon 1301 system for a $2,000 loss.

4-24-80 Halon system discharged by electric fault or faulty control panel. $5,940 loss.

5-21-80 A Halon system was discharged by smoke from a faulty fan motor. $1,246 loss.

6-15-80 A fire in a new $85,000 computer auxiliary unit was extinguished by an automatic Halon system for a loss of $16,400. About $1 million worth of other equipment was in the room.

8-2-80 Electric maintenance tests on a printer-plotter circuit damaged the unit for a $1,500 loss.

8-14-80 The electrification of normal office equipment results in near-computer values in ordinary offices. A typewriter unit fell from a cart and was damaged to the extent of $2,600.

1980 A fire originated in a food canteen area of a large computer facility and was extinguished by the operation of two sprinkler heads. Loss was held to $574.

6-26-81 A weekend fire, cause unknown, damaged an unsprinklered printed circuit laboratory for a $25,000 loss.

10-21-81 An electrician made a wrong connection, overloading a computer unit for a total damage of $4,500.

11-4-81 A control room Halon system was discharged for unknown reasons. $2,900 loss.

12-12-81 At the same site a control panel module short discharged a Halon system for a $2,800 loss.

12-23-81 A severe storm occurred while an office building roof was undergoing repairs, resulting in damage to the computer room totalling $40,000.

3-22-82 Lack of notification of a planned power outage resulted in $1,104 damage when power was suddenly interrupted to computers.

10-29-82 Smoke from dirty heating system coils discharged a Halon system for a $1,300 loss.

10-20-82 Lighting strikes caused a power outage, resulting in motor, computer, and assorted electronics damage to the sum of $11,400.

12-4-82 A fluorescent fixture in a computer room fell, damaging two terminal units for an $1,100 loss.

2-10-83 Overheated test equipment leads actuated the automatic Halon 1301 system. Loss was $2,500.

Summarizing the data from all of the DOE losses is informative, if not statistically significant. Listed in order of the mean loss, the following ranking results:

| CAUSE | TOTAL LOSSES | NO. OF CASES | MEAN LOSS |
|---|---|---|---|
| 1. Flood or nonspklr. water damage | $49,300 | 2 | $29,650 |
| 2. Fires-no auto ext. system | $368,426.5 | 14 | $26,316 |
| 3. Fire-all cases | $398,677.5 | 21 | $18,993 |
| 4. Spklr. damage | $15,000 | 2 | $7,500 |
| 5. Fires-ext. by Halon sys. | $18,492 | 3 | $6,164 |
| 6. Elect damage, no fire | $18,504 | 4 | $4,626 |
| 7. Fires-ext. by spklr. system | $11,949 | 4 | $2,987 |
| 8. Accidental Halon discharge | $21,027 | 8 | $2,628 |
| 9. Mechanical dmg. | $5,700 | 3 | $1,900 |

While the total number of incidents in any category is too few to have any real statistical significance, some of the results correspond to those from other studies. For instance, note that the fire loss from fires where there was no automatic extinguishing system was almost nine times the mean loss of fires where a sprinkler system was present. Surprisingly, the loss where a Halon system was the extinguishing system was over twice that of sprinkler-extinguished fires. Presumably, this is due to the few number of cases in either category.

Also, while the number of cases is insignificant, the water damage incidents conform to studies published in the DOE Annual Summary reports, namely; the non-sprinkler water damage incidents equalled the sprinkler incidents in number, and the mean loss exceeded the sprinkler mean loss by a factor of four.

Also of interest is the fact that a number of accidental trips of Halon systems have resulted in a mean loss over one-third of the mean loss of the sprinkler incidents. While the halon loss is not due to an impact on the equipment, the cost of Halon, and the volumes required result in sizeable monetary loss from accidental trips.

Fire has historically been the major single cause of dollar loss in **AEC/ERDA/DOE,** accounting for over half of the total loss from all causes of accidents combined. The importance of fire protection to computers is even more evident from the above. In these incidents fire damage is responsible for 78.5 percent of the total loss from all causes.

## APPENDIX E

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National Fire Protection Association, 60 Batterymarch Street, Boston, Massachusetts 02110.

**NFPA**

| No. | Title |
|---|---|
| 10 | Installation of Portable Fire Extinguishers |
| 10A | Recommended Good Practice for the Maintenance and Use of Portable Fire Extinguishers |
| 12 | Carbon Dioxide Extinguishing Systems |
| 12A | Halogenated Fire Extinguishing Agent Systems - Halon 1301 |
| 12B | Halogenated Fire Extinguishing Agent Systems - Halon 1211 |
| 13 | Sprinkler Systems |
| 70 | National Electrical Code |
| 75 | Electronic Computer/Data Processing Equipment |
| 80 | Fire Doors and Windows |
| 90A | Air Conditioning and Ventilation Systems |
| 232 | Protection of Records |
| 255 | Tests of Surface Burning Characteristics of Building Materials |

Underwriters' Laboratories, Inc., 207 East Ohio Street, Chicago, Illinois 60611

Standards of Safety

**UL**

| No. | Title |
|---|---|
| 478 | Electronic Data Processing Units and Systems |
| 900 | Air Filter Units |

American Society of Testing Materials, 1961 Race Street, Philadelphia, Pennsylvania 19103

**ASTM**

| No. | Title |
|---|---|
| E-136 | Determining Non-Combustibility of Elementary Materials |

# APPENDIX F

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A number of excellent articles have appeared in the National Fire Protection Association's "Fire Journal" over the years, including a number by Department of Energy or DOE contractor personnel. A number of these references are listed below.


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## APPENDIX G—ILLUSTRATIONS

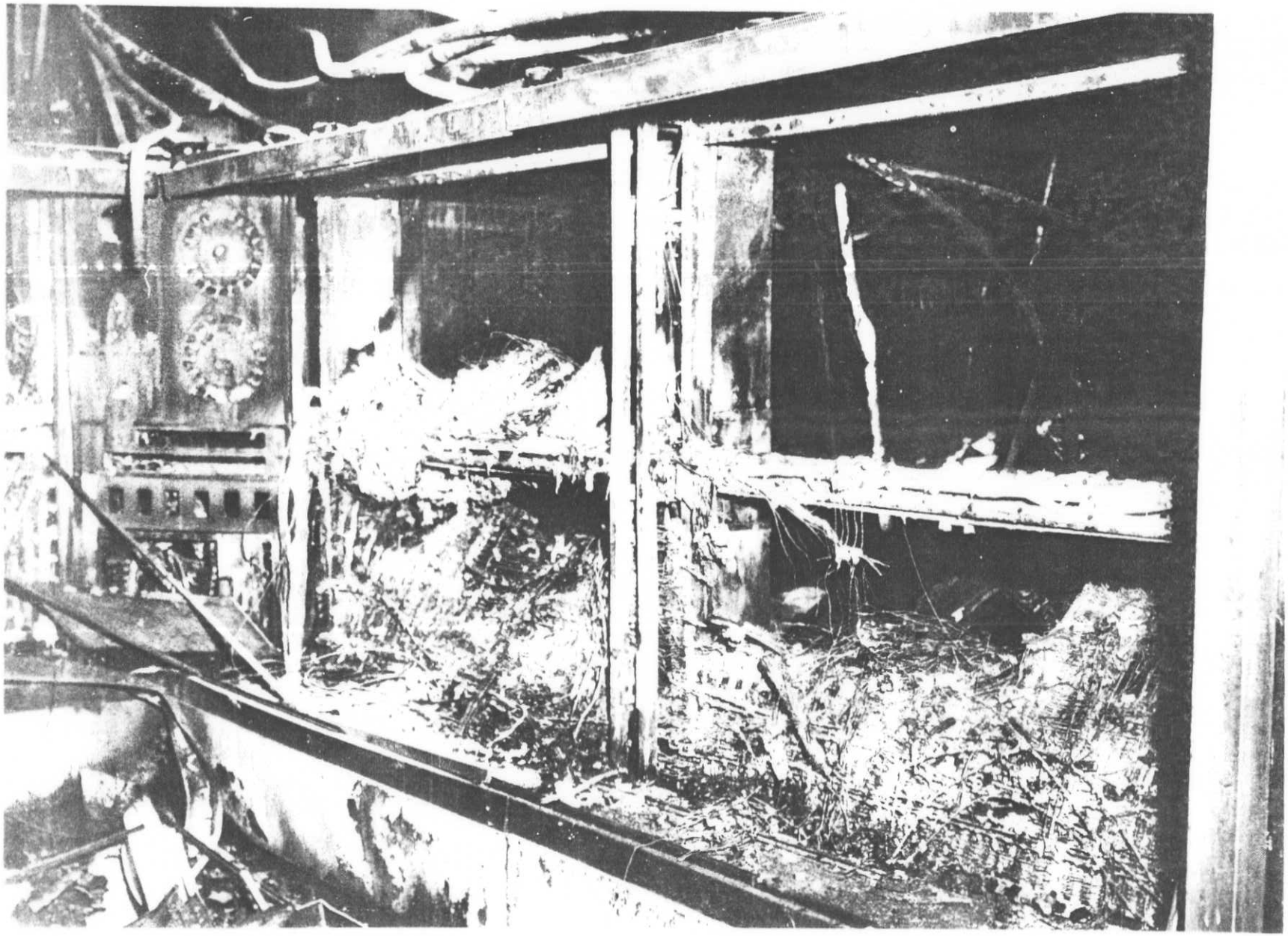

Figure 1.—Computer internal components can be totally destroyed by fire.
(Federal Fire Council, RP-1)

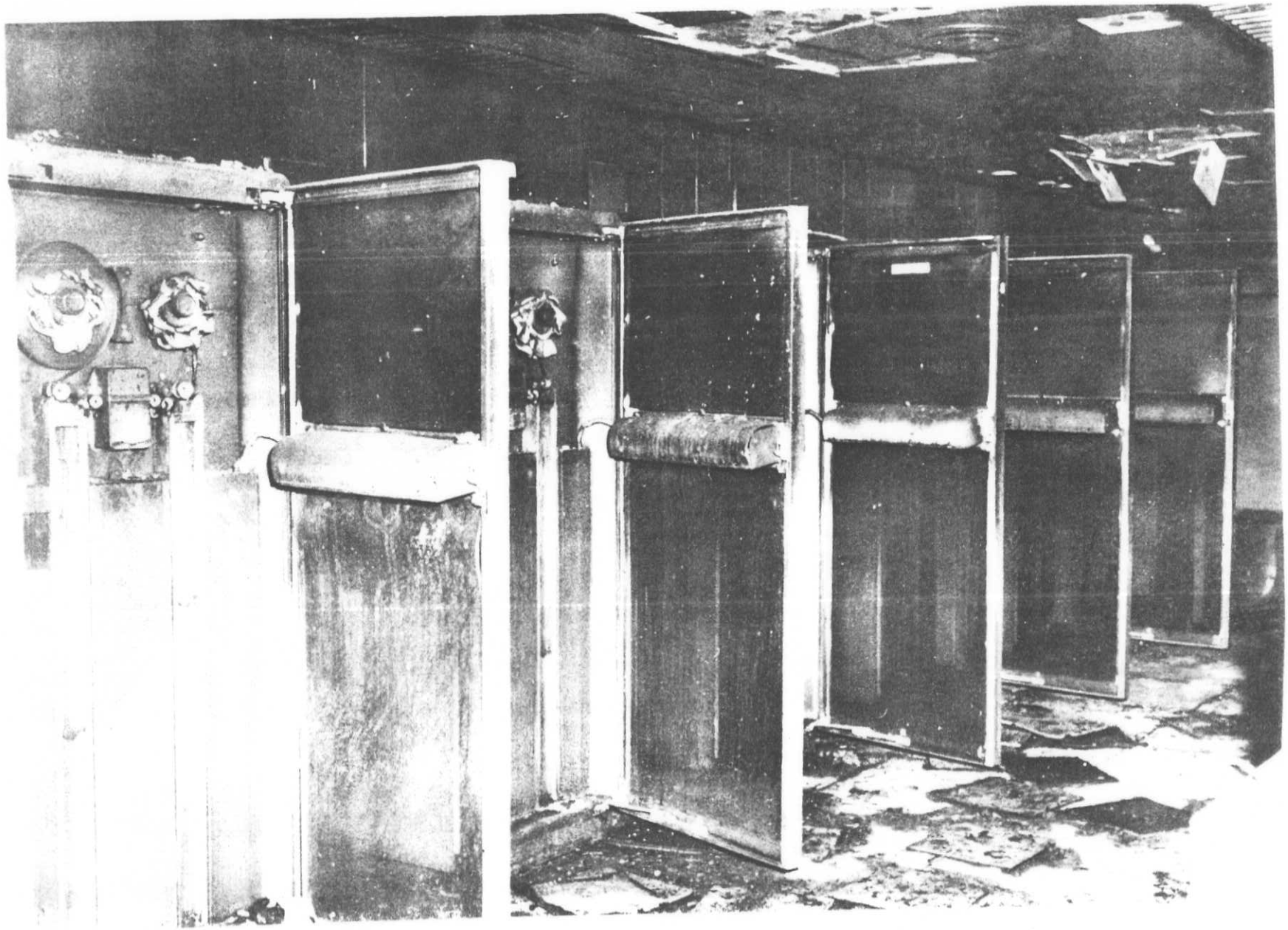

Figure 2.—Exposed equipment, such as these tape drives, can be severely damaged by smoke and heat. (Federal Fire Council, RP-1)


Figure 3.–EARLY WARNING DETECTOR TO SOUND AN ALARM AND HEAT DETECTOR TO ARM THE PREACTION SPRINKLER SYSTEM IN A COMPUTER ROOM.
(Brookhaven National Lab photo)

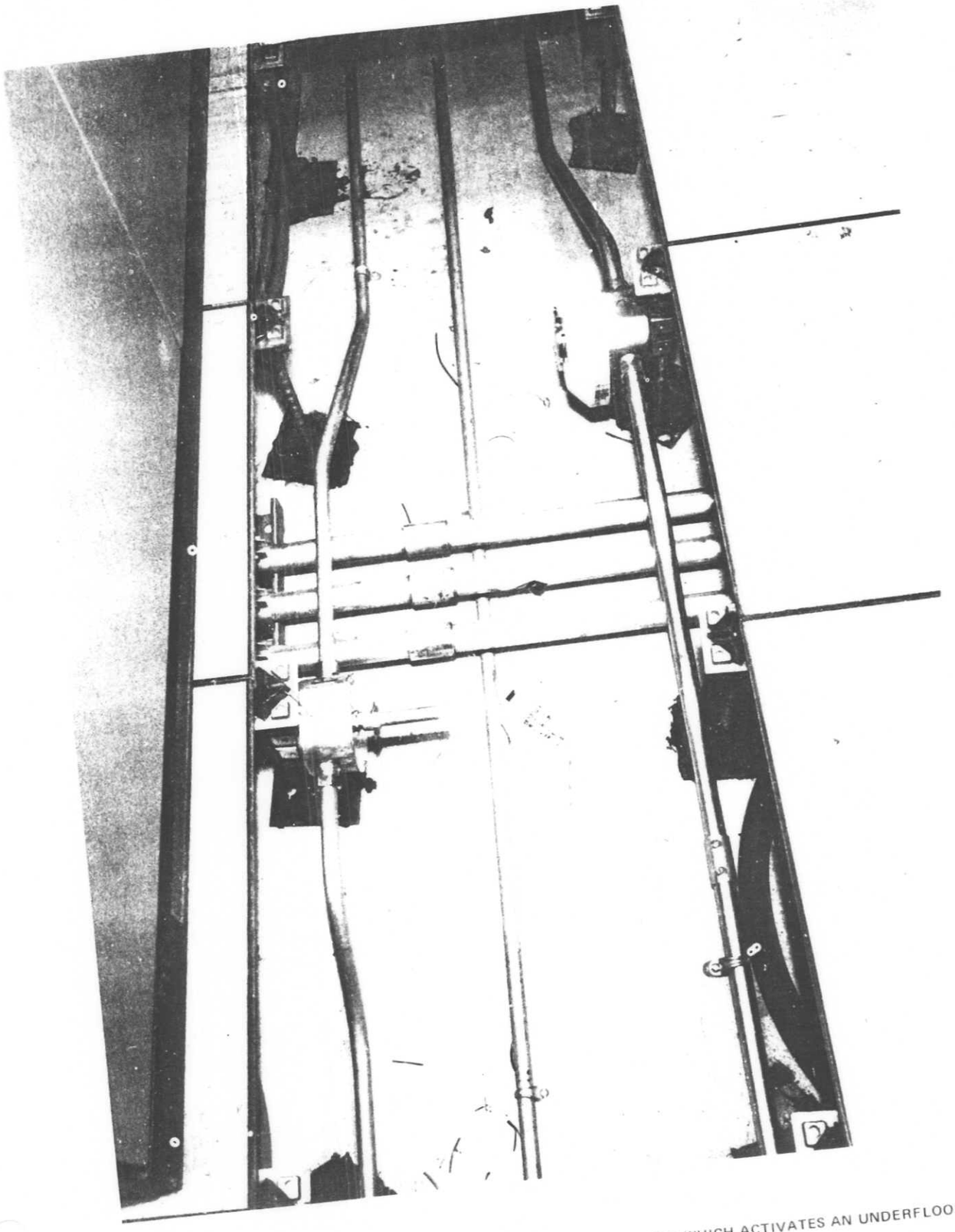

Figure 4.—EARLY WARNING DETECTOR AND A HEAT DETECTOR WHICH ACTIVATES AN UNDERFLOOR HALON 1301 SYSTEM. (BROOKHAVEN NATIONAL ~~A~~BL PHOTO)


Figure 5. — A pre-action sprinkler system, with rate-compensated detectors as the sprinkler detection system and product-of-combustion detectors for early warning. (Oak Ridge National Laboratory)

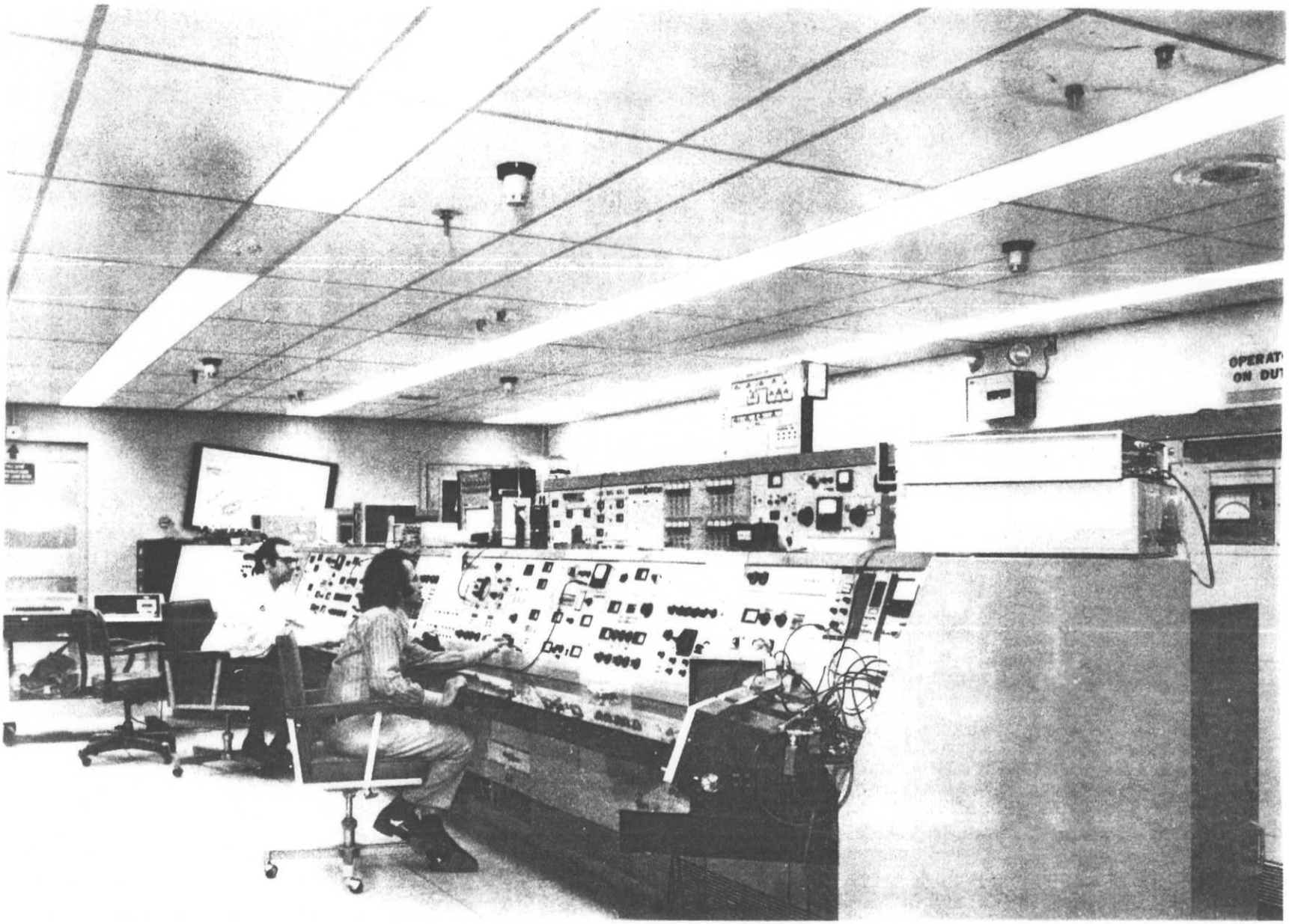

Figure 6.—A control room with total-flooding Halon protection and combined temperature and smoke detection systems. (Brookhaven National Laboratory)

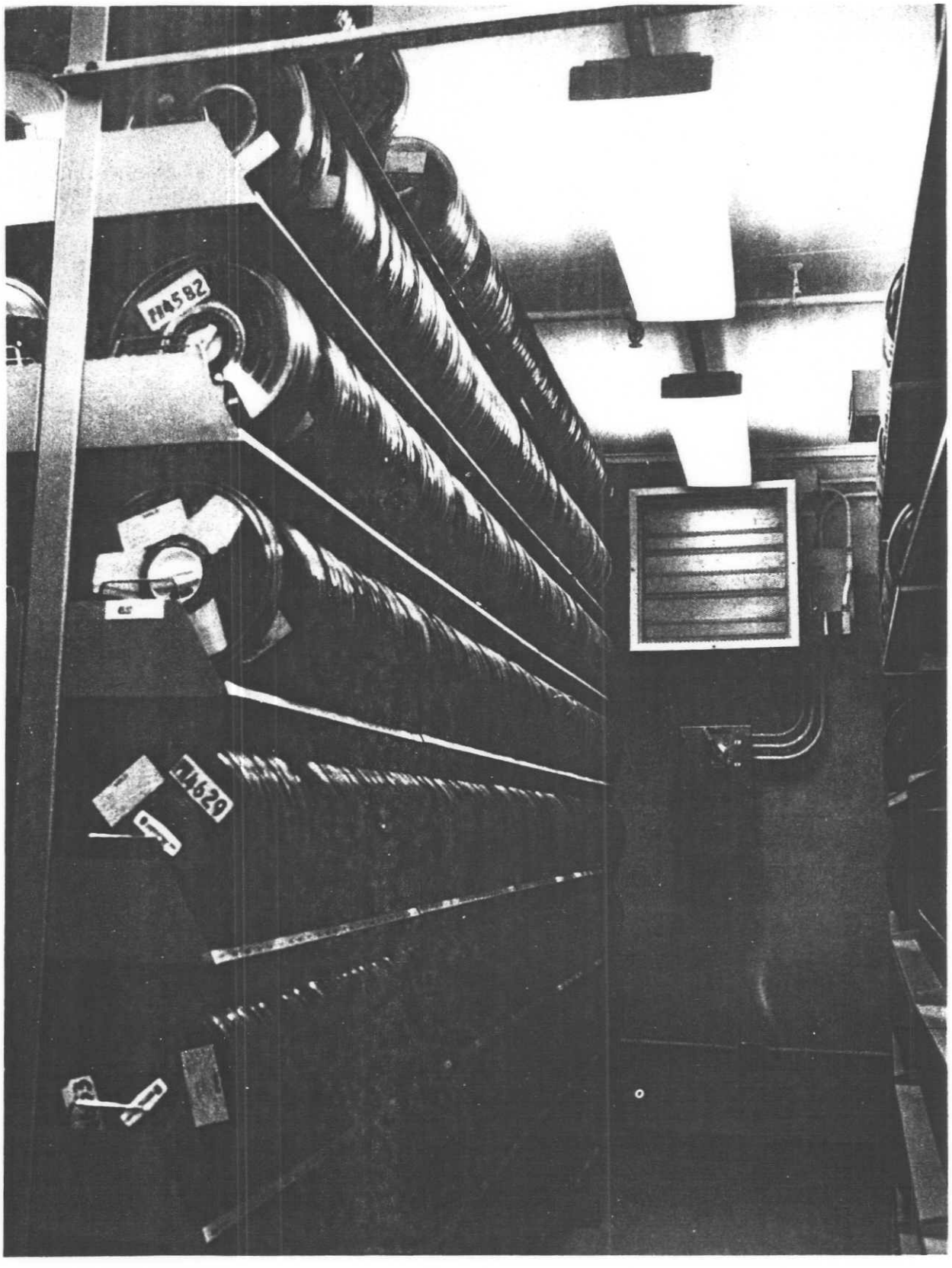

Figure 7.—A TAPE STORAGE ROOM WITH A SMOKE EXHAUST VENT AND SPRINKLER SYSTEM PROTECTION.
(OAK RIDGE OPERATIONS OFFICE PHOTO)

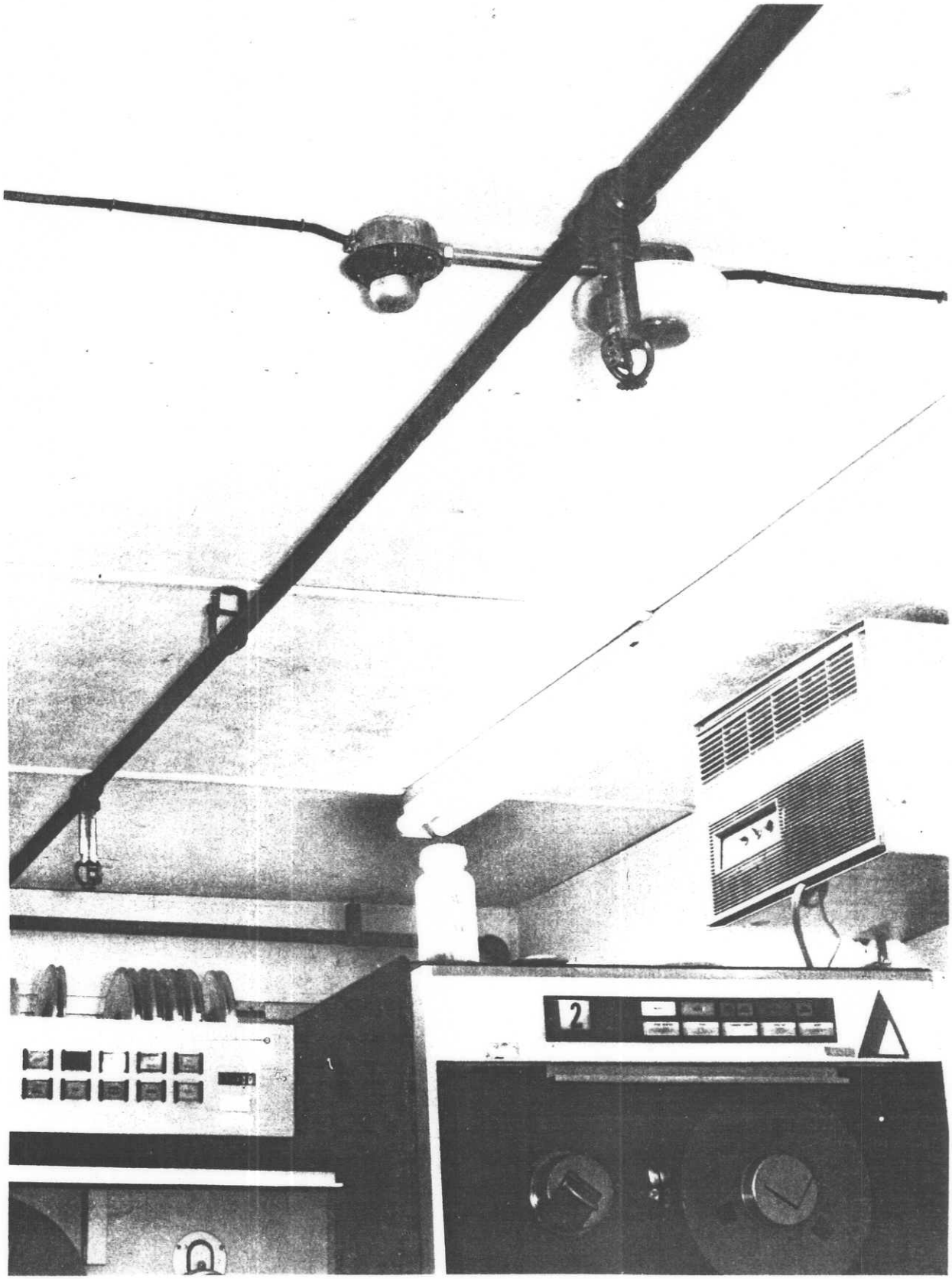

Figure 8.–A COMPUTER WITHIN A TRAILER PROTECTED BY A PREACTION SPRINKLER SYSTEM AND FIRE DETECTION DEVICES. (BROOKHAVEN NATIONAL LAB PHOTO)

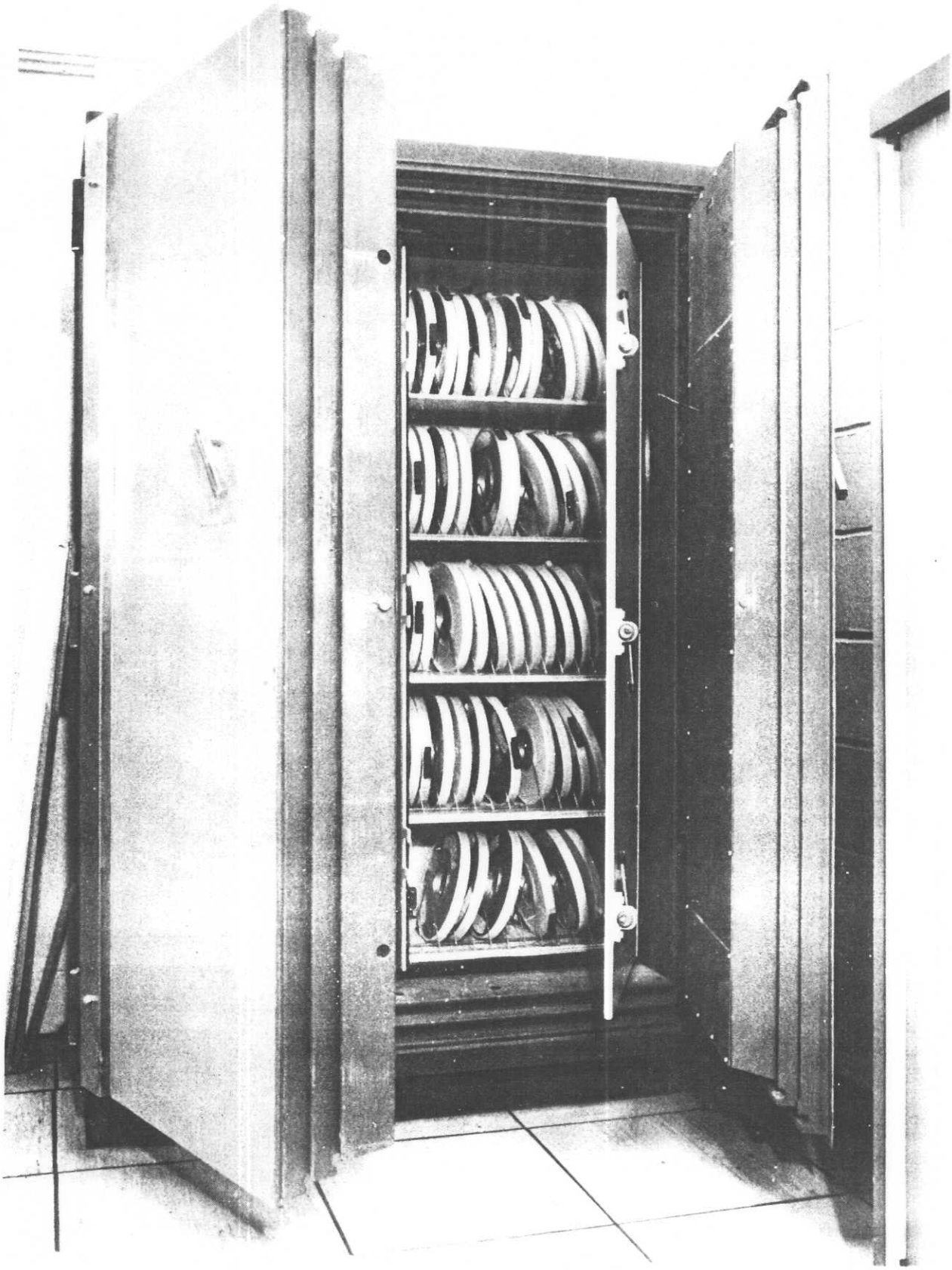

Figure 9.—A fire-resistive tape storage vault for critical tapes.

Figure 10.—Unprotected tapes are extremely vulnerable to fire damage. (Federal Fire Council, RP-1)



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