Report of Committee on Storage

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Johnson & Higgins

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Thomas E. Goonan, Schirmer Engineering Corp.
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(Alternate to R. S. Johnson)
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Jack Castleberry, International Paper Co.

These lists represents the membership at the time the committee was balloted on the text of this edition. Since that time, changes in the membership may have occurred.

The Report of the Committee on Storage is presented in 2 parts.


Part I has been submitted to letter ballot of the Technical Committee on General Storage which consists of 24 voting members; of whom 16 voted affirmatively, 2 negatively (Messrs. Brown and Johnson), 5 ballots were not returned (Messrs. Bean, Fustich, Germond, Goonan and Lowsbury), and 1 has been recorded as not voting (Mr. Carroll).

Part I has also been submitted to letter ballot of the Correlating Committee on Storage which consists of 7 voting members; of whom 6 voted affirmatively, and 1 ballot was not returned (Mr. Robertson).

Mr. Brown voted negatively because the major subject of tiered storage over 15 ft high of baled cotton is no longer covered in NFPA 231E, 231C or anywhere creating a partially useless document.

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Mr. Johnson voted negatively because the deletion of Section 5-6 protection requirements for tiered storage is no longer covered as this is not included in NFPA 231C. Also, without 2-4, guidelines are no longer given for yard storage exposure to buildings or the use of separation to limit storage quantities in buildings. Therefore this entire "Recommended Practice" should be returned to Committee for suitable revisions.


Part II has been submitted to letter ballot of the Technical Committee on General Storage which consists of 24 voting members; of whom 20 voted affirmatively, 1 negatively (Mr. Zuber), 2 ballots were not returned (Messrs. Germond and Goonan), and 1 has been recorded as not voting (Mr. Carroll).

Mr. Zuber voted negatively because:

NFPA standard 11A, High Expansion Foam Systems, referred to in Chapter 5, page 9, provides requirements requirements for protection of rolled paper storage in both sprinklered and unsprinklered buildings, without limitations on height of storage.

Proposed Standard 231F covers only storage in sprinklered buildings with stock height above 10 ft and ceiling heights not exceeding 30 ft.

Recommended further coordination by this Committee with foam Committee to eliminate confusion of conflicting standards.

Proposed Standard 231F, Paragraph 1-1.3.2 includes reference to NFPA 13 for information on sprinkler protection for stock heights not covered by this standard. Similar reference to NFPA 11A should be included for information on High Expansion Foam Protection for stock heights, etc. not covered by this spec.

Mr. Carroll was recorded as not voting on both NFPA 231E and 231F because he had no expertise in either subject.

Part II has also been submitted to letter ballot of the Correlating Committee on Storage which consists of 7 voting members; of whom 6 voted affirmatively, and 1 ballot was not returned (Mr. Goonan).
PART I

Chapter 1 Introduction

1-1 Scope.

1-1.1 This recommended practice provides fire protection guidance for the storage of baled cotton in buildings and in yards.

1-1.2 No provisions outlined are considered mandatory; however, it is suggested that property owners follow these recommended practices as a minimum means of limiting fire spread by the application of storage methods outlined, separation of major storages by fire walls or clear spaces, and by providing an adequate means of extinguishment.

1-1.3 These guidelines may be applied to new or existing facilities.

1-1.4 There is no intent to restrict new technologies or alternative arrangements that may offer improved protective features over those outlined.

1-2 General.

1-2.1 Cotton fiber is readily ignitable and will burn freely, and when stored in relatively large quantities offers special fire control problems not generally encountered in other common commodities.

Cotton fiber is compressed to various densities into baled form for transport, storage and handling, and is largely covered by a bagging of industry-acceptable materials and bound by steel, synthetic, or wire bands, or wire. The bale surfaces normally present a ragged appearance due to the loose fibrous material not confined by the binding or wrapping. Frequently, the appearance is further aggravated by sampling which exposes additional fibrous material and can contribute to the rapid spread of fire.

Relatively large quantity bale storage may offer the greatest fire control problems due to the potential flash-over and large area of involvement that could overcome even a well designed and supplied sprinkler system; thus, this recommended practice takes into consideration bale number limitations per building or fire division and size of storage blocks.

When the bales are tiered or piled in buildings or outdoors, the loose surface fibers offer a ready source of ignition and fire may flash over the entire mass or body of the material with great rapidity, commonly called "flash-over." Fire may then burrow into the bale interiors making detection and extinguishment difficult, particularly in large mass storage. A quick hot fire may then ensue and spread beyond the control of ordinary extinguishing methods.

In properly arranged storage and with adequate automatic sprinkler protection, fire is normally confined to the pile of origin, although an aisle fire can be expected to involve more than one tier or pile. Sprinklers will usually operate beyond the confines of the fire and wet down bales immediately adjacent to the burning pile.

On the other hand, if adequate sprinkler protection is lacking, tiers or piles are too large or high, aisle separation is not properly maintained, or the bales are otherwise improperly arranged, the fire spread will be correspondingly greater, if not total, to the section, building, or area of involvement.

1-2.2 Common causes of fire in baled cotton include but are not limited to:

(a) Fire-packed bales from the ginning or other process.
(b) Steel bands breaking and striking or rubbing (friction) against each other or other metallic objects causing sparks.
(c) Extraneous sparks from vehicle exhausts, incinerators, etc.
(d) Miscellaneous sources such as cutting and welding, electrical and mechanical faults, and smoking.

Authority Having Jurisdiction. The "authority having jurisdiction" is 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 fire 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, health department, building official, electrical inspector, or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or another insurance company representative may be the "authority having jurisdiction." In many circumstances the property owner or his 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."

Baled Cotton. A natural seed fiber wrapped and secured in industry-accepted materials, usually consisting of burlap, woven polypropylene or sheet polyethylene, and secured with steel, synthetic or wire bands or wire. May also include linters (lint removed from the cotton-seed) and motes (residual material from the ginning process). (See Table A-1-3.)

Block Storage. The number of bales closely stacked in cubical form and enclosed by aisles or building sides or both.

Cold Cotton. Baled cotton five or more days old after the ginning process.

Fire-Packed. A fire that has been packed within a bale as a result of a process, ginning being the most frequent cause.

Flash-over. A fire that spreads rapidly over the exposed linty surface of bales.

Labeled. Equipment or materials to which has been attached a label, symbol or other identifying mark of an organization 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. In those cases, the "authority having jurisdiction" should utilize the system employed by the listing organization to identify a listed product.
walls should be parapeted as follows:

NFPA 80, Standard for Fire Doors and Windows. Door:

2-3.3 It is preferable that fire walls be without openings.

2-3.1.1 Fire divisions or clear spaces between buildings should be in accordance with NFPA 220, Recommended Practice for Protection of Buildings from Exterior Fire Exposures.

2-3.1.2 Baled cotton storage generally has a fire loading in excess of 15 lb per sq ft (73 kg/m^2) which would place its classification, according to NFPA 80A, Recommended Practice for Protection of Buildings from Exterior Fire Exposures, in the "severe" category.

2-3.2 Fire walls should be of masonry and rated at least four hours (based on NFPA 251, Standard Methods of Fire Tests of Building Construction and Materials, ASTM E119, and UL 263). Such walls should be parapeted as follows:

(a) For wood frame (Type V (111-000)), and ordinary or heavy timber masonry (Type III (211-200) and IV (2 HH)) construction parapets should extend at least 5 ft (1.5 m) above the highest point of any adjacent monitor or roof structure within 50 ft (15.2 m) of the fire wall. Where monitors or roof structure adjoin a fire wall the parapet should extend not less than 7 1/2 ft (2.3 m) horizontally from the vertical side of the roof structure. If intersecting end or side walls are other than masonry, the fire wall should extend outward 10 ft (3.1 m) beyond the same, or be "teed" at the end 10 ft (3.1 m) each side from the wall, or "elled" 20 ft (6.2 m) and be of equivalent fire rating.

(b) For noncombustible construction (Type II (000)) other than that outlined in (c), parapets should be at least 2 1/2 ft (0.75 m) above the roof. If intersecting side walls are other than masonry, such wall construction should conform to that outlined in (a).

(c) For noncombustible construction (Type II (222-311)) having masonry walls and with roofs of concrete, gypsum, or Class I (UL Classified) metal deck, the parapet should extend at least 12 in. (0.3 m) above the roof.

(d) For walls and roofs of fire-resistive construction (Type I (443-322)) parapets are not required.

Note: For a complete description of Construction Types I, II, III, IV, and V, see NFPA 220, Standard on Types of Building Construction.

2-3.3 It is preferable that fire walls be without openings. Where openings are necessary, the number should be held to the minimum required and each side should be protected by an approved and listed 3-hour rated fire door. Where openings are necessary, the number should be held to the minimum required and each side should be protected by an approved and listed 2-hour rated fire door. Doors should be automatic closing with detectors or fusible links installed on both sides of the opening and interconnected so that the operation of any single detector or fusible link will close both doors simultaneously.

2-3.3.1 Substantial guards of a size to protect fire doors from damage or obstruction should be provided.

Chapter 2 Building Construction

2-1 Construction.

2-1.1 Buildings used for the storage of baled fibers, which are stored and protected in accordance with this recommended practice, may be of any of the types described in NFPA 220, Standard on Types of Building Construction.

2-1.1.1 Buildings equipped, or to be equipped, with automatic sprinkler protection should also meet the requirements outlined in Chapter 4.

2-2 Emergency Smoke and Heat Venting. Protection outlined in this recommended practice applies to buildings with or without roof vents and draft curtains.

2-3 Fire Divisions or Clear Spaces Between Buildings.

2-3.1 A fire division is a building, compartment or section cutoff by fire walls or separation.

2-3.1.1 Fire divisions or clear spaces between buildings should be in accordance with NFPA BOA, Recommended Practice for Protection of Buildings from Exterior Fire Exposures.

2-3.1.2 Baled cotton storage generally has a fire loading in excess of 15 lb per sq ft (73 kg/m^2) which would place its classification, according to NFPA 80A, Recommended Practice for Protection of Buildings from Exterior Fire Exposures, in the "severe" category.

2-3.2 Fire walls should be of masonry and rated at least four hours (based on NFPA 251, Standard Methods of Fire Tests of Building Construction and Materials, ASTM E119, and UL 263). Such walls should be parapeted as follows:

(a) For wood frame (Type V (111-000)), and ordinary or heavy timber masonry (Type III (211-200) and IV (2 HH)) construction parapets should extend at least 5 ft (1.5 m) above the highest point of any adjacent monitor or roof structure within 50 ft (15.2 m) of the fire wall. Where monitors or roof structure adjoin a fire wall the parapet should extend not less than 7 1/2 ft (2.3 m) horizontally from the vertical side of the roof structure. If intersecting end or side walls are other than masonry, the fire wall should extend outward 10 ft (3.1 m) beyond the same, or be "teed" at the ends 10 ft (3.1 m) each side from the wall, or "elled" 20 ft (6.2 m) and be of equivalent fire rating.

(b) For noncombustible construction (Type II (000)) other than that outlined in (c), parapets should be at least 2 1/2 ft (0.75 m) above the roof. If intersecting side walls are other than masonry, such wall construction should conform to that outlined in (a).

(c) For noncombustible construction (Type II (222-311)) having masonry walls and with roofs of concrete, gypsum, or Class I (UL Classified) metal deck, the parapet should extend at least 12 in. (0.3 m) above the roof.

(d) For walls and roofs of fire-resistive construction (Type I (443-322)) parapets are not required.

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(d) For walls and roofs of fire-resistive construction (Type I (443-322)) parapets are not required.

Note: For a complete description of Construction Types I, II, III, IV, and V, see NFPA 220, Standard on Types of Building Construction.

2-3.3 Cross aisles separating each storage block should be at least 4-ft (1.2 m) in width. The recommended 4-ft (1.2 m) aisles will allow sprinkler water to penetrate lower areas of storage; however, it should be noted that with aisles less than 8 ft (2.4 m) in width, a fire can be expected to readily communicate from one block to another, especially in the case of an easily ignitable commodity such as cotton fiber.

2-3.3.1 When a 15-ft (4.6-m) cross aisle is provided after every fourth or fifth tiered block, each storage block may then be increased to 600 bales of compressed cotton and 400 bales of flat cotton. The purpose of this alternate method of tiered storage is to encourage wider cross aisles at least intermittently without reducing the suggested storage capacity, as an aid in reducing the flash-over fire potential. Because of the increase in block sizes, however, it is suggested that the authority having jurisdiction be consulted prior to practicing this method.

2-3.4 Cross aisles separating each single or double-row rack storage configuration should be at least 10 ft (3.1 m) in width.

2-3.5 Aisles should be maintained clean of loose fibers.

2-3.6 Freshly Ginned Cotton Bales. (See Section 5-5.)

2-5 Other Than Cotton Storage.

5-1 Cotton warehouses, in general, may be used for the storage of other commodities, subject to the following:

(a) There is no intent to prohibit the storage of other commodities in a building when it is not being used for baled cotton.

(b) High hazard commodities, such as nitrates or similar oxidizing materials, flammable liquids or gases, explosives, or materials of a highly combustible nature, should not be permitted when baled cotton is stored in the fire division.

(c) Any commodities that may be hazardous in combination with each other should be stored so that they cannot come in contact with each other.
3-5.1.1 When it is necessary to store other commodities with baled cotton storage, a clear space of at least 15 ft (4.6 m) should be maintained between the baled cotton storage and other commodities.

3-5.1.2 Where commodities of different classifications are allowed and stored in the same building, whether on a seasonal basis or otherwise, the protection should be adequate for the most hazardous material. For protection of other commodities refer to NFPA 231, Standard for Indoor General Storage, NFPA 231C, Standard for Rack Storage of Materials, and NFPA 231D, Standard for Storage of Rubber Tires. (See Appendix C.)

3-6 Clearances.

3-6.1 Proper clearances should be maintained from lights or light fixtures to prevent possible ignition. Incandescent light fixtures should have guards to prevent ignition of a commodity from hot bulbs where the possibility of contact exists.

3-6.2 No storage should be within 3 ft (0.9 m) of any electrical switch or panel boards and fuse boxes.

3-6.3 Baled cotton storage and other combustibles should be kept at least 4 ft (1.2 m) from fire door openings so that transmission of fire through a door opening is minimized.

3-6.4 At least 2 ft (0.6 m) of clearance should be maintained around all doors (other than indicated in 3-6.3), fire protection equipment (including automatic sprinkler risers, controlling valves, hose stations and portable extinguishers), and telephones for accessibility.

3-6.5 Clearance of at least 3 feet (0.9 m) should be maintained between the top of storage and the roof or ceiling construction in order to allow sufficient space for the effective use of hose streams in buildings not equipped with automatic sprinkler protection.

Chapter 4 Fire Protection

4-1 Automatic Sprinkler Systems.

4-1.1 Automatic sprinkler protection is not a requirement of this recommended practice. However, it is unfortunate that in a fire situation, human response is, in most cases, unreliable in the first critical moments of fire development. Sprinkler protection is, therefore, the most reliable method of fire detection and suppression. Property owners are encouraged to provide sprinkler protection as the best means of minimizing a large loss.

NOTE: See Section 3-5 for sprinkler protection for other than fiber storage.

4-1.2 Automatic sprinkler systems, where provided, should be installed in accordance with NFPA 13, Standard for the Installation of Sprinkler Systems, except as modified by this Chapter.

4-1.3 For tiered or rack storage up to a nominal 15 ft (4.6 m) in height, sprinkler discharge densities and areas of application should be in accordance with Figure 4-1.3. See NFPA 231C, Standard for Rack Storage of Materials.

4-1.3.1 The density provided for the area of operation may be from any point on the selected curve. It is not necessary to meet more than one point on the selected curve. There is no modification allowed in sprinkler density or area of operation for tiered or rack storage below the height indicated.

4-1.3.2 Baled storage that is not tiered may be based on the single point design "E" for wet-pipe systems and "F" for dry-pipe systems. This untiered design density would limit storage to one bale high, on side or on end, and prohibit possible future tiering without a probable redesigning of the sprinkler system.

4-1.3.3 In warehouses that have mixed rack, tiered or untiered storage, or both, the curve applicable to the storage configuration should apply and the highest density requirement extend at least 15 ft (4.6 m) beyond the required operating area.

4-1.3.4 Minimum sprinkler operating areas should be 3,000 ft² (279 m²) for wet-pipe systems and 3,000 ft² (363 m²) for dry-pipe systems; maximum operating area should not exceed 6,000 ft² (557 m²). No area credit is recommended for the use of high temperature sprinkler heads.

Figure 4-1.3 Sprinkler System Design Curves.

Curve Legend
A -- Wet-pipe system for tiered storage to 15 ft (4.6 m).
B -- Dry-pipe system for tiered storage to 15 ft (4.6 m).
C -- Wet-pipe system for rack storage to 15 ft (4.6 m).
D -- Dry-pipe system for rack storage to 15 ft (4.6 m).
E -- Wet-pipe system for untiered storage.
F -- Dry-pipe system for untiered storage.

4-1.4 Clearance between the top of the storage and the sprinkler deflectors should be at least 18 in. (45 cm). Building heights should generally be adequate with consideration to allow for proper clearance between the pile height and sprinkler deflectors. Fire tests of high piled storage have shown that sprinklers are generally more effective if between 1 1/2 and 4 1/2 ft (.46 and 1.4 m) above the storage height.

4-2 Water Supplies.

4-2.1 Total water supply available should be sufficient to provide the required sprinkler discharge density over the required area, plus not less than 500 gpm (32 L/s) for hose streams.

4-2.2 Water supplies should be capable of supplying the total demand for sprinklers and hose streams for not less than two hours.

4-2.3 Recommended water supplies contemplate successful sprinkler operation when installed. However, because of the flash-over fire potential and inherent unfavorable features of cotton warehousing, there should be an adequate water supply available for fire department use.

4-3 Hydrants. At locations without public hydrants, private hydrants should be provided. (See NFPA 24, Standard for Private Fire Service Mains and Their Appurtenances.)

4-4 Manual Inside Protection.

4-4.1 In buildings 15,000 sq ft (1380 m²) or larger, small hose (1 1/2 in. [38 mm]), with combination water-spray nozzle, should be provided to reach any portion of a storage area with due consideration to access aisle configuration with maximum length of 100 ft (30.5 m) of hose. Such small hose may be supplied from:

(a) Outside hydrants;

(b) A separate piping system for small hose stations (see NFPA 14, Standard for the Installation of Standpipe and Hose Systems);
4-6.1 Arrangements should be made to permit rapid entry into the premises by the municipal fire department, police department, or other authorized personnel in the case of fire or other emergency.

4-6.2 Portable listed fire extinguishers should be provided in accordance with NFPA 10, Standard for Portable Fire Extinguishers, except as amended by this chapter. Up to one-half of the required complement of portable fire extinguishers for Class A fires may be omitted in storage areas where fixed small hose lines are installed in accordance with 4-4.1.

4-6.2.1 Cotton and its wrappings represent a Class A fire. Experience has shown that extinguishment using "wet water" (a chemical agent additive to lower the surface tension of water, thus increasing its penetrating and spreading qualities) is the most effective on baled cotton fires.

Plain water, from casks and pails, pump tanks, and small pressurized tanks, is effective on surface fires but lacks the penetrating power of "wet water."

Dry chemical extinguishers using sodium bicarbonate, potassium bicarbonate, or potassium chloride base powders have been used to control a surface fire on baled fibers, mainly coating the fiber with the fire retardant powder, but such chemicals will not affect a smoldering or burrowing fire beneath the surface.

Dry chemical extinguishers using sodium bicarbonate, potassium bicarbonate, or potassium chloride base powders have been used to control a surface fire on baled fibers, mainly coating the fiber with the fire retardant powder, but such chemicals will not affect a smoldering or burrowing fire beneath the surface.

4-6.2.2 Additional listed extinguishers, suitable for Class B and C fires, or multipurpose types, should be provided at each press location and for each motorized vehicle or area of hazard other than Class A.

4-6.3 Wheeled listed wetting-agent (see NFPA 18, Standard on Wetting Agents) pressurized extinguishing units may be used, subject to the authority having jurisdiction, in lieu of Class A conventional types or small hose lines, distributed on the following basis:

(a) An equivalent rating of 20A for each 15,000 sq ft (1380 m²) of floor area or less.

(b) For each 30,000 sq ft (2760 m²) of floor area, or greater fraction thereof, a unit or units having the equivalent extinguishing capacity of 40A or more.

4-6.3.1 Placement of extinguishing units should be at readily accessible locations to main aisles and properly protected from damage.

4-4.4 Extinguishers should be nonfreezing types or protected against freezing where necessary.

4-5 Alarm Service.

4-5.1 Automatic sprinkler systems should have approved central station, local, auxiliary, remote station, or proprietary water flow supervised alarm service. Local water flow alarm service is acceptable where standard guard service is provided. (See NFPA 601, Recommendations for Guard Operations in Fire Loss Prevention.)

Alarm service should comply with one of the following:


4-5.2 To assure sprinkler valve security, accessible valves should be chained or padlocked open or both. (See NFPA 26, Recommended Practice for the Supervision of Valves Controlling Water Supplies for Fire Protection.)

4-6 Fire Emergency Organization.

4-6.1 Arrangements should be made to permit rapid entry into the premises. Local alarm service should be obtained as soon as possible and maintain continuous operation during manual fire fighting operations until visibility is cleared so that the fire can be clearly seen and the extent of fire reduced to a stage requiring only mopping up. It is essential that charged hose lines be available before venting is started because of a possible increase in fire intensity. When a sprinkler valve is closed, a responsible person should remain at the valve so it can be opened promptly if necessary. The water supply for the sprinkler system should be augmented where possible and care exercised so that the water supply for the sprinkler system is not rendered ineffective by the use of excessive hose streams.

Where a private fire brigade is provided, sufficient large hose (2 1/2 in.) and related equipment should be available. (See also Appendix B.)

4-6.2 If sprinkler water is not available, firemen should be instructed and trained in the following procedures:

(a) Maintaining the security of the premises.

(b) Means of summoning outside aid immediately in an emergency.

(c) Use of portable fire extinguishers and small hose lines on small fires and for mop-up operations.

(d) Operation of the sprinkler system and water supply equipment.

(e) Use of material handling equipment while sprinklers are still operating to effect final extinguishment.

(f) Attendance of sprinkler system valves after the system is turned off so that the sprinklers can be reactivated if the fire rekindles.

(g) Need for, and use of breathing apparatus.

(h) Proper operation of emergency smoke and heat venting systems where provided.

4-6.2.1 Manual fire fighting operations are not a substitute for sprinkler operation. The sprinkler system should be kept in operation during manual fire fighting operations until visibility has cleared so that the fire can be clearly seen and the extent of fire reduced to a stage requiring only mopping up. It is essential that charged hose lines be available before venting is started because of a possible increase in fire intensity. When a sprinkler valve is closed, a responsible person should remain at the valve so it can be opened promptly if necessary. The water supply for the sprinkler system should be augmented where possible and care exercised so that the water supply for the sprinkler system is not rendered ineffective by the use of excessive hose streams.

Where a private fire brigade is provided, sufficient large hose (2 1/2 in.) and related equipment should be available. (See also Appendix B.)

4-6.3 Information on emergency organization is given in the following publications:


NFPA 37, Recommendations for Organization, Training and Equipment of Private Fire Brigades.

4-6.4 Fire departments should be encouraged to make periodic inspections of the property in cooperation with management and personnel for the purpose of loss prevention and fire planning. (See NFPA 13E, Recommendations for Fire Department Operations in Properties Protected by Sprinkler and Standpipe Systems.)

4-6.5 A fire watch should be maintained when the sprinkler protection is not in service.

5-1 General.

5-1.1 This chapter is intended to apply to baled cotton storage yards designated for that purpose. Generally, yards are at or convenient to compress warehouses and gins, but may include storage at locations remote from normal operations.

5-1.2 Reference in this chapter is made to seed cotton trailers or modules, vehicles, incinerators, and other facilities, or exposures from same, only for the purpose of establishing recommended distances to designated yard storage areas.

5-2 Definitions. Unless expressly stated elsewhere, for the purpose of this chapter only, the following definitions apply:

Block. A basic yard storage unit comprising multiple row storage with clear spaces on all sides.

Designated Yard. An area marked by boundary lines intended for outside storage purposes only.

Group of Yards. Multiple yards with maximum block and minimum clear space limitations.

Protected. (See Section 5-7.)

Quarantine Yard. A segregated area for the storage of known or suspected fire-packed bales.

Row. A minimum yard storage unit comprised of adjoining bales.

Unprotected. Not meeting the provisions of Section 5-7.

Yard. A storage unit consisting of multiple storage blocks subject to bale and clear space limitations.

5-3 Site. Preference should be given to locations having adequate public fire and police protection, adequately supplied fire hydrants for protection of yard areas, good drainage, all weather roads or driveways for emergency vehicle use, and remoteness from buildings or other combustible storages or facilities which may constitute an exposure hazard.

5-4 Storage Arrangements.
5-4 Tiered storage is not recommended; however, yard or outdoor storage conditions may necessitate storage methods other than those outlined. The authority having jurisdiction should be consulted for approval in such cases.

5-4.2 Storage should be arranged so as to provide reasonable fire breaks and ready access for fire fighting.

5-4.3 A row of storage should be limited to 100 bales.

5-4.4 Maximum storage limitations should be based on the following:

(a) Protected block, 10 rows (1,000 bales).
(b) Unprotected block, 5 rows (500 bales).
(c) Protected yard, 5 protected blocks (5,000 bales).
(d) Unprotected yard, 5 unprotected blocks (2,500 bales).
(e) Protected group yard, 4 protected yards (20,000 bales).
(f) Unprotected group yard, 4 unprotected yards (10,000 bales).

5-4.5 Minimum clear spaces should be based on the following:

(a) 10 ft (3 m) between parallel rows and 25 ft (7.6 m) between rows end on.
(b) 50 ft (15.2 m) between protected or unprotected blocks.
(c) 200 ft (61 m) between protected or unprotected yards.
(d) 1000 ft (305 m) between protected or unprotected group yards.

5-4.6 Rows should be arranged so that prevailing winds blow in the direction of the parallel clear spaces between rows.

5-5 Quarantine Yards.

5-5.1 Freshly ginned cotton bales are highly subject to insidious fires. Commonly called "fire-packed bales," these originate from the ginning operation. Known or suspect fire-packed bales should be marked as such and kept segregated from other contents or buildings for a period of not less than five days; should no fire be detected after that period, the bales may then be handled in a normal manner. (See Appendix B.)

5-5.2 A clear space of at least 100 ft (30.5 m) from any yard storage and 25 ft (7.6 m) from all buildings should be established as a quarantine area for known or suspect fire-packed bales.

5-5.3 Known or suspect fire-packed bales should be separated from each other by at least a 10 ft (3 m) clear space.

5-6 Exposure Clear Space. Unobstructed clear space should be maintained to designated yard storage as follows:

(a) 100 ft (30.5 m) to any approved sprinklered building.
(b) 200 ft (61 m) to any nonapproved sprinklered or nonsprinklered building.
(c) 200 ft (61 m) to an approved incinerator.
(d) 500 ft (152.5 m) to a nonapproved incinerator or open fires.
(e) 100 ft (30.5 m) to vehicle and seed trailer or module parking areas and trash piles.
(f) 50 ft (15.2 m) to roadways and railroad mainlines and sidings.
(g) 200 ft (61 m) upwind of any reconditioning activity.
(h) Yard storage areas should be maintained clear and clean of loose cotton, dry grass, weeds and combustible trash, and for a distance of at least 50 ft (15.2 m) around the yard perimeter.

NOTE: In the case of buildings, sprinklered or unsprinklered, the above clear space may be reduced up to 50 percent if construction is fire-resistant, or facing walls are masonry and parapeted with adequately protected openings. This area reduction may also be applied to noncombustible buildings of a type limited to corrugated iron or asbestos panel walls and roof on a steel frame.

5-7 Fire Protection.

5-7.1 To qualify as a protected yard, hydrants should comply with Section 4-3 of this recommended practice except as amended by this chapter.

5-7.1.1 All areas of yard storage should be within 500 ft (152.5 m) of a fire hydrant. Adequate clearance should be maintained between storage and hydrants.

5-7.2 Approved extinguishing units should be provided on the basis of an equivalent 40A rating for each protected or unprotected yard area (see Section 5-4) or greater fraction thereof.

5-7.2.1 Subject to the authority having jurisdiction, self-propelled wet water unit(s) may be substituted for the 5-7.2, if one of 250 gal (946 L) or greater capacity is provided for each yard group area up to 20,000 bales total.

5-7.2.2 Placement of wheeled or self-propelled units should be at readily accessible locations within 250 ft (76.2 m) of each yard, protected from damage and maintained in good operating condition at all times.

5-7.3 Water casks and pails, if used, should be distributed at a ratio of one 40 gal (151 L) or greater size cask with two pails for each 100 bales of storage. However, wheeled wet water pressure or hand pump extinguishers may be acceptable in lieu of casks and pails.

5-7.4 All motorized vehicles used in designated yard areas should be equipped with a listed multipurpose dry chemical extinguisher of a size appropriate for the anticipated hazard. See 4-4.2 for information on portable fire extinguishers.

5-7.5 A suitable and reliable means of communication should be available to promptly summon the fire department or other appropriate personnel, to sound a general alarm in the case of fire or other emergency, or both.

5-7.6 Reference should be made to Section 6-6 of this recommended practice for fire emergency organization and procedures that may apply to yard storage.

5-8 Yard Maintenance and Operations.

5-8.1 Smoking should be strictly prohibited within 100 ft (30.5 m) of yard storage areas and signs conspicuously posted to that effect. (See Note to Section 6-6.)

5-8.2 All internal combustion equipment used in or around yard storage areas should be equipped with a suitable spark arrestor-type muffler properly maintained and otherwise approved by the authority having jurisdiction.

NOTE: The US Department of Transportation (DOT) has safety jurisdiction over a major segment of the trucking industry, specifically those vehicles used in transportation for interstate or foreign commerce. Reference should also be made to NFPA 512, Standard for Truck Fire Protection, which incorporates many requirements of DOT's Federal Motor Carrier Safety Regulations for the benefit of those not subject to DOT safety jurisdiction.

5-8.3 Guard watch service should be provided throughout all designated yard storage areas when cotton bales are less than 5 days old after ginning, or when total stock exceeds 1,000 bales, during all shut-down periods.

5-8.3.1 Hourly recorded rounds should be made during all nonworking hours using an approved and listed portable clock and having key stations situated to ensure complete coverage of the area of responsibility. Watch service information may be obtained from NFPA 601, Recommendations for Guard Service in Fire Loss Prevention, and NFPA 601A, Standard for Guard Operations in Fire Loss Prevention.

Attention is also directed to the value of strategically placed watch towers and floodlights where a watchman stationed at a point of vantage can keep the entire property under observation.
6-1 Administration. The administration of buildings and equipment, and the maintenance thereof, is an important consideration in the reduction of fire incidence and loss. The finest buildings and protective features may be quickly dispelled by indifference to the continuous, necessary maintenance of fire loss prevention programs and protective equipment. Thus, management, at all levels, plays a critical part in the reduction of fire loss.

Aside from the recommendations outlined in this Chapter, the liaison between management and personnel should include a meaningful loss prevention program that will: (1) encourage loss prevention habits; (2) teach the prompt sounding of alarms; (3) minimize panic and effect safe evacuation; (4) instruct key personnel how to utilize fire extinguishing equipment and other protective features effectively; and (5) teach basic salvage and cleanup techniques to minimize down time of operations.

6-2 Mechanical Handling Equipment.

6-2.1 Industrial Trucks. Power operated industrial trucks and mobile equipment should comply with NFPA 505, Fire Safety Standard for Powered Industrial Trucks Including Type Designations, Areas of Use, Maintenance and Operation. Cotton storage and handling areas are defined as Class III, Division 2, hazardous areas and require vehicles that are designated types DS, DY, ES, EE, EX, GS, LPS, and SS/SSP.

6-2.1.1 Gasoline and diesel fuel should be prohibited in cotton storage areas, platforms or exposing yard areas, except that contained in the vehicle tanks. Fueling should be done outside at a well-detached location in accordance with NFPA 30, Flammable and Combustible Liquids Code.

6-2.1.2 Liquefied petroleum gas fuel containers shall be exchanged or removed only outdoors. The valve at the fuel container should be closed and the engine allowed to run until the fuel line is exhausted. Tanks should be refueled only at well-detached locations. LP-Gas fuel systems on LP-Gas dual fuel powered trucks should be in accordance with the applicable provisions of NFPA 58, Standard for the Storage and Handling of Liquefied Petroleum Gas.

6-2.1.3 Storage battery charging equipment should be in a separate area, room or building designated for that purpose. If a separate room, the room should be lined with substantial noncombustible materials so constructed as to exclude "fly" or lint. Charging areas should be kept free of extraneous combustible materials and trash. Adequate ventilation should be provided to minimize concentrations of hydrogen gas during charging.

6-2.1.4 All mechanical equipment and refueling areas should be kept clean of accumulations of fibrous lint, oil, and trash, with particular attention paid to internal areas of vehicles.

6-2.2 Maintenance and Operations. For industrial trucks the following should be prior to entering or use in cotton storage or handling areas:

(a) All traces of fuel must be cleaned from the vehicle before it is started.

(b) Vehicles that have exhausted fuel tanks should be towed to the assigned fueling area for refueling.

(c) No repairing is permitted in cotton storage or handling areas.

(d) Alterations of the fire safety features should be prohibited.

(e) Maintenance procedures should comply with those outlined in NFPA 505. (See 6-2.1.)

NOTE: Lift trucks are a common cause of fires in cotton warehouses due mainly to the lack of maintenance and cleanliness, and the altering or improper substitution of fire safety features.

6-2.3 Inter-Plant Haulage. Tractors used for inter-plant hauling should be equipped with a suitable spark arrestor-type muffler properly maintained.

6-2.4 Motorized Vehicles. Motorized vehicles, other than those specified under 6-2.3, should not be permitted to enter any cotton storage area. A loading platform should be located so that trucks cannot come fully within the closing walls of a warehouse, with the traffic space in between away from the platform and lower than the platform. The loading area should be closed off from any under-floor building space.

6-2.5 Mechanical handling equipment, when not in use, should preferably be stored outside.

6-3 Building Service and Equipment.

6-3.1 Electrical Installation. It is preferred that cotton storage and handling areas be without an electrical installation; however, any that are necessary should comply with NFPA 72, National Electrical Code, for Class III, Division 2, hazardous areas.

6-3.1.1 Electrical extension cords should not be allowed in storage areas. If portable lights are necessary, battery-powered lanterns or flashlights may be used.

6-3.2 No open flame heating devices, permanent or temporary, should be permitted.

6-3.2 Shops and Equipment. No repairing or reconditioning, boilers or similar equipment should be permitted in cotton storage areas. It is recommended that separate buildings be provided for such purposes or be separated from storage areas by a standard two-hour fire wall.

6-3.3 The term, "reconditioning" applies mainly to cotton and means any opening, drying, cleaning, or picking of bales of loose cotton by any means whatsoever, except:

(a) Air drying (not compressed air) of baled cotton at room temperature where not more than one bale is removed from each bale being so dried.

(b) Picking of baled cotton by hand only where not more than five bales are in the process of being picked on the premises at any one time, and where at least two hands remain on each bale so picked. Removal of more than one bale is to be considered part of the picking operation.

(c) The opening of bales in the press room for pressing or recompressing.

(d) The cleaning of baled cotton by brushing (manual only) where the process employed does not remove an appreciable quantity of lint.

Mechanical reconditioning operations should confine lint and "fly" to the reconditioning building and should be separated from cotton storage (or compress) by a standard fire wall without openings or by unobstructed clear spaces as outlined in Chapter 2.

6-4 Cutting and Welding.

6-4.1 When cutting and welding operations are necessary, the precautions contained in NFPA 51B, Standard for Fire Prevention in Use of Cutting and Welding Processes, should be followed.

6-4.2 Welding, soldering, brazing, or cutting should be permitted only by the authorization of management. Proper precautions should be observed and include:

(1) Assignment of a supervisor to the operation.

(2) Assurance that the area has been made firesafe.

(3) When possible, work should be removed to a safe area.

(4) When performed on equipment or building components which cannot be moved, there should be no storage below or within a 35 ft (10.7 m) radius.

(5) Floors should be swept clean and wooden floors wet down within the 35 ft (10.7 m) radius.

(6) Cutting and welding equipment to be used should be in good operating condition and properly maintained.

NOTE: Personnel operating arc welding or cutting equipment should be protected from possible shock.

(7) Openings and cracks in wood construction should be tightly covered to prevent the passage of sparks.

(8) At all cotton bordering the area should be protected by flameproofed covers or otherwise shielded with metal or asbestos guards or curtains. Edges of the covers at the floor should be tight to prevent sparks from escaping. This precaution should extend to where several covers are used to protect a large storage pile.

(9) All fire protection equipment should be in service and ready for immediate use.

(10) A fire watch should be maintained, equipped with a portable extinguisher, during these operations and for not less than one hour following the completion of open flame operation.
6-5 Waste Disposal. Rubbish, trash, and other waste material should be disposed of at regular intervals. Approved waste cans with self-closing covers are recommended where needed. No open fires or incinerator operations are to be permitted within 100 ft (30.5 m) of any cotton storage building. (For additional details see NFPA 82, Standard on Incinerators, Waste and Linen Handling Systems and Equipment.)

6-6 Smoking. Smoking should be strictly prohibited, except in locations prominently designated as safe smoking areas. "No Smoking" signs should be conspicuously posted in prohibited areas.

NOTE: Cooperation of employees is more easily secured when a reasonable policy of control of smoking is adopted, with smoking permitted in specified locations, where there is little hazard, at specified times and under suitable supervision. Complete prohibition is likely to lead to surreptitious smoking in out of the way places where the hazard is most serious.

Appendix A

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

Table A-1-3

Typical Cotton Bale Types and Approximate Sizes

<table>
<thead>
<tr>
<th>Bale Type</th>
<th>Dimensions (in. x in. x in.)</th>
<th>Avg. Wt. (lb)</th>
<th>Avg. Volume (ft³)</th>
<th>Density (lb/ft³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gin Flat</td>
<td>55 x 45 x 28 (1397 x 1143 x 711)</td>
<td>500 (226.8)</td>
<td>40.1 (1.13)</td>
<td>12.5 (201)</td>
</tr>
<tr>
<td>Modified Gin Flat</td>
<td>55 x 45 x 24 (1397 x 1143 x 610)</td>
<td>500 (226.8)</td>
<td>34.4 (0.97)</td>
<td>14.5 (234)</td>
</tr>
<tr>
<td>Compressed Standard</td>
<td>57 x 29 x 23 (1448 x 736 x 594)</td>
<td>500 (226.8)</td>
<td>22.0 (0.62)</td>
<td>22.7 (366)</td>
</tr>
<tr>
<td>Gin Standard</td>
<td>55 x 31 x 21 (1397 x 787 x 533)</td>
<td>500 (226.8)</td>
<td>20.7 (0.58)</td>
<td>24.2 (391)</td>
</tr>
<tr>
<td>Compressed Universal</td>
<td>58 x 25 x 21 (1473 x 635 x 533)</td>
<td>500 (226.8)</td>
<td>17.6 (0.50)</td>
<td>28.4 (454)</td>
</tr>
<tr>
<td>Gin Universal</td>
<td>55 x 26 x 21 (1397 x 660 x 533)</td>
<td>500 (226.8)</td>
<td>17.4 (0.49)</td>
<td>28.7 (463)</td>
</tr>
<tr>
<td>Compressed High-Density</td>
<td>58 x 22 x 21 (1473 x 559 x 533)</td>
<td>500 (226.8)</td>
<td>15.5 (0.44)</td>
<td>32.2 (515)</td>
</tr>
</tbody>
</table>
Figure A-6-7 (a)

LOSS PREVENTION SELF-INSPECTION FORM
FOR BALE FIBER STORAGE

WAREHOUSE NO. | COMPARTMENT NO.
--- | ---

GENERAL HOUSEKEEPING

<table>
<thead>
<tr>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
</table>

1. Inside Buildings.
   a) Floor and docU areas clean of loose cotton and trash?
   b) Covered metal containers for loose cotton and trash?

2. Outside Buildings.
   a) Surrounding areas free of dried grass, weeds, and combustible trash?

SMOKING

<table>
<thead>
<tr>
<th>Evidence of smoking in unauthorized areas?</th>
</tr>
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<tbody>
<tr>
<td>Yes</td>
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<table>
<thead>
<tr>
<th>Signs posted and readily visible?</th>
</tr>
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<tbody>
<tr>
<td>Yes</td>
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</table>

ELECTRICAL EQUIPMENT

<table>
<thead>
<tr>
<th>Extension cords prohibited?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>Storage in contact with lights or wiring?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Wiring properly supported and undamaged?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Circuits properly fused?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>All panels, junction, switch, and receptacle boxes covered?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

MECHANICAL EQUIPMENT

<table>
<thead>
<tr>
<th>Listed for fiber storage (Type DS, DY, ES, EX, GS, or LPS)?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Spark retardant mufflers maintained?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Refueled outside at designated area?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Stored outside when idle?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>General condition and maintenance good?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

BUILDINGS

<table>
<thead>
<tr>
<th>Fire walls in good repair, including around fire door openings?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fire doors in proper working condition and tested for ease of closing each week? (Overhead, roll-type doors should be tested at least annually.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Fire door guards in place and maintained?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Floor and exterior walls in good repair?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Exterior wall openings have doors and windows in place that will close properly and lock?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
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</table>

<table>
<thead>
<tr>
<th>Space under grade floor, if any, closed off?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
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</tbody>
</table>

STORAGE ARRANGEMENTS

<table>
<thead>
<tr>
<th>Storage Blocks.</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Within prescribed height (16 ft.)?</td>
</tr>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>b) Sprinkler heads unimpaired (18 in. clearance)?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>c) Block sizes limited to 700 bales pressed or 350 flat?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>d) Tied storage, stable and secure?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
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</table>

<table>
<thead>
<tr>
<th>aisles.</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) At least one main aisle 12 ft. or more in width?</td>
</tr>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>b) Cross or work aisles at least 4 ft. in width?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>c) Any damaged bales, broken bands or wet stock?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

PIECE DEPARTMENT

<table>
<thead>
<tr>
<th>Fire number prominently displayed at each phone?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Personnel instructed on procedure in case of fire?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
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</table>

WATCH SERVICE

<table>
<thead>
<tr>
<th>Making regular rounds?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>All key stations punched?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Records checked, dated and filed?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

FIRE ALARM SERVICE

<table>
<thead>
<tr>
<th>Automatic fire alarm system in service?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Manual pull stations clearly marked and accessible?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Date last tested?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

MANUAL FIEXQUISHING EQUIPMENT PORTABLE FITTINGHISERS

<table>
<thead>
<tr>
<th>Hand units.</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Properly distributed?</td>
</tr>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>b) Kept full?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>c) Two buckets per barrel?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Barrels and Buckets.</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Properly placed and accessible?</td>
</tr>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>b) Recharged within the last year?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>c) All in good condition?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

BARREL EQUIPMENT

<table>
<thead>
<tr>
<th>Properly placed and protected from damage?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Charged and ready for service?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

INSECT HOG

<table>
<thead>
<tr>
<th>Hose and nozzle attached to each?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rack and in good condition?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Easily accessible and ready for use?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Valves operate readily?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

YARD HYDRANTS AND WISE HOUSES

<table>
<thead>
<tr>
<th>Yardly accessible?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hose racked or reel and in good condition?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Nozzles, spanners, hydrant wrench available?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hydrants operable?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>General condition: Good Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

REMARKS (Report any unusual conditions and action taken):

Report by: Date:

Figure A-6-7 (b)

SELF-INSPECTION FORM FOR AUTOMATIC SPRINKLERS IN BALE FIBER WAREHOUSES

WAREHOUSE NO. | COMPARTMENT NO.
--- | ---

VALVE INSPECTIONS

<table>
<thead>
<tr>
<th>Inspect locked or supervised valves at least monthly, and all unlocked valves at least weekly. Valves should be completely closed and opened at least once each year; to assure ease of control and operation. This applies to all valves, inside and outside, as well as valves in pits controlling water supplies.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>No. Valve Location</th>
<th>Area Controlled</th>
<th>Open</th>
<th>Shut</th>
<th>Locked</th>
<th>Sealed</th>
</tr>
</thead>
</table>

NO. Valve Location | Area Controlled | Yes | No |
--- | --- | --- |

<table>
<thead>
<tr>
<th>Valve inspections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Valve closets heated?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Accelerators in service?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Any sprinkler heads missing?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Low point drained?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Any sprinkler heads missing?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>All risers accessible?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

WATER SUPPLIES

<table>
<thead>
<tr>
<th>Valves from city open?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fire Dept. Conn. accessible?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gravity or Ground Tanks found full?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>If not, was it filled?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tank heater operating properly?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Water temp.?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

FIRE PUMP

<table>
<thead>
<tr>
<th>Turned over weekly?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Today?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>In good condition?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Auto. control tested?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fuel tank full?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pump room well ventilated and safely heated?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Priming tank full?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Battery charger operating?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Battery water level?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Battery hydrometer reading?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Any delay in starting, picking up suction, or other problems?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Remarks (explain any deficiencies or problems):</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remarks (Express all unusual conditions and action taken):</td>
</tr>
</tbody>
</table>

Report by: Date:

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Appendix B
Suggestions for Fighting Fires in Baled Cotton

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

B-1 Introduction

The information contained herein is a summary of knowledge gained over the years by cotton warehousemen, fire fighters, and insurance authorities in fighting fires in the Cotton Belt.

A baled cotton fire has its own peculiarities which should be understood and respected if a large loss is to be avoided with minimum danger to personnel. Automatic sprinklers, if properly designed and supplied, can be expected to control a baled cotton fire where storage methods outlined in this recommended practice are followed, but extinguishment should not be expected.

The primary rule for any fire is to always call the responding fire department first. Fighting fires of any type is a profession in itself and, even with a well-trained private fire organization, professional aid should be effected as soon as possible and plant personnel should not be unduly exposed to the peril.

The myriad of small fibers that make up a cotton bale, especially a naked bale or one wrapped in burlap, and cover its surface, offer a highly visible source of ignition as well as the potential for a rapid flame spread, known as "flash-over." The flash-over is usually followed by a slower flame spread at the surface, then tenacious burning into the pile between bales and penetration of the interiors of individual bales. High density bales are less vulnerable to a burrowing fire, but the consideration should not be ignored.

B-2 Causes.

Some of the causes of cotton fiber fires are variously listed as from the breaking of metal bands (ties) striking other metallic objects, resulting sparks, fire-packed bales, electrical faults, mechanical equipment (defective lift trucks), friction (bale ties rubbing together, railroad boxcars), lightning, cutting and welding, and smoking. Sparks from bale ties and fire-packed bales appear to be the most prominent fire cause. Incandescence and exposures are also a consideration.

B-3 Incipient Stage.

If caught in the incipient stage, control can often be effected provided the proper procedures are followed. Portable extinguishing equipment, such as casks and pails, or pressurized or pump-type water units, may be used to quickly wet the exterior of the bale down.

Should small extinguishers not do the job, the use of portable wheeled "wetting agent" tanks or standpipe hose or both should then be used. The last resort would be hose streams from outside hydrants. Extreme caution should be exercised when using straight hose streams as the force of the stream may scatter the burning wads or portions of cotton over a wide area. Spray or fog nozzles are recommended, but, if not available, it may be possible to deflect a solid stream off the walls, roof, or other solid objects.

Once the exterior of the bale or bales are well wet down and fire suppressed, the bales involved should then be removed to an outside, safe location for final extinguishment. (Caution: an obviously burning bale should never be dragged or mechanically moved down aisles as this will likely spread the fire to bales bordering the aisle. (See Salvage Operations, Section B-9)

B-4 Active Stage in Sprinklered Buildings.

Should a fire get well beyond the incipient stage, or involve more than a few bales and further fire spread is likely, the building may readily prove untenable and dense smoke could quickly obscure vision. It is best then to have all personnel vacate the building to a point of safety. As drafts, including early venting across-draft. Also, try to open only the door on the lee side and not the windward side of the building.

B-5 Sprinkler Failure.

If the sprinkler system fails to maintain fire control, then hose streams should be used, preferably through door openings only large enough for the hose.

When it is apparent that the fire is beyond the control of the sprinklers, and the building is nearing the point of collapse, the control valve(s) to the sprinkler systems in the building section involved should be shut off to conserve water for hose stream use.

B-6 Active Stage in Nonsprinklered Buildings.

Immediately on arrival at the fire, see that all openings are closed to the compartment involved.

Have ready as many hose lines as possible, preferably supplied with a wetting agent.

Open doors only enough to allow the use of the hose in a spray-like fashion. Caution should be exercised to open these doors slowly, so as to minimize the chance of an explosion. Do not open doors on opposite sides of the compartment, permitting a cross-draft. Also, try to open only the door on the lee side and not the windward side of the building.

B-7 Cotton Yard Fires.

Conditions are not as controllable as in a warehouse as draft conditions are almost entirely dependent upon the climatic conditions at the time of the fire; and if an adverse wind prevails, a small involvement might easily become a catastrophe. Here, especially, preplanning is important and the following conditions prevailing upon arrival should dictate what immediate steps to take.

(1) Utilize, if available, fire department connection to the hydrants.

(2) Lay out hose lines.

(3) Using divided stream nozzles, apply water ahead and downwind of the fire, then work towards the fire.

(4) Look for fire under the bales and dunnage.

(5) Be alert for flying sparks.

(6) Remove the uninvolved cotton nearby to make a fire break.

(7) Remove burned cotton to segregated area.

B-8 After Watch.

When the fire-involved cotton has been removed leaving behind undamaged stock, a minute and unobserved spark will often cause a rekindling of the previous fire with disastrous results. Inspect and carefully clean up the involved area. Maintain hose lines and fire department watch until the area is known to be safe. Before leaving scene of fire, advise responsible plant personnel that After Watch should be kept for at least 24 hours. One of the most disastrous fires would possibly have been prevented with adequate After Watch following a minor involvement.

B-9 Salvage Operations.

Salvage is important and every precaution should be taken to protect the salvage. The usual violence of a fire in a cotton warehouse, along with the appearance of the charred bales, is misleading with regards to the amount of remaining salvage.

Water will not damage cotton and if the charred bales are kept cool with hose streams until proper salvage operation is begun, the amount of the loss can be reduced substantially.

After the fire is brought under control all bales involved should be removed to a safe outside location as quickly as possible and practicable. Then each bale must be handled individually in order to effect complete extinguishment. This is best accomplished by use of small hose lines or barrels and buckets, using a wetting agent known as "wet water." WARNING: DO NOT REMOVE THE BANDS OR WIRES FROM THE BALES. To do so will expose more lint to fire and the loss of the entire bale.

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Salvage crews should be ready to move the cotton out of the involved shed as rapidly as possible. Extreme caution should be exercised in preparing and watching the path along which the burning bales are removed from the involved shed. Burning fibers of cotton are easily blown from the bale, especially in the haste and excitement of moving the bales outside. It may be necessary to move the uninvolved bales back away from the exit route (or from the entire compartment), or even make a hole in the side of the compartment. Spreading fire with burning bales along the exit route is not uncommon. The burning bales should be wetted down and moved to a safe, segregated place as soon as possible for individual attention.

Steps in the Salvage Operation:
(1) Select an open area, without exposures, to move the burning bales.
(2) Have a salvage crew stationed at this yard.
(3) Have a good supply of wetting agent on hand.
(4) Have a good supply of water on hand.
(5) Have casks and pails, and stirrup pump-type extinguishers on hand, filled with wet water.
(6) Wet the burning bales down and remove them from the fire area as soon as possible. Place them about 3 ft (0.9 m) apart, in an open area away from other exposures.
(7) Care must be exercised in removing these bales so as not to start another fire along the way. If the side of the compartment is metal-clad or frame, it may be best to remove a portion of the side, through which the cotton may be removed. Some warehouse personnel take time to remove cotton from the compartments through which the burning will travel, before salvage operations are permitted to start. If there is any question about additional exposures, remove them, if possible, before moving the burning bales.
(8) Knock down any outside blaze on the bale. Apply the wet water to each smoldering spot on the bale. Often a hand full of cotton soaked in the wet water may be applied directly on or in the smoldering spot. Cotton fires burrow into the bale, so it will be necessary to apply the wet water as far into the hole as possible, soaking the area thoroughly. In order to be sure the fire is out, remove the burned cotton from each hot spot, while applying wet water to the hole. When the area around the spot is no longer warm, it may be assumed that the fire has been extinguished.
(9) Do not remove the bands from the bales. To do so will expose more lint to the fire and the bale will probably be a complete loss.
(10) Bales involved in a fire should be closely watched for at least five days after the last spark is thought to have been extinguished.

B-10 Fire-Packed Bales

During the cotton ginning operation, sparks, caused by stones, metal, or other foreign objects in the seed cotton striking metal parts of the gin, can ignite the fibers. Occasionally a fire immediately erupts, and often the smoldering lint will be carried on to the press box where it will be packed, undetected, into the bale. Usually the fire burns through to the outside of the bale within a few hours, but may remain undetected for several days. Sometimes the odor is noticeable or the bale may feel excessively warm.

These bales are known as "fire-packed bales," and are a prominent cause of fires in baled cotton.

The recommended procedure for handling and extinguishing fire-packed bales is as follows:
(1) All known or suspected fire-packed bales should be stored in the open and segregated from buildings and other storage. They should be separated about 3 ft (0.9 m) from other such bales.
(2) These bales should be under constant surveillance to detect the fire as soon as it comes to the surface.
(3) A supply of an approved type wetting agent and at least one stirrup pump should be on hand at all times.
(4) When fire is detected, the area around the hot spot should immediately be wetted to prevent the spread of the fire. The hot spot should then be saturated with wet water. The burned cotton should be removed by hand, while constantly applying water to the hole. This procedure should be continued until no warm areas are detected. It is not uncommon for several fires to be packed into a single bale.

Note: There is no set time after which a fire may be considered extinguished in a bale, as this depends on the thoroughness of extinguishment. However, five days after the fire is thought to have been extinguished is generally considered to be a "rule of thumb" safe period.

Appendix C Referenced Publications

C-1 This portion of the Appendix lists publications referenced within this NFPA document... and thus is considered part of the recommendations of the document.

C-1.1 NFPA Publications. The following publications are available from the National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

NFPA 10-1981, Standard for Portable Fire Extinguishers
NFPA 13-1983, Standard for the Installation of Sprinkler Systems
NFPA 13A-1981, Recommended Practice for the Care and Maintenance of Sprinkler Systems
NFPA 13E-1979, Recommendations for Fire Department Operations in Properties Protected by Sprinkler and Standpipe Systems
NFPA 14-1983, Standard for the Installation of Standpipe and Hose Systems
NFPA 18-1979, Standard on Wetting Agents
NFPA 24-1981, Standard for Installation of Private Fire Service Mains and Their Appurtenances
NFPA 30-1981, Flammable and Combustible Liquids Code
NFPA 50-1979, Standard for the Storage and Handling of Liquefied Petroleum Gases
NFPA 70-1981, National Electrical Code
NFPA 71-1982, Standard for the Installation, Maintenance and Use of Central Station Signaling Systems
NFPA 72A-1979, Standard for the Installation, Maintenance and Use of Local Protective Signaling Systems for Guard's Tour, Fire Alarm, and Supervisory Service
NFPA 72B-1979, Standard for the Installation, Maintenance and Use of Auxiliary Protective Signaling Systems for Fire Alarm Service
NFPA 72C-1982, Standard for the Installation, Maintenance and Use of Remote Station Protective Signaling Systems
NFPA 72D-1979, Standard for the Installation, Maintenance and Use of Proprietary Protective Signaling Systems
NFPA 72E-1982, Standard on Automatic Fire Detectors
NFPA 80A-1980, Recommended Practice for Protection of Buildings from Exterior Fire Exposures
NFPA 220-1979, Standard on Types of Building Construction
NFPA 231-1980, Standard for Indoor General Storage
NFPA 231C-1980, Standard for Rack Storage of Materials
NFPA 231D-1980, Standard for Storage of Rubber Tires
NFPA 251-1979, Standard Methods of Fire Tests of Building Construction and Materials
NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates explanatory material on that paragraph in Appendix A.

Information on referenced publications can be found in Appendix C.

Chapter 1 Introduction

1-1 Scope.

1-1.1 This standard applies to the storage of roll paper when stored in buildings or structures.

1-1.2* The provisions contained in this standard apply to new facilities for roll paper storage and when converting existing buildings to roll paper storage occupancy. They may be used as a basis for evaluating existing storage facilities.

1-1.3 This standard does not apply to:

1-1.3.1 Horizontal Storage.

1-1.3.2 Storage under 10 ft (3 m) in height. For storage under 10 ft (3 m) in height, see NFPA 13, Standard for the Installation of Sprinkler Systems.

1-1.3.3 Storage in unsprinklered buildings and structures.

1-1.3.4 Storage on racks. (See NFPA 231C, Standard for Rack Storage of Materials).

1-1.3.5 Incidental storage.

1-1.3.6* Storage of lightweight paper and tissue.

1-1.3.7* Storage in buildings or structures with roofs or ceilings greater than 30 ft (9 m) high.

1-1.3.8 Storage of waxed paper, synthetic paper, encapsulated rolls and palletized roll storage other than a single floor pallet or raised floor platform.

1-2 Purpose. The purpose of this standard is to provide a reasonable degree of protection for the storage of roll paper when stored in buildings or structures through installation requirements based upon sound engineering principles, test data and field experience. Nothing in this standard is intended to restrict new technologies or alternate arrangements providing the level of safety prescribed by the standard is not lowered.

1-3 Definitions.

Approved. Acceptable to the "authority having jurisdiction."

NOTE: The National Fire Protection Association does not approve, inspect or certify any installations, procedures, equipment, or materials nor does it approve or evaluate testing laboratories. In determining the acceptability of installations or procedures, equipment or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization concerned with product evaluations which is in a position to determine compliance with appropriate standards for the current production of listed items.

Array.

Closed Array. A vertical storage arrangement where the distances between columns in both directions is small (not more than 2 in. (50 mm) in one direction and 1 in. (25 mm) in the other).

Standard Array. A vertical storage arrangement where the distance between columns in one direction is small (1 in. (25 mm) or less).

Note: The occasional presence of partially used rolls on top of columns of otherwise uniform diameter rolls will not appreciably affect the burning characteristics.

Open Array. A vertical storage arrangement where the distance between columns in both directions is large (all vertical arrays other than closed or standard).
Authority Having Jurisdiction. The "authority having jurisdiction" is the organization, officer, 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 organization such as a fire chief, fire marshal, chief of a fire prevention bureau, labor department, health department, building official, 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 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."

Banded Storage. Rolls provided with a circumferential steel strap (3/8 in. (9.5 mm) or wider) at each end of the roll.

Clearance. The distance from the top of storage to ceiling sprinkler deflectors.

Column. A single vertical stack of rolls.

Core. The central tube about which paper is wound to form a roll.

Encapsulated. A method of packaging consisting of a plastic sheet completely enclosing the sides and top of roll paper.

Exfoliation. The characteristic of paper wound in rolls to separate in sheets when one side of the roll is cut either mechanically or by burning.

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.

Paper (general term). The name of all kinds of felted sheets made from natural fibrous materials, usually vegetable but sometimes mineral or animal and formed on a fine wire screen from water suspension.

Rack Storage. Any combination of vertical, horizontal or diagonal members that can support roll paper storage. Racks may be fixed or portable.

Shall. Indicates a mandatory requirement.

Should. Indicates recommendations or that which is advised but not required.

Sprinklers.

Sprinkler Orifice Size. A 1/2 in. (12.7 mm) sprinkler orifice size a nominal 1/2 in. (12.7 mm) orifice, a large orifice sprinkler has a nominal 17/32 in. (13.5 mm) orifice, and a large drop sprinkler has a nominal 0.64 in. (16.3 mm) orifice.

Sprinkler Temperature Rating. A 150°F (65°C) rating includes temperature ratings between 135°F (57°C) and 175°F (79°C) and 280°F (137°C) rating includes temperature ratings between 250°F (121°C) and 300°F (149°C).

Storage. Horizontal Storage. Rolls stored with the cores in the horizontal plane (on-end storage).

Incidental Storage. Roll paper that occurs in areas such as manufacturing, shipping, receiving or general warehouses which by virtue of small quantities or storage configuration does not present a hazard beyond the capabilities of the existing sprinkler protection.

Storage Height. The maximum vertical distance above the floor at which roll paper is normally stored.

NOTE: The size of rolls and limitations of mechanical handling equipment must be considered in determining maximum storage height.

Vertical Storage. Rolls stored with the cores in the vertical plane (on-end storage).

Wrapped Storage.* Rolls provided with a complete heavy kraft covering around both sides and ends.

Weight of Paper.* (See A-2)

1-4 Units. Metric units of measurement in this standard are in accordance with the modernized metric system known as the International System of Units (SI). One unit (1 liter) outside of but recognized by SI, is commonly used in international fire protection. For conversions and information, see ASTM E380, Standard for Metric Practice.

1-4.1 If a value for measurement as given in this standard is followed by an equivalent value in other units, the first stated is to be regarded as the requirement. A given equivalent value may be approximate.

1-4.2 The conversion procedure for the SI units has been to multiply the quantity by the conversion factor and then round the result to the appropriate number of significant digits.

Chapter 2* Classification of Roll Paper

NOTE: The following classes were derived from a series of large-scale and laboratory-type small-scale fire tests. It is recognized that not all paper in a class will burn with exactly the same characteristics. Presence of a properly applied wrapper has the effect of changing the class of a given paper excluding tissue to essentially that of the wrapper material.

2-1 Heavy Weight Class. Includes paperboard and paper stock having a basis weight (weight per 1,000 sq ft (93 m²)) of 20 lb (9.1 kg) or greater.

2-2 Medium Weight Class. Includes the broad range of papers having basis weight (weight per 1,000 sq ft (93 m²)) from 10 lb (4.5 kg) to 20 lb (9.1 kg).

2-3 Light Weight Class. Includes all papers and tissues having a basis weight (weight per 1,000 sq ft (93 m²)) less than 10 lb (4.5 kg).

2-4 Tissue Class. Includes the broad range of papers of characteristic gauzy texture, in some cases fairly transparent. For purposes of this standard, tissue is to mean the soft absorbent type regardless of basis weight. Specifically, crepe wadding and the sanitary class including facial tissue, paper napkins, bathroom tissue and toweling.

Chapter 3 Building Construction

3-1 Construction.

3-1.1* Buildings used for storage of materials which are stored and protected in accordance with this standard may be of any of the types described in NFPA 220, Standard on Types of Building Construction.

3-1.2 Adequate access shall be provided to all portions of the premises for fire fighting purposes.

3-2* Emergency Smoke and Heat Venting. Protection outlined in this standard applies to buildings with or without roof vents and draft curtains.

3-3* Structural Steel Protection. Protection outlined in this standard applies to buildings with or without fireproofing or other modes of steel protection except as modified by 4-2.2.

Chapter 4 Storage Arrangement

4-1 Piling Procedures and Precautions. Floor load design shall take into account the added weight of water which could be absorbed during fire fighting operations by certain commodities such as tissue, newsprint and corrugating medium.

4-2 Commodity Clearance.

4-2.1 The clearance between top of storage and sprinkler deflectors shall conform to NFPA 13, Standard for the Installation of Sprinkler Systems, except as modified by this standard.

4-2.2 If the commodity is stored above the lower chord of roof trusses, at least 1 ft (0.3 m) clear space shall be maintained to permit wetting of the truss unless the truss is protected with one-hour fireproofing.

4-2.3 Storage clearance from ducts shall be maintained in accordance with NFPA 91, Section 240, Standard for the Installation of Blower and Exhaust Systems for Dust, Stock and Vapor Removal or Conveying.
5-1 Automatic Sprinkler Systems.

5-1.1 Sprinkler systems installed in buildings or structures used for the storage of roll paper shall be in accordance with NFPA 13, the Standard for Installation of Sprinkler Systems, except as modified by this chapter.

5-1.2* Sprinkler design criteria for vertical storage of roll paper 10 ft (3 m) high and higher in buildings or structures with roofs or ceilings up to 30 ft (9 m) shall be in accordance with Figure 5-1.2. For storage height see 1-2 Definitions.

5-1.3 The minimum discharge pressure from any sprinkler in the design area shall not be less than 15 psig (105 kPa).

5-1.4 The 17/32 in. (13.5 mm) nominal orifice sprinkler shall be the minimum size sprinkler used for new installations.

5-1.5* 231°F (110°C) temperature rated sprinkler heads shall be used for installations protecting roll paper stored 15 ft (4.5 m) or higher.

5-1.6 The protection area per sprinkler shall not exceed 100 sq ft (9.3 m²) or be less than 70 sq ft (6.5 m²).

5-1.7 In buildings which are occupied in part for vertical roll paper storage, and only a portion of the sprinkler system is hydraulically designed, the design area shall extend not less than 20 ft (6 m) beyond the area occupied by the roll paper storage.

5-1.8 Where dry pipe systems are used, the areas of operation indicated by the area curves shall be increased by 30 percent.

5-2 High Expansion Foam.

5-2.1 When high expansion foam systems are installed in addition to automatic sprinklers, they shall be installed in accordance with NFPA 11H, the Standard for Medium and High Expansion Foam Systems, except as modified by this chapter.

5-2.2 When high expansion foam systems are installed, sprinkler discharge design density can be reduced to not less than 0.25 gpm/sq ft ([0.9 L/min/m²]) with a minimum operating area of 2,000 sq ft (186 m²).

5-2.3 High expansion foam systems shall be automatic in operation.

5-3 Water Supplies.

5-3.1 Water supplies shall be capable of delivering the total demand of sprinklers plus hose streams plus high expansion foam systems where provided for a minimum of 2 hours.

5-3.2 At least 500 gpm (1893 L/min) shall be added to the sprinkler demand for large and small hose stream demand.

5-4 Manual Inside Protection.

5-4.1 Small Hose Systems. Small hose lines (1 1/2 in.) shall be available to reach all portions of the storage area.

5-4.2 Portable Fire Extinguishers. Portable fire extinguishers shall be provided in accordance with NFPA 10, the Standard for Portable Fire Extinguishers. Up to one-half of the required complement of portable fire extinguishers for Class A fires may be omitted in storage areas where fixed, 1 1/2 in. hose lines are available to reach all portions of the storage area. Also see NFPA 14, Standard for the Installation of Standpipe and Hose Systems.

5-5 Hydrants. At locations without public hydrants, or where hydrants are not within 250 ft (75 m), private hydrants shall be installed in accordance with NFPA 24, Standard for Private Fire Service Mains and Their Appurtenances.

5-6 Fire Organization.

5-6.1 Arrangements shall be made to permit rapid entry into the premises by the municipal fire department, police department, or other authorized personnel in case of fire or other emergency.

5-6.2 Plant emergency organizations where provided shall be instructed and trained in the following procedures:

(a) Maintaining the security of the premises.
(b) Means of summoning outside aid immediately, in an emergency.
(c) Use of hand extinguishers and small (1 1/2 in.) hose lines on incipient fires and mop-up operations.
(d) Operation of sprinkler system and water supply equipment.
(e) Use of material handling equipment while sprinklers are operating to effect final extinguishment.
(f) Supervision of sprinkler valves after system is turned off so that system can be reactivated if rekindling occurs.
(g) Employee safety during firefighting and mop-up operations, including knowledge of the hazard potential of roll paper, i.e. collapse and tumbling.
(h) Operation of foam systems and appropriate safety and evacuation procedures.

NOTE: Information on emergency organization is given in the following publications:

NFPA 604, Recommended Practice on Salvaging Operations.
5-6.3 A fire watch shall be maintained when the sprinkler system is not in service.

5-7* Alarm Service. Central station, auxiliary, remote station, or proprietary sprinkler waterflow alarm shall be provided. Local waterflow alarm may be acceptable where standard recorded guard service is provided. (See NFPA 71, Standard for the Installation, Maintenance and Use of Central Station Signaling Systems; NFPA 72A, Standard for the Installation, Maintenance and Use of Local Protective Signaling Systems; NFPA 72B, Standard for the Installation, Maintenance and Use of Auxiliary Protective Signaling Systems; NFPA 72C, Standard for the Installation, Maintenance and Use of Remote Station Protective Signaling Systems; and NFPA 72D, Standard for the Installation, Maintenance and Use of Proprietary Protective Signaling Systems.)

Appendix A

This appendix is not part of the requirements of this NFPA Standard, but is included for information purposes only.

A-1-1.2 Existing Storage Facilities. Sprinkler systems protecting existing roll paper storage facilities may be evaluated in accordance with Figure A-1-1.2.

A-1-1.3.1 Sprinkler design criteria for horizontal storage of roll paper from 10 ft to 30 ft (3 m to 9 m) high in buildings or structures with roof or ceilings up to 35 ft (10.5 m) should be in accordance with Figure A-1-1.2, Closed Array.

A-1-1.3.6 Protection requirements for soft lightweight tissue paper have not been clearly defined by the large scale fire tests conducted to date. Fire tests have been conducted on 20 ft (6 m) vertical storage of tissue with 10 ft (3 m) clear space to ceiling in piles extending to six columns in either direction. In these tests, target columns of tissue were located directly across an 8 ft (2.4 m) aisle from the main pile. 17/32 in. 28°F (13.5 mm, 141°C) sprinklers were used on a 100 sq ft (9.3 m²) spacing with constant pressures of 14 psi, 60 psi, and 95 psi (97, 414 and 655 kPa respectively). The significant characteristic of these fire tests was the rapid initial fire spread across the surface of the rolls. Ceiling temperatures were controlled at the higher pressures but the extent of fire spread within the pile could not be clearly established. Aisle jump was experienced except at the 95 psi pressure (655 kPa). Water absorption and pile instability caused pile collapse in all tests. This characteristic must be considered when manually attacking a fire in tissue storage occupancies. A summary of these fire tests can be found in Appendix B. Available fire experience in roll tissue storage occupancies does not correlate well with the full scale fire tests regarding number of sprinklers operating and extent of fire spread. Thirteen fires reported in storage occupancies ranging from 10 to 20 ft (3 to 6 m) high and protected by wet pipe sprinkler systems ranging from ordinary to extra hazard to 0.6 gpm per ft sq (12.4L/m²/min) design densities were controlled with an average of 17 sprinkler heads. The maximum number of wet pipe sprinkler heads opening was 45 and the minimum was 5 vs. 88 and 26 respectively in the tests. One fire in tissue storage protected by a dry pipe system opened 143 sprinklers but was reported as controlled.

A-1-1.3.7 Sprinkler design criteria for vertical storage of roll paper from 10 ft to 30 ft (3 to 8 m) high in buildings or structures with roofs or ceilings up to 35 ft (10.5 m) should be in accordance with Figure A-1-1.2

Wrapped Storage. Rolls which are completely protected with a heavyweight kraft wrapper both sides and ends will have a reduced degree of fire hazard. Standard methods for wrapping and capping rolls are outlined in Figure A-1-2.

In some cases, rolls are protected with laminated wrappers using two sheets of heavy kraft with a high temperature wax laminate between. When applying this standard, the overall weight of wax laminated wrappers should be based on the basis weight per 1000 sq ft (91 m²) of the outer sheet only rather than the combined basis weight of the outer and inner laminated wrapper sheets combined. The presence of a properly applied wrapper can have the effect of changing the class of a given paper to essentially that of the wrapper material.

<table>
<thead>
<tr>
<th>Storage Height (ft)</th>
<th>Clearance (ft)</th>
<th>Closed</th>
<th>Banded</th>
<th>Unbanded</th>
<th>Banded</th>
<th>Unbanded</th>
<th>Closed</th>
<th>Banded or Unbanded</th>
<th>Banded</th>
<th>Standard</th>
<th>Banded or Unbanded</th>
<th>Open Banded or Unbanded</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>&gt;5</td>
<td>.3/2000</td>
<td>.3/2500</td>
<td>.3/3000</td>
<td>.45/3500</td>
<td>.45/4000</td>
<td>.3/2500</td>
<td>.45/4000</td>
<td>.45/4000</td>
<td>.45/4000</td>
<td>.45/4000</td>
<td>.45/4000</td>
</tr>
<tr>
<td>25</td>
<td>5</td>
<td>.45/2500</td>
<td>.45/3000</td>
<td>.45/3500</td>
<td>.6/2500</td>
<td>.6/3000</td>
<td>.6/2500</td>
<td>.6/3000</td>
<td>.6/2500</td>
<td>.6/2500</td>
<td>.6/2500</td>
<td>.6/2500</td>
</tr>
<tr>
<td>25</td>
<td>&gt;5</td>
<td>.45/3000</td>
<td>.45/3500</td>
<td>.45/4000</td>
<td>.6/3000</td>
<td>.6/3500</td>
<td>.6/3000</td>
<td>.6/3500</td>
<td>.6/3500</td>
<td>.6/3500</td>
<td>.6/3500</td>
<td>.6/3500</td>
</tr>
<tr>
<td>30</td>
<td>5</td>
<td>.6/2500</td>
<td>.6/3000</td>
<td>.6/3000</td>
<td>.6/3500</td>
<td>.6/4000</td>
<td>.6/3500</td>
<td>.6/4000</td>
<td>.6/4000</td>
<td>.6/4000</td>
<td>.6/4000</td>
<td>.6/4000</td>
</tr>
</tbody>
</table>

Figure A-1-1.2

NOTE: Densities and/or areas may be interpolated between any 5 ft storage height increment.

231F 231F
weight per 1,000 sq ft for papers measured on a sheet of different area. To determine the basis weight per 1,000 sq ft for papers measured on a sheet of different area, apply the following formula:

\[
\text{Basis weight per 1,000 sq ft} = \frac{\text{Basis weight} \times 1,000}{\text{Measured area}}
\]

Example: Determine the basis weight per 1,000 sq ft of 16 lb bond paper.

16 lb  X 1,000 = 12.3 lb/1,000 sq ft
1,300 sq ft

Large and small scale fire tests indicate that the burning rate of paper varies with the basis weight. Heavyweight paper burns slower than lightweight paper. Full scale roll paper fire tests were conducted with the following types of paper:

- Linerboard - 42 lb/1,000 sq ft Nominal Basis Weight
- Newsprint - 10 lb/1,000 sq ft Nominal Basis Weight
- Tissue - 5 lb/1,000 sq ft Nominal Basis Weight

The rate of fire spread over the surface of the tissue rolls was extremely rapid in the full scale fire tests. The rate of fire spread over the surface of the linerboard rolls was relatively slower. Based on the overall results of these full scale tests along with additional data from small scale testing of various paper grades, the broad range of papers have been classified into three major categories as follows:

- Heavy Weight - Basis weight of 20 lb per 1000 sq ft or greater.
- Medium Weight - Basis weight of 10 lb to 20 lb per 1000 sq ft.
- Light Weight - Basis weight of less than 10 lb per 1000 sq ft.

The various types of papers normally found in each of the three major categories are illustrated in the following table:

<table>
<thead>
<tr>
<th>Paper Classes</th>
<th>HEAVYWEIGHT</th>
<th>MEDIUM WEIGHT</th>
<th>LIGHTWEIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linerboards</td>
<td>Bond &amp; Reproduction</td>
<td>Medium</td>
<td>Vellum</td>
</tr>
<tr>
<td>Kraft Roll Wrappers</td>
<td>Offset</td>
<td>Toilet Tissue</td>
<td>Medium</td>
</tr>
<tr>
<td>Milk Carton Board</td>
<td>Tablet</td>
<td>Towel Tissue</td>
<td>Medium</td>
</tr>
<tr>
<td>Folding Carton Board</td>
<td>Computer</td>
<td>Carbonizing Tissue</td>
<td>Medium</td>
</tr>
<tr>
<td>Bristol Board</td>
<td>Envelope</td>
<td>Cigarette</td>
<td>Medium</td>
</tr>
<tr>
<td>Tag</td>
<td>Book</td>
<td>Fruit Wrap</td>
<td>Medium</td>
</tr>
<tr>
<td>Vellum Bristol Board</td>
<td>Label</td>
<td>Onion Skin</td>
<td>Medium</td>
</tr>
<tr>
<td>Index</td>
<td>Magazine</td>
<td>Magazines</td>
<td>Medium</td>
</tr>
<tr>
<td>Cupstock</td>
<td>Butcher</td>
<td>Butcher</td>
<td>Medium</td>
</tr>
<tr>
<td>Pulp Board</td>
<td>Bag</td>
<td>Newsprint (Unwrapped)</td>
<td>Medium</td>
</tr>
</tbody>
</table>

A-2 Paper Classification. Paper can be soft or hard, thick or thin, heavy or light and can also be coated with various materials. The broad range of papers can be classified according to various properties. One important property is basis weight which is defined as the weight of a sheet of paper of a specified area. Two broad categories are recognized by industry, paper and paperboard. Paperboard normally has a basis weight of 20 lb or greater measured on a sheet 1,000 sq ft in area. Stock with a basis weight less than 20 lb per 1,000 sq ft is normally categorized as paper. The basis weight of paper is usually measured on a sheet 3,000 sq in area. The basis weight of paper can also be measured on the total area of a ream of paper which is normally the case for the following types of printing and writing papers:

- Bond Paper - 500 Sheets 17"x22" = 1,300 sq ft/Ream
- Book Paper - 500 Sheets 25"x38" = 3,300 sq ft/Ream
- Index Paper - 500 Sheets 25.5"x30.5" = 2,700 sq ft/Ream
- Bristol Paper - 500 Sheets 22.5"x35" = 2,734 sq ft/Ream
- Tag Paper - 500 Sheets 24"x36" = 3,000 sq ft/Ream

A-2-2. With protection installed in accordance with this standard, fire protection of overhead steel and steel columns is not necessary.

Consideration should be given to subdividing large area warehouses in order to reduce the amount of stock that would be exposed to a single fire.

It is desirable to provide walls or partitions to separate the storage area from manufacturing or other occupancies to prevent the possibility of transmission of fire or smoke between the two occupancies.

A-2-3. Smoke removal is important to manual fire fighting and overhaul. Since most fire tests were conducted without smoke and heat venting, protection specified in Section 5-1 was developed without the use of such venting. However, venting through eave line windows, doors, monitors or mechanical exhaust systems is essential to smoke removal after control of the fire is achieved. (See NFPA 204, Guide for Smoke and Heat Venting).

A-4-2.4 For additional guidance, see NFPA 87M, Manual on Clearances for Heat Producing Appliances.

A-4-2.5 Incandescent light fixtures should have shades or guards to prevent ignition of commodity from hot bulbs where possibility of contact with storage exists.

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A-4-3.2 Fire tests indicate that fire will not spread between piles which are separated by eight feet or greater aisles when sprinkler protection is provided in accordance with this standard. Main and cross aisles should be located opposite window or door openings in exterior walls. This is of particular importance in buildings where exterior openings are few.

A-5-1.2 Large drop sprinklers can be used to protect roll paper storage except tissue and other lightweights.

Full scale fire tests indicate that the following roll paper exposures can be protected by Factory Mutual approved large drop sprinkler systems designed as outlined:

- All classes of paper except tissue and lightweights when stored vertically in a standard array up to 20 ft (6 m) high in a building or structure with a roof or ceiling up to 30 ft (9 m) high.
- All arrays of banded, heavyweight paper stored vertically up to 20 ft (7.8 m) high in a building or structure with a roof or ceiling up to 60 ft (18 m) high.

Large drop sprinkler systems protecting roll paper storage should be wet pipe systems using 286°F (141°C) large drop sprinkler heads with a maximum head spacing of 100 ft² (9.3 m²) and a minimum head spacing of 80 ft (24 m).

Large drop sprinkler systems protecting roll paper storage should be hydraulically designed to provide a minimum of 50 psi (350 kPa) with the most hydraulically remote 15 sprinkler heads operating.

Factory Mutual System Loss Prevention Data Sheet 2-7 installation rules for sprinkler systems using large drop sprinkler or NFPA 13, Standard for the Installation of Sprinkler Systems rules, or both can be used as a guideline for the installation of large drop sprinkler systems protecting roll paper storage except as modified above.

A-5-1.6 Generally more sprinklers open in fires involving roll paper storage protected by sprinkler heads rated below the 286°F (141°C) (high temperature) range. A 67 percent increase in the design area should be considered.

A-5-7 Central station, auxiliary remote station, or proprietary sprinkler waterflow alarm should be provided.

Appendix B

This Appendix is not a part of the requirements of this NFPA document, but is included for information purposes only.

Appendix B provides a summary of the data developed from the tissue test series of full scale roll paper tests conducted at the Factory Mutual Research Center, West Glocester, RI.

The test building is approximately 200 ft x 250 ft (50,000 sq ft (4.65 km sq) in area), of fire-resistive construction, and contains a volume of approximately 2.9 million cu ft (63,761.86 m³), the equivalent of a 100,000 sq ft (9.29 km sq) building 22.5 ft (6.86 m) high. The test building has two primary heights beneath a single large ceiling. The east section is 30 ft (9.15 m) high and the west section is 60 ft (18.29 m) high.

The tissue test series was conducted in the 30 ft (9.15 m) section with clearances from top of storage to ceiling nominally 10 ft (3.05 m).

Figure B-1 illustrates a typical storage array used in the tissue series of tests.

Basic criteria used in judging test failure included one or more of the following:

1. Fire spread to the north end of the storage array.
2. Gas temperatures near the ceiling maintained at high levels for a time judged to be sufficient to endanger exposed structural steel.
3. Fire jumped to the target stacks.

Figure B-2 outlines the tissue test results.
<table>
<thead>
<tr>
<th>Test Number</th>
<th>B1*</th>
<th>B2</th>
<th>B3</th>
<th>B4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Date</td>
<td>10/4/79</td>
<td>7/23/80</td>
<td>7/30/80</td>
<td>10/15/80</td>
</tr>
<tr>
<td>Paper Type</td>
<td>Tissue</td>
<td>Tissue</td>
<td>Tissue</td>
<td>Tissue</td>
</tr>
<tr>
<td>Stack Height (ft-in.)</td>
<td>21-10</td>
<td>20-0</td>
<td>21-8</td>
<td>18-6</td>
</tr>
<tr>
<td>Paper Banded</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Paper Wrapped</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Fuel Array</td>
<td>Std.</td>
<td>Std.</td>
<td>Std.</td>
<td>Std.</td>
</tr>
<tr>
<td>Clearance to Ceiling (ft-in.)</td>
<td>8-2</td>
<td>10-0</td>
<td>8-4</td>
<td>11-6</td>
</tr>
<tr>
<td>Clearance to Sprinklers (ft-in.)</td>
<td>7-7</td>
<td>9-5</td>
<td>7-9</td>
<td>10-9</td>
</tr>
<tr>
<td>Sprinkler Orifice (in.)</td>
<td>17/32</td>
<td>17/32</td>
<td>17/32</td>
<td>0.64</td>
</tr>
<tr>
<td>Sprinkler Temp. Rating (°F)</td>
<td>280</td>
<td>280</td>
<td>280</td>
<td>280</td>
</tr>
<tr>
<td>Sprinkler Spacing (ft x ft)</td>
<td>10 x 10</td>
<td>10 x 10</td>
<td>10 x 10</td>
<td>10 x 10</td>
</tr>
<tr>
<td>Water Pressure (psi)</td>
<td>14**</td>
<td>60</td>
<td>95</td>
<td>50</td>
</tr>
<tr>
<td>Moisture Content of Paper (%)</td>
<td>9.3</td>
<td>9.3</td>
<td>10.2</td>
<td>6.0</td>
</tr>
<tr>
<td>First Sprinkler Operation (min:sec)</td>
<td>0:43</td>
<td>0:32</td>
<td>0:38</td>
<td>0:31</td>
</tr>
<tr>
<td>Total Sprinklers Open</td>
<td>88</td>
<td>33</td>
<td>26</td>
<td>64</td>
</tr>
<tr>
<td>Final Flow (gpm)</td>
<td>2575**</td>
<td>1992</td>
<td>1993</td>
<td>4907</td>
</tr>
<tr>
<td>Sprinkler Demand Area (ft²)</td>
<td>8800</td>
<td>3300</td>
<td>2600</td>
<td>6400</td>
</tr>
<tr>
<td>Avg. Discharge Density (gpm/ft²)</td>
<td>0.29**</td>
<td>0.60</td>
<td>0.77</td>
<td>-</td>
</tr>
<tr>
<td>Max. One Min. Avg. Gas Temp. Over Ignition (°F)</td>
<td>1680**</td>
<td>1463</td>
<td>1634</td>
<td>1519</td>
</tr>
<tr>
<td>Duration of High Temp. Within Acceptable Limits</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Marginal</td>
</tr>
<tr>
<td>Max. One Min. Avg. Fire Plume Gas Velocity Over Ignition (ft/sec)</td>
<td>-</td>
<td>40.7</td>
<td>50.2</td>
<td>47.8</td>
</tr>
<tr>
<td>Target Ignited</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Extent of Fire Damage Within Acceptable Limits</td>
<td>No</td>
<td>No</td>
<td>Marginal</td>
<td>Marginal</td>
</tr>
<tr>
<td>Test Duration (min)</td>
<td>17.4</td>
<td>20</td>
<td>20</td>
<td>25.5</td>
</tr>
</tbody>
</table>

*Phase I Test.
**Pressure increased to 50 psi at 10 min.

Figure B-2 Summary of Roll Paper Tissue Tests
Appendix C Referenced Publications

C-1 This portion of the Appendix lists publications referenced within this NFPA standard and thus is considered part of the requirements of the document.

C-1.1 NFPA Publications. The following publications are available from the National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

NFPA 10-1981, Standard for Portable Extinguishers
NFPA 11A-1983, Standard for Medium and High Expansion Foam Systems
NFPA 14-1983, Standard for the Installation of Standpipe and Hose Systems
NFPA 13-1983, Standard for the Installation of Sprinkler Systems
NFPA 71-1977, Standard for the Installation, Maintenance and Use of Central Station Signaling Systems
NFPA 72A-1972, Standard for the Installation, Maintenance and Use of Local Protective Signaling Systems for Guard's Tour, Fire Alarm and Supervisory Service
NFPA 72B-1979, Standard for the Installation, Maintenance and Use of Auxiliary Protective Signaling Systems for Fire Alarm Service
NFPA 72C-1982, Standard for the Installation, Maintenance and Use of Remote Station Protective Signaling Systems
NFPA 72D-1979, Standard for the Installation, Maintenance and Use of Proprietary Protective Signaling Systems
NFPA 91-1973, Standard for the Installation of Blower and Exhaust Systems for Dust, Stock and Vapor Removal or Conveying
NFPA 220-1979, Standard on Types of Building Construction

C-1.2 Other Publications.

C-2 This portion of the Appendix lists publications which are referenced within this NFPA standard for information purposes only and thus is not considered part of the requirements of the document.

C-2.1 NFPA Publications. The following publications are available from the National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

NFPA 204-1968, Guide for Smoke and Heat Venting

C-2.2 Other Publications.
Installation rules for sprinkler systems using large drop sprinklers, Data sheet 2-7, Factory Mutual Research Corporation, 1151 Boston-Providence Turnpike, Norwood, MA 02062.