

NFPA 232A

Guide for Fire Protection for Archives and Records Centers

1995 Edition



National Fire Protection Association, 1 Batterymarch Park, PO Box 9101, Quincy, MA 02269-9101
An International Codes and Standards Organization

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NFPA 232A

Guide for Fire Protection for Archives and Records Centers

1995 Edition

This edition of NFPA 232A, *Guide for Fire Protection for Archives and Records Centers*, was prepared by the Technical Committee on Records Protection and acted on by the National Fire Protection Association, Inc., at its Annual Meeting held May 22-25, 1995, in Denver, CO. It was issued by the Standards Council on July 21, 1995, with an effective date of August 11, 1995, and supersedes all previous editions.

This edition of NFPA 232A was approved as an American National Standard on August 11, 1995.

Changes other than editorial are indicated by a vertical rule in the margin of the pages on which they appear. These lines are included as an aid to the user in identifying changes from the previous edition.

Origin and Development of NFPA 232A

The Committee on Record Protection prepared NFPA 232A, *Guide for Fire Protection for Archives and Record Centers*, as a source for planning fire protection for collections of records stored in large volumes. It supplements NFPA 232, *Standard for the Protection of Records*, which does not contain provisions for protecting large archives and record centers. This document is neither a standard nor a recommended practice, but a guide that is intended to provide records managers and others responsible for safeguarding large collections with the information necessary to plan intelligently for fire protection. The guide was presented originally at the 1970 NFPA Annual Meeting, where it was tentatively adopted.

The revised 1980 edition was adopted officially on May 21, 1980, at the NFPA Annual Meeting in Boston, MA. It was released by the Standards Council on June 11, 1980. The 1986 edition was a reconfirmation of the 1980 edition.

The 1991 edition was revised completely in order to make it more understandable to the user. Most changes were editorial in nature. Substantive changes were made in two new chapters that address construction features as well as building equipment and associated facilities. New appendix material on salvage procedures for damaged library materials was added.

This edition of the standard incorporates editorial changes and provides expanded information with regard to fire alarm systems, maintenance of water-based fire protection systems, and security features.

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NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents on the protection of books, papers, plans, and other records from loss incident to fire.

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NOTICE: Information on referenced publications can be found in Chapter 8 and Appendix C.

Chapter 1 Introduction

1-1 Scope. This guide applies to collections of records in file rooms exceeding 50,000 ft³ (1416 m³) and to all archives and records centers.

Since its adoption in 1947, NFPA 232, *Standard for the Protection of Records*, has been the recognized standard for the protection of records against fire. However, this document is concerned primarily with relatively small quantities of records that are kept immediately accessible to the originator or user. NFPA 232A covers facilities larger than those contemplated in NFPA 232.

1-2 Purpose. The purpose of this guide is to provide recommendations for fire-safe storage in archives and records centers. It should be used where the size or character of the records holdings is not covered in NFPA 232, *Standard for the Protection of Records*, and to provide archivists, records managers, and others responsible for safeguarding large collections with the information necessary to plan intelligently for fire protection.

1-3 Definitions. For the purpose of this guide, the following terms have the meanings specified below.

Approved. Acceptable to the authority having jurisdiction.

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Archives. Noncurrent records preserved for their historic value; also applied to the building, structure, or enclosure where such records are deposited or retained.

Authority Having Jurisdiction. The organization, office, or individual responsible for approving equipment, an installation, or a procedure.

NOTE: The phrase "authority having jurisdiction" is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building offi-

cial; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

File Room. An area used for the storage and reference of current records.

Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation that maintains periodic inspection of production of labeled equipment or materials and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

Listed. Equipment or materials included in a list published by an organization acceptable to the authority having jurisdiction and concerned with product evaluation that maintains periodic inspection of production of listed equipment or materials and whose listing states either that the equipment or material meets appropriate standards or has been tested and found suitable for use in a specified manner.

NOTE: The means for identifying listed equipment may vary for each organization concerned with product evaluation, some of which do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

Records Center. A building or enclosure used for the retention and reference of semicurrent records pending their ultimate disposition.

Should. Indicates a recommendation or that which is advised but not required.

Chapter 2 General

2-1 Types of Record Media. This guide covers traditional paper records and records on magnetic, photographic, micrographic, and other special media. It is not possible to ensure total fire protection of records in archives and records center facilities. It is possible, however, to provide a very high level of fire protection that normally can limit the potential loss of records in such facilities. Therefore, it is important that the archivist or records manager is aware of the degree of protection available or, conversely, the degree of potential damage possible using the protection systems available for the archives or records center. The archivist or records manager should determine which, if any, of the records need the higher level of protection provided by the use of special vaults, safes, or insulated containers as specified in NFPA 232, *Standard for the Protection of Records*. It is essential that storage of cellulose nitrate film should not be permitted in archives or records centers. NFPA 40, *Standard for the Storage and Handling of Cellulose Nitrate Motion Picture Film*, should be referenced for these protection requirements.

2-2 Arrangement. Storage devices include, but are not limited to, traditional file cabinets, records storage boxes (corrugated or solid fiberboard cartons), transfer cases, and miscellaneous containers of varying construction. The usual arrangement consists of either cartons on freestanding shelving or filing cabinets. Locations can vary from a separate area within a general office complex to specially constructed records facilities. It is not uncommon for records to be stored in basements or attics, in office spaces, in factories or warehouses, or in underground or other readily available facilities, with all such facilities of various types of construction and levels of fire safety. Keeping all records storage at least 3 in. (76 mm) above the floor minimizes the effect of flooding.

2-3 Fire Risk Evaluation Factors. In considering the protection of records stored in mass, several basic factors should be evaluated:

(a) The exposure from the building housing the records, from nearby buildings, or from neighboring operations; (e.g., the possibility of involving the records in a fire originating outside of the records facility);

(b) The potential of fire initiation within the records facility, including the susceptibility of the records or containers to ignition;

(c) The potential of fire development posed by the stored records themselves, particularly as that potential relates to the available or proposed fire control capabilities or mechanisms;

(d) The potential impact of fire development in the stored records on the housing structure and adjacent operations;

(e) The fire control systems with the resultant extent and type of damage from fire, fire effects (e.g., heat, smoke), and fire extinguishing efforts (principally water and physical disruption of records necessary to effect manual fire fighting); and

(f) The potential threat to life to occupants and fire service personnel.

2-4 Exposure. A maximum amount of care or the most sophisticated of protection systems within the records storage area is of little value for records stored within a structure that burns as a result of some occurrence or operation outside of the records area. Any archivist or records manager should consider the potential of the records being destroyed by a fire that initiates in an area external to the operations. The degree of additional risk imposed by neighbors varies according to the type and height of the building, the nature or hazard of the neighbors, and the type of protection used by the neighboring operations. Any reasonable degree of protection for records stored in mass quantities in any multistory building should include fire-resistive construction adequately designed to withstand the maximum fire impact of the exposing occupancy within. The same applies to single-story buildings unless a proper fire wall separates the records area from the remainder of the building. Where records need to be housed in a building that could burn around them, properly rated vaults, safes, or insulated containers capable of resisting a total burn-out as specified in NFPA 232, *Standard for the Protection of Records*, should be used and are the only known means of protection that can provide reasonable assurance of records recovery. Where a separate building or a segregated floor or section of a fire-resistive building is used for records storage, however, the methods described in the chapters that follow provide a degree of protection commensurate with the type of system selected.

2-5 Facility Design. The inherent risks in the storage of large quantities of records and the requirement for incorporation of appropriate passive and active systems to deter, detect, contain, and control records storage fires mandate that an experienced and competent fire protection engineer be consulted regarding the design of new facilities or major alterations to existing facilities.

2-6 Fire Prevention Program. The most important factor in preventing fire loss in records facilities is the maintenance of a good fire prevention program based on good housekeeping, orderliness, maintenance of equipment, and absolute prohibition of smoking or use of open-flame devices. All of these items are fundamental precepts of good records management. Experience has shown, however, that regardless of how careful or complete the fire prevention program, the risk of fire initiation through either human error or situations beyond the control of the archivist or records manager (such as lightning striking the facility) is a distinct possibility, and any program based entirely on fire prevention activities is perpetually at risk of a major disaster.

2-7 Operations in Records Storage Areas. Work within records storage areas normally is limited to placing records in, retrieving records from, or removing records from storage. Any additional operations could introduce ignition hazards and could be inappropriate in records storage areas. In archival facilities, records storage areas should be separated from processing areas, offices, and research rooms by a proper fire wall. Records center facilities involve considerably more staff activity in the records storage areas. Wherever records centers and archives are located within the same facility, the archival storage area should be separated from the records center storage area by a fire wall.

Other fire risks in the records storage areas can be reduced by the following means:

(a) The use of manual instead of power-operated equipment;

(b) The use of electric instead of gas-fueled fork lifts;

(c) Prohibiting the use of portable space heaters, lights on extension cords, hot plates, coffee makers, duplicating devices, battery chargers, welding or cutting torches, and other such ignition sources within storage areas;

(d) Prohibiting the storage of oils, paints, or other flammables in or contiguous to the records areas.

2-8 Fire Retardant Treatments. Attempts have been made to develop economical methods of increasing the fire resistance of typical records storage cartons. The method tried most frequently is coating the cartons with an intumescent type of fire retardant paint. Tests of cartons protected by such paint that has been properly applied show that the coating prevents actual ignition of the cardboard. However, intumescent paint does not intumesce effectively under approximately 400°F (204°C). The temperature of even a small exposure fire (such as might occur on a library cart) could weaken the paper in the box to the point where the box breaks open under the weight of the paper it contains, exposing the ordinary combustible paper contents of the box. Similar results have occurred in tests of boxes that have been covered with aluminum foil, with the additional effect of transmission of heat through the aluminum, causing ignition of the cardboard carton beneath it. In a small-scale test conducted as a joint effort of the NFPA Technical Committee on Record Protection and the U.S. General Services Administration, the effect of a fire retardant

paint coating on boxes demonstrated a very brief delay only in the ignition and development of fire up and across the face of the records storage. Therefore, as a records container still is made of paper, the inherent characteristics of easy ignition and rapid fire development associated with paper do not change.

Chapter 3 Fire Characteristics

3-1 Metal Containers.

3-1.1 Fire Initiation. In some facilities, all records are kept in metal file equipment or equivalent metal containers (closed on six sides), and the arrangement, housekeeping, and operational methods prohibit the maintenance of any combustible materials of any type in locations outside the steel containers. Where the surrounding building and all its associated materials are noncombustible, the risk of fire or the possibility of fire development should be considered to be the burnout of one drawer and damage to the materials in the surrounding drawers above, below, behind, and beside the drawer of origin under the following conditions:

- (a) All of the records are kept exclusively in metal file cabinets or equivalent metal cabinets (closed on all six sides);
- (b) The arrangement, housing, and operational methods prohibit combustible materials outside the metal containers; and
- (c) The surrounding buildings and all their associated materials are noncombustible.

3-1.2 Fire Development. Where all records housed are contained within closed metal file equipment, transfer cases, or similar containers (whether or not of the insulated type) so that no fuel is exposed to flames outside the containers and there are no other combustibles in the area, no significant fire development would be expected from most initiating sources. Fire spread from a significant ignition source would be anticipated to be very slow.

3-2 Open Shelving.

3-2.1 Fire Initiation. Records facilities use various shelf filing equipment, normally with the records either contained in file folders or stored in various styles of open or closed cartons. Typically, rows of records face each other across long service aisles about 30 in. (762 mm) in width. The exposed faces present a wall of paper. Paper has an ignition temperature of approximately 450°F (232°C). Where exposed files exist, the loose ends of the papers or the edge of the file folders can be ignited almost instantly by any source ranging from a match to a faulty fluorescent ballast or by direct contact with an exposed incandescent light bulb. Because of their mass, closed cartons resist ignition slightly longer, but there is a good probability that an ordinary match could ignite them. Ignition of a few pieces of paper, such as might occur on a service cart, could readily ignite the faces of the boxes.

3-2.2 Initial Fire Development. Where records are stored on open-type shelving, it can be expected that fire development would occur and would approximate a typical pattern of development demonstrated in tests conducted on high-piled storage by Underwriters Laboratories Inc., Factory Mutual Research Corporation, and in tests conducted on 6-ft (1.8-m) high archive shelving arrangements by the U.S. General Services Administration. In each instance, the initiating fire was

small [2 lb (0.91 kg) of paper laid on the floor in the Underwriters Laboratories test, 1/2 pt (0.24 L) of heptane on cellulose cotton in an open carton of records in the Factory Mutual tests, and two open cartons of records on a library cart in the U.S. General Services Administration test]. The initial fire development progressed for a brief period at a low level, producing the type of fire that could be approached and easily extinguished if promptly discovered. The period of low-level development lasted between a minimum of approximately 3 minutes to a maximum of approximately 12 minutes to 15 minutes, with an average of approximately 5 minutes. During this period, the fire was directly approachable, since heat levels were not high; however, significant quantities of smoke were produced. The temperature levels at the ceiling were sufficiently low to make it unlikely that any heat-reacting fire detection devices would have signaled the presence of fire. In view of the relatively large smoke production, smoke detectors could have detected such a fire early in its development. In tests with 14-ft (4.3-m) open shelving, smoke detectors operated within 30 seconds to 1 minute, but fire was judged to be beyond portable extinguisher control in less than 3 minutes, providing little justification for the cost of installing smoke detection systems in this case.

3-2.3 Full Fire Development. By the end of the relatively short early development stage in each of the tests described in 3-2.2, a sufficient number of the exposed boxes had been preheated so that the fire development characteristics changed suddenly, the temperatures increased rapidly, and the flames enveloped large areas, extending almost immediately beyond human approach and the ability to attack using simple portable extinguishers. Fire development increased rapidly from this point. In each of these cases, a fire control mechanism was being tested, and the fires were not allowed to progress to their ultimate potential.

In some Factory Mutual tests, however, loose records in boxes were released by the fire and exfoliated into the aisle, providing very rapid acceleration of the fire and a condition approaching full fire development in a limited area, perhaps 60 ft² to 70 ft² (5.6 m² to 6.5 m²). On the other hand, in the same test series, a fire test was conducted in which all of the papers were oriented perpendicular to the aisle and stored loose on edge in shelving 14 ft (4.3 m) high. The box fronts were removed to expose the loose paper edges. Contrary to expectations, the fire developed slowly and was never beyond the control of modest local forces employing small hose. Prevention of exfoliation of burning paper apparently served to avoid the dramatic increase in fire intensity.

3-2.4 Fire Severity Potential. Unless fire development is stopped by either manual or automatic fire extinguishment, the entire records storage in one room or on one floor could become involved in fire quickly. The spread of a fire and the extent of damage is related directly to the total quantity of combustibles involved. The severity of a fire is approximately 1 hr for each 10 lb/ft² (49 kg/m²) of gross weight of combustibles involved. The weight of paper in a typical records storage area is equivalent to approximately 10 lb/ft² (49 kg/m²) for each shelf height of storage. A typical center with records stored seven shelves high contains fuel in quantities of approximately 70 lb/ft² (342 kg/m²) of floor area, and in a center where records are stored 15 shelves high, the weight of the paper would approximate 150 lb/ft² (732 kg/m²). In either case, there are no traditional types of fire-resistive construction capable of withstanding the total impact of burnout. This

is particularly important in any situation where records are stored in a multistory building.

3-2.5 Inherent Fire Capacity. Any archives or records centers using open-type shelving are inherently prone not only to the destruction of the records, but also to the destruction of the facility itself and its neighboring operations, unless all fires are stopped in their early stages.

3-3 Mobile Shelving.

3-3.1 Fire Initiation. Shelving in records facilities that is mounted on rollers, usually on tracks, is used to conserve space. One aisle is provided for a series of shelving units, and, to gain access to a particular shelf, units are moved manually or by motor until the desired shelf unit is positioned to be accessible from the aisle. Ignition sources are similar to those in open-type shelving but with the added potential of an ignition source from the electric drive units. Slow-developing, burrowing fires can be expected except in the exposed aisle, where a fire would be similar in character to that in open-type shelving.

3-3.2 Initial Fire Development. Tests conducted by Factory Mutual Research Corporation for the U.S. General Services Administration and U.S. Library of Congress indicated that fires originating in the open aisle could be expected to follow the pattern of open shelving fires in initial development and quickly involve both faces. The length and height of mobile units is determined by available space, loaded weight, access time, and other factors. A recommended limit for length is 25 ft (7.6 m). Fire spread down an open aisle with facing combustible storage is likely to be rapid. Fire spread tunneling through the shelving array is likely to be very slow, providing some opportunity for control and extinguishment by a public fire department if the fire is discovered and reported promptly.

3-3.3 Fire Severity Potential. The potential for a total burn-out of a records facility is exactly the same as for a similar quantity of records on open shelving, except that a fire that involves mobile shelving takes considerably longer to spread beyond the control of a municipal fire department.

3-3.4 Inherent Fire Capacity. As in the case of records stored on open shelving, records stored on mobile shelving are inherently prone not only to the destruction of the records, but also to the destruction of the facility itself. The slow spread of a fire within the shelves improves the effectiveness of outside efforts to stop the fire.

Chapter 4 Fire Control

4-1 General. The basic elements of fire control are two-fold: detection of the existence of fire plus its extinguishment. The individual efficiency and capability of both detection and extinguishment determines the degree of safety or, conversely, the extent of damage in case of fire.

4-2 Water. Most archivists or records managers are seriously concerned about water damage. In view of the constant problems involved in the leakage of domestic water systems and steam mains, the rain intrusion from leaky roofs or windows, and the resultant damage from mildew or decomposition of paper, this concern is understandable. It is important, however, for the archivist or records manager to realize that wet records can be recovered, while burned records are lost per-

manently. Furthermore, unless there is a specialized fire extinguishing system to control the development and growth of a fire, responding fire-fighting forces have no choice but to attack the fire with fire department hose streams. In many records facilities, the quantity of paper fuel involved is such that the fire department has to attack a fire from a distance and under extremely adverse conditions. This normally forces the fire department to use heavy hose streams having the characteristics of a hydraulic ram. Wide and forceful disruption of the records storage arrangement is a routine consequence of efforts to prevent total destruction.

4-3 Salvage. Recovering wet records is a problem whether the source of water is a result of fire-fighting efforts, a fire, or another source, such as a flood, a hurricane, a heavy rain-storm, roof leakage, spillage from operations located above, or a breakdown of any of the numerous water or steam systems in a building. Virtually any wet paper records can be recovered, provided prompt and proper action is taken. Effective salvage necessitates prompt action, special techniques, facilities, and expert advice. Preplanning is essential.

NOTE: Archivists and records managers interested in salvage should reference NFPA 910, *Recommended Practice for the Protection of Libraries and Library Collections*, Appendix O "Salvage of Wet Books," and the Federal Fire Council Recommended Practice No. 2, *Salvaging and Restoring Records Damaged by Fire and Water*, which is available from the Clearinghouse, U.S. Department of Commerce, Springfield, VA 22151. Salvage of wet records from the 1973 fire at the Military Personnel Records Center, St. Louis, MO, is treated in considerable detail in the July 1974 NFPA *Fire Journal* and the October 1974 *American Archivist*. Also useful as background material is the publication *Conservation of Library Materials*, a manual and bibliography on the care, repair, and restoration of library materials by George M. and Dorothy G. Cunha (Metuchen, NJ: The Scarecrow Press, Inc., 1971; two volumes; LC # 77-163871). Volume I is the manual, and Volume II is the bibliography.

4-4 Fire Extinguishers. Regardless of the other types of fire extinguishment systems provided, it is essential that every records storage facility be provided with an adequate supply of well-distributed Class A portable fire extinguishers suitable for extinguishing fires in paper and plastic records. The extinguishers should be of the trigger action type in which the flow can be started and stopped by the operator. NFPA 10, *Standard for Portable Fire Extinguishers*, should be referenced for specific information regarding portable fire extinguishers. Gaseous extinguishers are not effective for extinguishing deep-seated fires in paper materials. The presence of proper extinguishers enables the working or guard force, on discovery of a fire or on response to an alarm from an early warning detection system, to attack and extinguish the fire while it is small with minimum damage to the records. It is important that local forces are instructed properly in the use of small extinguishing appliances.

4-5 Fire Departments. The fire department is an essential part of any fire protection plan. The role of the fire department depends on the type and capabilities of an automatic extinguishing system, if provided. Where no extinguishing system is provided and total dependence is placed on the fire department for control of any fire that exceeds the capabilities of persons using hand extinguishers, it is reasonable to expect that the fire department will be forced to make a massive attack because of the size and position of the fire at the time of arrival. Fire fighters are limited by their tolerance to heat and smoke. To reach the actual seat of the fire, the fire depart-

ment could undertake actions that are disruptive or damaging to records that are not actually burning. Rows of records might block access to the seat of the fire. High density smoke might conceal the seat of the fire. To save the structure and to prevent propagation of the fire to other areas, it might be necessary for the fire fighters to disrupt the storage arrangement in unignited areas to obtain access to the ignited area or to use high-pressure hose streams in a general sweeping action in an effort to provide a general cooling/quenching effect. In any sizable records facility, the total amount of fuel necessitates the use of heavy hose streams. In some communities, fire departments have the capability and are likely to use monitor- or snorkel-type hose streams. Properly constructed fire walls, confining the fire to a single fire area, assist a fire department in limiting the size of a fire. All records within the fire area are likely to be affected seriously by either fire or by water from the high pressure streams, or by both.

4-6 Role of Fire Department and Extinguishing Systems. Where an automatic extinguishing system of proper design is provided, the role of the fire department changes from the implementation of direct fire attack to assisting and supplementing the automatic extinguishing system.

4-6.1 If the system is an automatic sprinkler system, the primary responsibilities of the fire department are to supplement the water supply, determine the proper time to discontinue the flow of water, extinguish fire in any small, shielded areas that the sprinkler system could not reach, and overhaul the actual burned areas to prevent rekindling or reignition. For further information, NFPA 13E, *Guide for Fire Department Operations in Properties Protected by Sprinkler and Standpipe Systems*, should be referenced.

4-6.2 Where a total flooding carbon dioxide or Halon 1301 system is provided and has been successful in its operation, the primary responsibility of the fire department is to vent the gas and to prevent the possibility of rekindling by wetting and removing the materials that were ignited. The period during which carbon dioxide gas is phased out is critical, and, unless the smothering action has been totally effective, rekindling of a serious fire can occur. This procedure is potentially hazardous and should be executed only with the full capabilities of the fire department in readiness.

4-6.3 If high-expansion foam is used, the primary responsibility of the fire department is to assist in removal of the foam and to extinguish any small glows (deep-seated fires) or flames that are found while the foam is removed. Depending on the situation, it could be desirable to continue the application of the high-expansion foam for a soaking period. However, the length of time that the foam is kept in place affects the degree of wetting. Therefore, overhaul procedures should be carried out rapidly but cautiously, with extinguishing equipment standing by in readiness.

4-7 Fire Department Preplanning. Fire department preplanning for attack in specific locations is essential in all systems of fire control. It is important that the archivist or records manager contact the appropriate chief officer of the responding fire department to establish prefire planning arrangements. The best extinguishing system can be overcome if a fire officer, due to lack of knowledge, makes improper use of the system or prematurely removes an automatic system from operation. Conversely, lack of knowledge and a sense of caution can result in a fire officer maintaining the operation of an

extinguishing system for an excessive length of time, increasing damage to the records from the extinguishing agent.

Chapter 5 Fire Control Systems

5-1 Detection.

5-1.1 General. In any fire control system, the first step should be the detection of the presence of fire with immediate notification of emergency response forces, including the fire department (*see Section 5-5*). A number of different methods of detection are available, ranging from highly sophisticated devices for almost immediate detection of products of combustion to dependence on passersby. Detection of fire, while vitally important, does not in itself prevent fire damage. Detection needs to be followed by extinguishment, which includes the use of fire extinguishers or other first aid fire appliances by facility personnel or guards, attack by the fire department using the various manually directed appliances at its disposal, or control by automatic suppression systems, such as sprinklers, carbon dioxide, or halon. The capabilities and efficiency of each of these systems vary significantly and also can affect the extent of fire damage.

5-1.2 Human Detection Capabilities. An evaluation of the various methods of fire detection demonstrates that any detection system that relies only on casual observation by those persons whose activities take place outside the records storage area is undependable, and a facility that depends upon detection by passersby is at risk of total burnout. Some records centers assign responsibility for fire detection to watchpersons or guards around the clock or a combination of employee responsibility during the workday and watchpersons or guards after business hours. While this approach is superior to dependence on casual observation, it should be considered very limited. (The major fire at the Military Records Center in St. Louis was first reported by a passerby, although the building had guard patrols.) As previously described, the period during which such observation can result in the detection and response to a small fire situation is quite limited if, for instance, a fire initiates within the service aisles of the stack area. Since this usually is the most critical and damaging type of fire, it is considered to be the type that most necessitates early detection. Normally, guard rounds are regulated at intervals of 1 hour or more. A major fire catastrophe could develop between periods of observation of the most alert and conscientious guard. The presence of guards can be effective in peripheral situations, such as a small office fire. They also can function in fire prevention programs. Guards are, however, of limited value in controlling a fire in record shelving, except in notifying the fire department.

5-1.3 Heat Detection. Fixed temperature or rate-of-rise heat detection equipment sometimes is used in records facilities. As described in Chapter 3, these devices are not likely to respond to a fire until it has developed into its major stage. At this point, unless there is an installed automatic extinguishing system, the fire is likely to be beyond the capabilities of local forces. The heat detection system alone cannot control the fire. It is likely that, when the municipal fire department arrives at the scene and sets up operations, they will be severely challenged by the fire. This complicates fire-fighting efforts and increases the resultant records damage. On the other hand, if the heat-actuated detection equipment is used to

operate an automatic fire control system, it could provide a very effective function.

5-1.4 Automatic Sprinkler Detection. In considering detection systems that initiate the operation of an extinguishing system, it is necessary to consider briefly the detection aspects of automatic water sprinkler systems. Each automatic sprinkler is a fixed temperature device that opens (fuses) when heated to a preset temperature. Where the automatic sprinkler system is equipped with a waterflow detection device, the sprinkler system virtually becomes a fixed temperature fire detection system as well as an automatic water extinguishing system. For this reason, the detection of waterflow in the sprinkler system is important, and it is considered axiomatic that every sprinkler system installed in a records storage facility should be equipped with waterflow detection that activates the building fire alarm system and thus transmits the alarm.

5-1.5 Early Warning Detection. These devices, known generically as smoke detectors, respond to either the visible (smoke) or invisible (molecular size) products of combustion, or both, produced from the moment of ignition. In a properly engineered installation, these devices can detect a smoldering fire in its low energy stage. Where ignition from a smoldering fire is likely, smoke detectors can provide warning very early in the development of fire.

5-1.5.1 Listed or approved smoke detectors include ionization type, photoelectric beam or spot type, infrared type, and others. It is possible, if necessary, for these early warning systems to activate associated fire extinguishing systems. Such smoke detectors may be permitted to be considered part of the overall system in any important records collection where a smoldering fire is possible.

5-1.5.2 Total dependence on a combination of smoke detection and hand fire extinguisher attack still leaves the facility subject to a major disaster. Dependence solely on an early warning detection system exposes the facility to full fire development before effective efforts can be undertaken.

5-1.6 Locating Smoke Detectors. It is important that the system be individually engineered by competent personnel. Where the devices are used, they are installed because of the desire to detect fire as early in its development as possible. The various types of air movement, including stratification caused by heating or other air-handling systems, as well as those caused by the records storage arrangement, are important considerations. The system should be capable of detecting and locating the presence of fire in any portion of the records storage area within a brief time in order to obtain maximum protection. While the time element specified directly affects the cost of the system, it also affects the extent of the damage. Generally, the shorter the time for detection, the higher the cost of the system. NFPA 72, *National Fire Alarm Code*, should be referenced for further information on the spacing of smoke detectors.

5-1.7 Fire Alarm Systems. Fire alarm systems can perform numerous functions, such as detecting incipient fire, notifying on-premises first-response teams, notifying the fire department, sounding evacuation signals, shutting fire doors, starting smoke control systems, monitoring system status, and printing a permanent record of all events. They also can be used to activate certain types of fire suppression systems.

5-1.7.1 NFPA 72, *National Fire Alarm Code*, should be referenced for minimum standards for system components and their installation.

5-1.7.2 Three categories of input signals normally are provided: alarm, supervisory, and trouble signals. Alarm signals take priority over supervisory and trouble signals and include activation of manual fire alarm boxes, signals from automatic smoke and heat detectors, waterflow indications from sprinkler systems, and agent-release signals from special hazard suppression systems. Supervisory signals take priority over trouble signals and include activation by off-normal sprinkler functions (such as temperature, pressure, and valve position). Monitoring functions include status of control and circuit conditions in fire alarm systems, status of certain fire suppression systems, status of watchperson tours, and other functions. The status of critical non-fire systems also can be monitored.

5-1.7.3 System output functions can include some or all of the following, depending on the size of the building, local codes, availability of trained emergency response teams, and other factors:

- (a) General evacuation signals (bells, horns, and strobes);
- (b) Presignal alarm devices for initially alerting only selected staff;
- (c) Selective evacuation signals (voice/tone signals, zoned);
- (d) Lamp or LED text displays identifying the type and source of the alarm or monitoring signal;
- (e) Logs (electronically recorded or printed) of all "change of status" events;
- (f) Remote indications of alarm and monitoring signals at locations such as central stations and fire departments;
- (g) Activation of fire suppression systems;
- (h) Activation of smoke control systems, including HVAC shutdown and damper and door releases;
- (i) Transmission of signals to building energy management systems, security monitoring systems, and other systems.

5-1.7.4 Fire and security functions can be integrated into a single system, but, generally, these functions should not be controlled from the building energy management system.

5-2 Automatic Sprinkler Systems.

5-2.1 General. The most effective fire protection element and the most economical automatic fire control system for protection of archives and records centers is the automatic wet-pipe sprinkler system. Such systems are also the most frequently opposed by records managers because of concern with water damage. Three factors serve to alleviate this concern:

- (a) Sprinklers actually constitute a method of fire control involving a minimum rather than a maximum of water.
- (b) Each sprinkler operates individually and, the operation of any single sprinkler does not cause the operation of any other sprinkler; therefore, only those sprinklers in the heat of the fire operate and discharge water.
- (c) Wet records are recoverable; burned records are not recoverable.

5-2.1.1 The probability of sprinkler operation when no fire exists is insignificant.

5-2.1.2 Because of the rapid heat development in records storage areas, high temperature-rated sprinklers [250°F to 300°F (121°C to 149°C)] are used commonly in lieu of ordinary-rated sprinklers [135°F to 170°F (57°C to 77°C)] to limit the number of sprinklers that operate in a fire to those that act directly in extinguishment. NFPA 13, *Standard for the Installation of Sprinkler Systems*, should be referenced for additional information on the use of sprinklers. In archival storage areas, consideration should be given to using ordinary ratings [135°F to 170°F (57°C to 77°C)] where the risks of fire development exceed the risks of water damage.

5-2.2 Waterflow Alarms. Where a records center is protected by an automatic sprinkler system, provision of a waterflow alarm that transmits a signal to the fire department on the fusing (opening) of one or more sprinklers eliminates the possibility of a sprinkler operating undetected and discharging water for a long period, excessively wetting the records underneath, after the fire has been successfully extinguished. The waterflow alarm feature, in addition to signaling the existence of a fire, also detects the flow of water in the rare instance of accidental or malicious damage to the system.

5-2.3 Sprinkler Operation Characteristics. The sprinkler system operates only when the fire has reached the point of rapid heat rise and has passed the phase of development where hand fire extinguishment is effective. Both tests and fire experience have shown that sprinklers can confine the fire to a relatively small portion of the row of shelving where the fire started. The sprinkler discharge does not necessarily extinguish fire concealed under the shelves or inside mobile shelving. It definitely does slow down or prevent further fire propagation, removes the heat, and prevents further damage or collapse of the stack equipment. Thus, fire fighters entering the building can approach the seat of the fire and use small hose streams to quench the glowing or flaming areas.

5-2.4 Sprinklers—Expected Results. Under normal conditions in a facility protected by sprinklers, it is probable that fire would be confined to an area of 100 ft² to 500 ft² (9.3 m² to 46.4 m²). Water damage would consist primarily of superficial wetting of cartons in those areas where cartons were involved or wetting of the edge and bottom of open file records. These areas of water damage probably would extend approximately 10 ft to 20 ft (3.0 m to 6.1 m) to each side of the area of fire damage. The records on top of the top shelves would be the wettest; those on lower shelves would be shielded from the direct impact of water and would be considerably drier. Total extinguishment and shutdown likely would take place before failure of the corrugated or pressboard cartons. In this respect, cartons with wire-stapled lap-joints (rather than those that are glued) are less likely to fail. Containers that are die cut for assembly without the use of glue or staples are also suitable as protection against water damage and for avoiding possible injury and the problems associated with wire staples. Boxes with handholes are more susceptible to water damage. Water discharge from the sprinklers is in the form of a fine spray and, therefore, would not disturb the position of the records storage. Fire department operations in a sprinklered facility likely would cause only minimal physical disruption. It is probable that smoke and soot damage would be minimal. Solid fiberboard (archival) boxes resist water damage to a much greater extent than corrugated cartons.

5-2.5 Sprinklers—Special Systems. There are four sprinkler types and systems that are considered to be suitable for records protection. NFPA 13, *Standard for the Installation of Sprinkler Systems*, should be referenced for installation details.

(a) *Pre-action System.* A pre-action system is a system in which the sprinkler piping normally is dry and in which the control valve opens only when the heat detection devices sense the development of a fire. As in the wet-pipe system, individual sprinklers are fused so that only those located directly over the fire operate. Although more costly than the ordinary system, it has the advantage of eliminating the discharge of water if a sprinkler or a line is broken accidentally or deliberately. It is more expensive than a wet-pipe system, since a complete detection system is needed in addition to the sprinkler system. It is less reliable than a wet-pipe system, since it cannot operate if the detection system is inoperative.

(b) *Recycling System.* A recycling system is an adaption of a pre-action sprinkler system with a recycling feature. When the sprinkler or sprinklers have extinguished the fire and the heat drops below a preset temperature [e.g., 140°F (60°C)], the detectors initiate a timing cycle that automatically discontinues the waterflow by closing a special valve in about 5 minutes. The system remains in readiness, and, if the fire rekindles, it recycles to start the waterflow. The system has the advantages of automatically determining when the temperature has decreased and of shutting the system off, making it almost impossible for maintenance personnel or others to close the valve accidentally.

As in the pre-action system, the recycling system needs a separate detection system. Since the system is designed to recycle, the detection system needs to be fire resistant and, therefore, is somewhat more expensive. An advantage of the recycling system over other sprinkler systems is that, if the system shuts off prematurely and fire continues or rekindles, it is reactivated automatically when the ceiling temperature increases.

(c) *On-Off Sprinklers.* Sprinklers with a recycling feature are available. Installed on wet-pipe sprinkler systems, each sprinkler operates individually at a predetermined temperature, but when the temperature drops below the predetermined temperature, the sprinkler shuts off. Each sprinkler operates independently, cycling on and off depending on the fire situation in its immediate area. No separate detection system is necessary.

(d) *Dry-Pipe Sprinkler Systems.* A dry-pipe system also is useful for the protection of records storage. The sprinkler piping is filled with compressed air. The release of air pressure through a fused sprinkler allows the water valve to open and supply water to the sprinkler piping. Each sprinkler operates independently, as do all other types described in this section. Releasing air pressure through a fused sprinkler takes appreciable time, during which the fire could grow and open additional sprinklers. Dry-pipe sprinkler systems are used primarily for protection of unheated areas where freezing temperatures are likely to occur.

5-3 High-Expansion Foam.

5-3.1 General. High-expansion foam is a total flooding extinguishing agent that inundates the protected space. The foam surrounds all materials within the protected area with an aggregate of bubbles, each of which carries a small quantity of water. NFPA 11A, *Standard for Medium- and High-Expansion Foam Systems*, should be referenced for more extensive coverage of the characteristics of this extinguishing agent.

In tests conducted by the U.S. Atomic Energy Commission involving records media, high-expansion foam extinguished test fires quickly and easily by filling the entire volume of the storage space. The degree of wetting was low; generally, the foam did not penetrate normal corrugated fiberboard cartons. Cartons with stapled or interlocking edges tend to hold up quite well, while cartons with glued edges tend to come apart and expose the records contents to foam. Identification labels tend to slip off.

However, after exposure to the foam, it was necessary to take corrective drying action on all the materials within the area contacted by the foam.

NOTE: Data on these tests are published in an Atomic Energy Commission report, "High Expansion Foam Fire Control for Records Storage Centers," IDO-12050, March 1966, available from the Clearinghouse, U.S. Department of Commerce, Springfield, VA 22157. Also see Beers, R.J., "High Expansion Foam Fire Control for Records Storage," *Fire Technology*, Vol. 2, No. 2, May 1966, pp. 108-117.

5-3.2 Design of High-Expansion Foam Systems. NFPA 11A, *Standard for Medium- and High-Expansion Foam Systems*, should be referenced for the minimum requirements and design for systems that provide adequate protection. There are three types of high-expansion foam systems available:

- (a) Total flooding systems
- (b) Local application systems
- (c) Portable foam application devices.

For the purposes of this guide, total flooding systems are most applicable. Total flooding involves filling the storage space with foam to a level above the combustible material.

Total flooding systems need to maintain sufficient foam to submerge the hazard, sufficient time to cover the hazard, and a minimum rate of discharge to compensate for the breakdown of the foam by sprinkler discharge, shrinkage, fire, and other factors. High-expansion foam systems require venting, closure of openings through which foam can escape, and maintenance of sufficient foam to cover the hazard to ensure control and extinguishment of fires. The rate of application of high-expansion foam is rapid, and a large vent area is needed for the displaced air. Automatic activation of the system is by means of a heat detection system similar to that described for other systems.

5-4 Gaseous Extinguishment.

5-4.1 General. Extinguishment by total flooding with gas is favored by many archivists and records managers since no water damage can occur and salvage problems are simplified. Two principal gases used for this application are Halon 1301 and carbon dioxide. Total flooding involves filling the entire protected volume with a specific concentration of gas.

5-4.2 Halon 1301 Gas Systems. While water-based agents depend on cooling and quenching and carbon dioxide depends primarily on oxygen-exclusion, Halon 1301 inhibits burning by chemically interacting with the flame radical. Halon 1301 (bromotrifluoromethane) is a liquefied gas under pressure, which is an effective flame inhibitor that also exhibits low toxic and corrosive properties. The design of Halon 1301 systems is covered by NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems*. The use of this agent for total flooding applications in records storage facilities has been limited, and installation should be attempted only with expert guidance.

Because it is a flame inhibitor, Halon 1301 is not effective against smoldering fires at normal concentrations. In a records storage facility, it is important that application be undertaken as early in the fire as possible, before it becomes deep-seated. To be effective, it also is important that the system be automatic and total flooding and that it employ a properly responsive detection system. It is essential that means be provided to contain the gas without significant leakage for an extended period. Halon 1301 systems are relatively expensive, and most installations have been limited to the protection of high value collections in moderate-size spaces [less than 50,000 ft³ (1416m³)]. Total extinguishment by Halon 1301 of a fire in Class A (paper) storage is not likely due to smoldering. Prevention of flaming fire pending the arrival of the municipal fire department might be adequate. Rapid fire growth would be inhibited in the interim. The fire department would be likely to use water to complete the extinguishment, possibly under conditions of low visibility. Many installations sound an evacuation alarm prior to gas discharge to prevent occupants from breathing halon or halon decomposition products. Use of Halon 1301 is not recommended for ordinary records centers or archive facilities but might be appropriate for the protection of isolated smaller collections and records of high intrinsic value.

5-4.3 Carbon Dioxide Systems. Fire extinguishment can be accomplished by a total flooding carbon dioxide system with a soaking period. The design and proper installation of such a system are critical. NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*, should be referenced for further information.

5-4.3.1 Systems for records storage protection are designed to provide a carbon dioxide concentration of 65 percent in the protected space to control stratification and to maintain soaking for 30 minutes. Openings that are not necessary for pressure venting are to be closed at the time of discharge to avoid loss of carbon dioxide during the soaking period. Underdesigned carbon dioxide systems are subject to failure at the time of fire. Proper performance can be ensured only by actual testing to make certain that the design concentration is achieved and maintained for the full soaking period.

5-4.3.2 Since atmospheres containing fire extinguishing concentrations of carbon dioxide cannot sustain life, it could be fatal to be trapped in the flooded space. Ample warning and time delay are to be given prior to discharge to allow occupants to escape from the area to be flooded. A person cannot leave the area safely after the discharge starts. Provision should be made for exhausting the atmosphere after the soaking period without creating a hazardous atmosphere in another location.

5-4.3.3 For effective fire control, the activation of the carbon dioxide system should be automatic in response to fire and triggered by a properly designed and installed heat detection system.

5-4.3.4 Discharge of carbon dioxide can cause condensation of humidity (fogging), which can obstruct vision.

5-5 Comparisons of Extinguishing Systems.

5-5.1 There are a number of factors involved in comparing extinguishing systems. Initial cost, reliability, cost of agent, susceptibility to false operation, area of application, damage to records by fire and by extinguishing agent, and consequences of failure are all important factors to be considered. All automatic systems are damage-initiated; a fire that causes damage

needs to occur before an automatic system detects it and activates. Generally, the smaller the fire a system can detect, the more sensitive the system, and the more likely it is to operate falsely. It is important that the alarms for all systems be connected to the municipal fire department so that it is notified of a fire when the system activates.

5-5.2 Automatic sprinklers are the most reliable and economic means of controlling fire in a records center. Wet-pipe sprinklers with hydraulically designed piping, adequate water supply, and supervised valves are reliable and trouble-free. Cyclic systems, pre-action systems, and dry-pipe systems, provided for insurance against water damage, introduce the potential for failure in the system and can slow system functioning during a fire, resulting in a larger fire. In the event of a fire, only sprinklers in the immediate vicinity of the fire are activated. In the Factory Mutual full-scale test series, with sprinklers located in positions as ineffective for extinguishment as possible, the three tests opened 6 sprinklers, 16 sprinklers, and 3 sprinklers, respectively. This covered 600 ft², 1600 ft², and 300 ft² (56 m², 149 m², and 28 m²) using an installed array of 77 heads in a facility having approximately 400 heads. In these tests, as in most records fires, regardless of the extinguishment means, final extinguishment was by hose line. All records wetted but not burned were recoverable.

5-5.3 Detectors that react to a spark are available, but smoke detectors are the most sensitive types of detectors used in records centers. Where used to initiate the discharge of an agent, a smoke detector usually is desensitized by means of two detectors on alternate circuits that activate prior to agent discharge. Although smoke detectors activate promptly when exposed to smoke, a smoldering fire is not sufficiently buoyant to carry smoke to a high ceiling, and detectors generally react to a smoldering fire after a long period due to the process of diffusion. A strong heat column from a brisk flaming fire causes a smoke detector to operate promptly, but heat detectors, including sprinklers, also react quickly to this type of fire. Full-scale fire tests showed little advance warning of flaming fires in a records center by means of smoke detectors.

The principal value of system detectors is to initiate the extinguishing and life safety alarms. It is advantageous to initiate manual extinguishment by local forces, since an incipient fire could be discovered and extinguished with minimal damage by employees using extinguishers or hand hose. If the fire grows beyond the incipient stage, employees are at significant risk due to their lack of experience, breathing equipment, and protective gear. A municipal fire department is far better equipped for manual fire fighting due to their use of protective gear and heavy hose streams and their experience. The time needed for discovery, reporting, travel, and setup can result in an established fire that is beyond manual control by municipal forces, as occurred in the unsprinklered Military Personnel Records Center fire and many other fires in records centers.

5-5.4 Gaseous extinguishment has the potential for causing the least damage if all elements of the system perform as designed. Automatic operation of the system and automatic closure of leakage openings is essential to the success of these systems. Neither halon nor carbon dioxide can be expected to extinguish a deep-seated fire condition that occurs if an archives or records center fire is allowed to become well-developed before application of the extinguishing gas. Gas leakage through an open door, a temporary opening, or a fire-caused breach also could result in a failure. Gas extinguishing systems that are equipped with more sensitive detectors are used

mainly on incipient fires to minimize damage and because the larger the fire, the less likely that extinguishment can be accomplished. However, using more sensitive detection can result in increased false operations, which are undesirable because of the high cost of agent and because of the hazards to personnel. All materials in the enclosure are exposed equally to the gas, whether near to or remote from the fire. Final extinguishment usually is performed by the fire department using hose streams. If the area is obscured by smoke, which is likely, directing hose streams could be haphazard and could result in widespread water damage.

5-5.5 High-expansion foam discharged through an automatic means has the capacity to overcome a well-established fire and, therefore, is far superior to gaseous extinguishment and is superior to the use of sprinklers. As in the case of gaseous extinguishment, high-expansion foam escapes through unenclosed openings, although a very lightweight partition such as fine mesh screen can contain it. In addition, as with gaseous agents, all materials in the enclosure are exposed equally to the extinguishing agent. Since foam dampens kraft boxes (and perhaps loosens identification labels), all materials in the enclosure become slightly damaged and need to be dried. Final extinguishment by fire department hose streams is likely to be necessary.

5-6 Installation and Maintenance of Systems and Equipment. To ensure reasonably that a fire detection control system, appliance, or device performs satisfactorily, it is necessary for the installation to be in compliance with the recognized standards and the manufacturer's instructions and that complete operational tests are conducted.

After installation, it is important that a complete routine scheduled maintenance program that follows recognized standards and manufacturer's instructions be developed and followed. This may be permitted to be performed either by competent maintenance employees or by service contractors.

NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, should be consulted for inspection, testing, and maintenance of fire sprinkler systems and standpipe systems and all related water-based fire extinguishing systems.

Chapter 6 Construction

6-1 General Principles for New Construction.

6-1.1 The more important general principles for fire-safe records center and archives construction are described in this chapter. Detailed recommendations for good practice also are contained in various NFPA publications. In most localities, building codes and ordinances govern the type of construction to be used to a large extent.

Codes frequently provide for the safety of persons in the building but not for the preservation of the building or the collections. Therefore, it is of critical importance during the development of the project for the records custodian to specify the level of fire safety to be achieved in the construction. For single-story, aboveground facilities, consideration should be given to including a clause in the professional service contract(s) for the design of the project that mandates retaining and providing the consulting services of a qualified fire protection engineer, acceptable to the records custodian, to participate in the development of the fire safety system, including the determination of the requirements to be provided in the

final project documentation. For multistory or below-grade facilities, the services of a qualified fire protection engineer are essential.

6-1.2 The design of the automatic sprinkler protection and other fire protection and detection systems and building construction are interrelated. In addition to protecting combustible contents and providing improved safety to life, automatic fire suppression systems can, in some cases, enable the use of less expensive construction than would be possible without them. Properly designed automatic sprinkler systems in all areas of an archives or records center are mandatory.

6-1.3 For records center and archives construction, it is desirable to select materials and types of construction that are either noncombustible or that have resistance to fire. Fire-resistive construction is desirable and is essential for multistory structures. Fire-resistive construction should be in accordance with NFPA 220, *Standard on Types of Building Construction*, and requires structural members, including walls, partitions, columns, and floor and roof construction to be of noncombustible materials and to have fire resistance ratings from 2 hr to 4 hr, depending on the structural members.

6-1.3.1 Columns within shelving are potentially exposed to high temperatures exceeding the fire resistance of steel. Therefore, building columns within the records storage area should be of 2-hr construction from the floor to the point where they meet the roof-forming system.

6-1.3.2 Standard sprinklers might not protect lightweight roof structures (such as bar joists) during early fire development. Quick-acting sprinklers could avoid this problem.

6-1.4 The contents of an archive, or even a records center, often are considered to be of very high value or even irreplaceable, but they are always combustible. Therefore, every effort should be made to construct the building so that it resists the spread of fire. This means that during a fire the walls, roof, floor, columns, and partitions should prevent the passage of flame, smoke, or excessive heat and should continue to support their loads. "Fire resistant" is not equivalent to "noncombustible." A noncombustible structure might not keep a fire from spreading, since some materials that do not burn lose their strength when exposed to intense heat. This might cause walls or floors to collapse. Many types of construction using various building materials have been tested and rated according to the length of time they resist fire. The duration of the resistance needed by the archive or records center depends on the quantity of combustible material in the contents of each room as well as the structure itself. Different structural assemblies have fire resistance ratings ranging from less than 1 hr to more than 6 hr.

NOTE: NFPA 220, *Standard on Types of Building Construction*, classifies and defines various kinds of building construction. The *Building Materials List* published by Underwriters Laboratories Inc., under the heading "Fire Resistance Classification," provides information on structural assemblies that have been tested in accordance with NFPA 251, *Standard Methods of Fire Tests of Building Construction and Materials*.

6-1.5 It is not advisable to construct records centers and archives of materials that contribute fuel to a fire and that, by the nature of the construction, create combustible concealed spaces. Voids between a ceiling and the floor above are good examples of concealed spaces through which fire can spread rapidly and where access for fire fighting is difficult.

6-1.6 The term "compartmentation" in fire prevention is used to mean the subdivision of a building into relatively small areas so that fire or smoke can be confined to the room or section in which it originates. This principle can be applied to records centers and archives without restricting the flexibility of the arrangement of stack areas or the flow of visitors. Compartmentation necessitates fire-resistive wall and floor construction with openings that are provided with self-closing or automatic fire doors having specific fire resistance ratings. A major records keeper limits records center storage in a single fire subdivision to about 40,000 ft² (3720 m²) and archives storage in a single fire subdivision to 25,000 ft² (2325 m²). Offices, research rooms, and other support facilities always should be separated from the records storage areas by a properly rated fire-resistive wall.

In a similar way, properly enclosed stairways equipped with fire doors prevent the spread of fire, smoke, and heat from one level to another. Elevator shafts, dumb-waiter shafts, and all other vertical openings that pass through the structure also should be safeguarded. Air-handling systems (ventilation, heating, and cooling) should be constructed and equipped to prevent the passage of smoke, heat, and fire from one fire area to another or from one level to another in accordance with NFPA 90A, *Standard for the Installation of Air Conditioning and Ventilating Systems*.

6-1.7 Some architects have designed facilities that are located underground or largely underground, are windowless, or are completely ventilated by mechanical means. While these types of construction provide advantages in controlling temperatures, humidity, and air pollution, they do create problems for fire extinguishment and life safety in the event of fire. These problems are greatly magnified if loss of power impairs ventilating systems. Alternative means for allowing the escape of heat and smoke should be provided; adequate roof ventilation is particularly essential, since heated gases and smoke tend to rise. Provisions should be made for the safe emergency evacuation of people as well as for access by the fire department to the fire area. "Knockout" panels located to allow direct access to well-maintained aisles within the structure are invaluable for this purpose. Fire department officials should be consulted and should be aware of the existence of these panels to avoid unnecessary breaching of walls in the event of fire. Automatic sprinklers are essential in these types of buildings and are recommended. Smoke detection systems can provide critically important early detection to activate a smoke control system and provide early warning to occupants.

NOTE: See NFPA 101®, *Life Safety Code*®, Chapter 30, for guidance in providing life safety measures for underground structures and windowless buildings.

6-1.8 Consideration should be given to the proper selection of interior finishes and furnishings. Highly flammable wall and ceiling finishes should be avoided. NFPA 101, *Life Safety Code*, and most building codes should be consulted for specific minimum requirements for interior finish materials. Draperies, where used, should be noncombustible.

6-1.9 A high level of security often is a necessity for archives and records centers. Incompatibility between security and fire safety measures can be difficult to reconcile if not addressed in the building design. Security provided as an afterthought tends to conflict with the emergency evacuation requirements of the building and fire codes. Conflicts can be evaluated and mini-

mized through simultaneous consideration of fire safety and security needs while the facility is still in the planning stage.

Fire walls, for example, not only compartmentalize to reduce the fire exposure but also permit the use of horizontal exits, whereby people are channeled into another building, rather than evacuated to the outside, when a fire occurs. Courtyards and fenced-in grounds can be secure places of refuge for persons evacuated from a high-security building and can lessen the chances of having to escape with valuable records through emergency exit doors.

6-2 Records Storage Areas.

6-2.1 Fuel loads in records storage areas can range from 30 lb/ft² to hundreds of lb/ft² (146 kg/m² to approximately 1000 kg/m²), with corresponding fire durations greater than those of commonly used building construction. Furthermore, the higher fuel loading in records storage areas can result in fire durations that more closely resemble those in warehouse occupancies than those found in business occupancies. Analysis of the Military Personnel Records Center fire in St. Louis in 1973 indicates that a fire in a lower floor of a multistory building with sprinklers not installed, shut off, or inadequately designed results in total loss of the building, regardless of the way in which it is subdivided, unless the fire load is less than the structural fire resistance. There is no construction recognized that supports a building above an uncontrolled archives or records center fire.

6-2.2 In some archives and records centers, the part of the building used to house records is only a shell. The metal stacks are self-supporting and extend through several floor levels of the building. The stack floors are merely platforms that provide a walkway through the stacks. This results in slot-like openings between the stacks and the walkways, allowing a rapid, uninterrupted, upward flow of air, heat, smoke, and flames. In new records centers and archives, or in major renovations of existing structures, these types of stacks should be avoided. Floors should be of conventional building construction with appropriate fire resistance ratings, and the shelves installed thereon should be constructed as ordinary furniture.

6-2.3 In records storage areas where high-rise, self-supporting stacks are used, special attention should be given to fire protection as follows:

- (a) The most efficient automatic fire detection available, together with suitable reporting means, should be provided;
- (b) Complete automatic sprinkler protection should be provided, including waterflow alarms; and
- (c) A plan of action should be established with the fire department in advance to determine the best means of gaining access to the stacks, venting smoke, and reaching and fighting a stack fire at its source.

6-2.4 The practice of mounting records storage shelves on tracks is appearing now in new records center and archives construction and renovations as an application of modern warehousing technology (compact storage). This practice results in a high fire load density that can lead to a fire that threatens even the strongest code-prescribed fire barriers and construction (e.g., structural collapse). Without sprinkler protection for compact storage, fire endurance could exceed the resistance of fire compartment walls and the ability of the fire service to control the fire. Automatic sprinklers should be mandatory.

Associated fire protection problems that should be given consideration include the following:

- (a) Existing automatic fire detection and fire suppressant systems might have to be modified.
 - (b) Compact storage modules could conceal the origin of smoke, compounding the difficulty of locating and extinguishing the fire.
 - (c) Compact storage modules prevent the penetration of water from hose streams for fire extinguishment.
- Proper engineering can solve these problems effectively.

NOTE: See Chapter 10, Section 2 of the NFPA *Fire Protection Handbook* for a discussion of fire protection in compact storage. Underwriters Laboratories Inc. conducted additional tests on August 29 and 31, 1989. The published results of these tests are available from the National Archives and Records Administration, Washington, DC 20408.

6-2.5 Service Aisles. Otherwise dead-end service aisles should be terminated at least 18 in. (458 mm) from the wall to prevent entrapment by fire.

6-3 Protection Against Outside Exposure Fires.

6-3.1 Outside fires pose an exposure hazard. Clear space provides optimum protection. If sufficient clear space cannot be provided, the exterior walls of the records center or archives facing adjacent buildings should be of masonry or other adequately fire-resistive construction without doors, windows, or other openings. Where openings in an exposed wall are necessary, provision should be made to prevent the transmission of heat or flames from a nearby fire through such openings. Suitable protection includes fire windows with wired glass, fire doors, outside sprinklers, fire shutters, or a combination of these. Combustible roof coverings, window frames, and eaves could add to the hazard from an exposure fire and should be given special consideration in planning fire protection.

6-3.2 The requirements for protection from exposure fires are determined by the distance between the archives and records centers and neighboring buildings and the hazards associated with the individual occupancies (e.g., residence, factory, office building). With so many variables, the records center or archives need to consider the risk of fire spreading from neighboring occupancies, whether in other buildings or in the building housing the records center or archives (e.g., universities, museums, and other institutions). Determining the severity of such exposures is a matter of judgment based on the factors contributing to the hazard of radiant and convected heat.

NOTE: See NFPA 80A, *Recommended Practice for Protection of Buildings from Exterior Fire Exposures*, for further guidance with regard to exposure fires.

Chapter 7 Building Equipment and Facilities

7-1 Heating Systems.

7-1.1 A major potential source of fires is malfunction of heating equipment. For this reason, boilers and furnaces of central heating systems should be cut off from the remainder of the structure by rated fire walls or separations.

7-1.2 Oil-fired and gas-fired heating equipment, piping, and fuel oil storage facilities should be installed and maintained in accordance with the requirements of recognized safe prac-

tices. Heating equipment should be inspected and serviced at least annually by qualified personnel or a service contractor. All heating units should have safety devices appropriate for the particular type of installation. Combustibles, such as paper, wood, and textiles, should be kept away from steam piping or other heat piping and ducts.

7-1.3 Open-flame (gas and oil) space heaters are not compatible with storage of archives and valuable records and should be avoided wherever possible. Piping of fuel should be avoided in the vicinity of records storage areas.

7-1.4 The requirements for safety and fire protection where gas is used as fuel for heating should be in accordance with NFPA 54, *National Fuel Gas Code*. The requirements for the use of liquefied petroleum gas as fuel should be in accordance with NFPA 58, *Standard for the Storage and Handling of Liquefied Petroleum Gases*. The installation of oil burners and equipment used with them should be in accordance with NFPA 31, *Standard for the Installation of Oil-Burning Equipment*. The requirements of NFPA 90A, *Standard for the Installation of Air Conditioning and Ventilating Systems*, should be applied to air duct systems used for heating and ventilating. All these standards prescribe reasonable provisions for safety to life and property from fire.

7-2 Electrical Systems.

7-2.1 General. Installation and modifications to provide for the changing needs of the records center or archives including lighting, TV, sound systems, shop machinery, and appliances should be made by licensed or qualified electricians in accordance with NFPA 70, *National Electrical Code*®. The equipment should be listed.

7-2.2 Light Fixtures. Narrow aisle spaces [approximately 30 in. (800 mm)] mandate a limitation on the width of suspended, continuous lighting fixtures, since they can limit sprinkler penetration into the aisle. It has been shown that a 9-in. (230-mm) fixture in a 30-in. (800-mm) aisle does not interfere materially with water spray from a conventional sprinkler. Large-drop sprinklers have not been tested with respect to this problem. Lights installed tight against the ceiling can be arranged to avoid interference with sprinkler distribution.

7-3 Means of Egress.

7-3.1 General. It is imperative that security measures do not impede the safe emergency evacuation of visitors and employees. Attendance can vary greatly with the time of year, the exhibits offered, and other special events. Therefore, in planning the capacity of exits, serious consideration should be given to the maximum number of people who might be expected to be in the building at any given time. NFPA 101, *Life Safety Code*, contains information on construction, protection, and occupancy features designed to minimize danger to life from fire, smoke, fumes, and panic before buildings are vacated. NFPA 101 is the basis for legal requirements governing exit facilities in many government jurisdictions and should be consulted in planning life safety measures for a records center or archives.

7-3.2 Locking Devices. It is common for records centers and archives security measures to funnel all occupants through a few exits that can be monitored closely. Unfortunately, this often means that other doors required for egress are locked in violation of NFPA 101, *Life Safety Code*.

The 1994 edition of NFPA 101, *Life Safety Code*, includes equivalency concepts that allow the authority having jurisdiction to permit locking systems on these doors, provided that such systems afford a level of life safety equivalent to that prescribed in the *Code*. There are electromechanical and electromagnetic locking devices available that satisfy this requirement where installed in a properly designed system. Some of these systems provide an appropriate time delay before opening. Hydraulic and pneumatic devices are available that might meet this requirement. A properly designed system should include the following:

(a) Any failure of the device or the system should cause the system to fail in the open condition (unlocked).

(b) Sprinkler system operation should cause the system to unlock in the fire zone of origin.

(c) Fire alarms in the building should cause the system to unlock.

1. A manual fire alarm box should be provided at each exit egress door that is controlled by the system and that leads directly outside the building.

2. A sign should be placed on each required exit door stating that the door unlocks within 15 seconds to 30 seconds after pushing the panic bar or when the fire alarm sounds. Letters used in the sign should be 1 1/2-in. (38-mm) high with a 1/4-in. (6-mm) stroke.

(d) Smoke detection should cause the system to unlock.

(e) A daily functional test protocol should be conducted by an individual specifically assigned the responsibility.

NOTE: Use of these security devices or systems in combination with panic hardware maintains protection against unauthorized ingress while the system is unlocked for egress.

7-4 Air Conditioning and Ventilation Systems. Central air conditioning equipment should be located and installed in a manner that does not increase fire hazards to records centers or archives visitors or collections. Air conditioning ducts should be equipped with automatic fire dampers and fan shut-offs in accordance with NFPA 90A, *Standard for the Installation of Air Conditioning and Ventilating Systems*.

7-5 Lightning Protection. Lightning is always a potential fire hazard, more so in some areas or locations than in others. Lightning protection can be incorporated more effectively and economically in new construction than as an afterthought. NFPA 780, *Standard for the Installation of Lightning Protection Systems*, should be used in applying methods of protecting buildings from damage by lightning.

Chapter 8 Referenced Publications

8-1 The following documents or portions thereof are referenced within this guide and should be considered part of the recommendations of this document. The edition indicated for each reference is the current edition as of the date of the NFPA issuance of this document.

8-1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

NFPA 10, *Standard for Portable Fire Extinguishers*, 1994 edition.

NFPA 11A, *Standard for Medium- and High-Expansion Foam Systems*, 1994 edition.

NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*, 1993 edition.

NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems*, 1992 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 1994 edition.

NFPA 13E, *Guide for Fire Department Operations in Properties Protected by Sprinkler and Standpipe Systems*, 1995 edition.

NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, 1995 edition.

NFPA 31, *Standard for the Installation of Oil-Burning Equipment*, 1992 edition.

NFPA 40, *Standard for the Storage and Handling of Cellulose Nitrate Motion Picture Film*, 1994 edition.

NFPA 54, *National Fuel Gas Code*, 1992 edition.

NFPA 58, *Standard for the Storage and Handling of Liquefied Petroleum Gases*, 1995 edition.

NFPA 70, *National Electrical Code*, 1996 edition.

NFPA 72, *National Fire Alarm Code*, 1993 edition.

NFPA 90A, *Standard for the Installation of Air Conditioning and Ventilating Systems*, 1993 edition.

NFPA 101, *Life Safety Code*, 1994 edition.

NFPA 220, *Standard on Types of Building Construction*, 1995 edition.

NFPA 232, *Standard for the Protection of Records*, 1995 edition.

NFPA 780, *Standard for the Installation of Lightning Protection Systems*, 1995 edition.

NFPA *Fire Protection Handbook*, 17th Edition, 1991 edition.

Appendix A Salvage of Water-Damaged Library Materials

This Appendix is not a part of the recommendations of this NFPA document but is included for informational purposes only.

The following material is taken from *Procedures for Salvage of Water-Damaged Library Materials* by Peter Waters, Restoration Officer, Library of Congress, 1975 (a Library of Congress publication on the conservation of library materials). Although it is directed to the recovery of water-damaged books, many of the procedures, warnings, and structures also apply to other types of records and archival material. Additional references can be found in Appendix B.

Assessment of Damage and Planning for Salvage

Weather is the critical factor in determining which course to take after any flood or fire in which museum, archival, or library materials are damaged. When it is hot and humid, salvage must be initiated with a minimum of delay to prevent or control the growth of mold. When the weather is cold, more time can be taken to plan salvage operations and experiment with various drying procedures.

The first step is to establish the character and degree of damage. Once an accurate assessment of the damage has been made, firm priorities and plans for salvaging the damaged materials can be drawn up. These plans must include a determination of the special facilities and equipment required. Overcautious, unrealistic, or inadequate appraisals of damage can result in the loss of valuable materials. Speed is of the utmost importance, but careful planning is equally essential in the salvage effort.

Where water damage has resulted from fire fighting measures, cooperation with the fire marshal is vital for a realistic

appraisal of the feasibility of salvage efforts. Fire marshals and safety personnel will decide when a damaged building is safe to enter. In some cases, areas involved in the fire may require a week or longer before they are cool enough to be entered. Occasionally, parts of a collection may be identified early in the salvage planning effort as being especially vulnerable to destruction unless they receive attention within a few hours after the fire has abated. If the fire marshal appreciates such needs, it may be possible to provide means of access to the area even when other parts of the building remain hazardous.

Once all entrances and aisles are cleared, the most important collections, including rare materials and those of permanent research value, should be salvaged first, unless other materials would be more severely damaged by prolonged immersion in water. Examples of the latter are books printed on paper of types widely produced between 1880 and 1946, now brittle or semibrittle. However, materials in this category that can be replaced should be left until last.

Salvage operations must be planned so that the environment of flooded areas can be stabilized and controlled both before and during the removal of the damaged materials. In warm, humid weather, mold growth may be expected to appear in a water-damaged area within 48 hours. In any weather, mold will appear within 48 hours in unventilated areas made warm and humid by recent fire in adjacent parts of the building. For this reason, every effort should be made to reduce high temperatures and vent the areas as soon as the water has receded or been pumped out. Water-soaked materials must be kept as cool as possible by good air circulation until they can be stabilized. To leave such materials more than 48 hours in temperatures above 70°F (21°C) and humidity above 70 percent will almost certainly result in heavy mold growth and lead to high restoration costs.

Damaged most by these conditions are volumes printed on coated stock and such highly proteinaceous materials as leather and vellum bindings. Starch-impregnated cloths, glues, adhesives, and starch pastes are affected to a lesser degree. As long as books are tightly shelved, mold will develop only on the outer edges of the bindings. Thus, no attempt should be made in these conditions to separate books and fan them open. Archival files packed closely together on the shelves in cardboard boxes or in metal file cabinets are the least affected.

As a general rule, damp books located in warm and humid areas without ventilation will be subject to rapid mold growth. Archival files that have not been disturbed will not be attacked as quickly by mold. Very wet materials, or those still under water, will not develop mold. As they begin to dry after removal from the water, however, both the bindings and the edges of books will be quickly attacked by mold, especially when in warm, unventilated areas. A different problem exists for books printed on coated stock, since, if they are allowed to dry in this condition, the leaves will be permanently fused together.

Summary of Emergency Procedures

1. It is imperative to seek the advice and help of trained conservators with experience in salvaging water-damaged materials as soon as possible. The Library of Congress is an excellent information source for technical advice where needed. Contact: Preservation Office, Library of Congress, Washington, DC (202) 287-5212.

2. Turn off heat and create free circulation of air.