

NFPA 231E

Recommended
Practice for the
Storage of
Baled Cotton
1996 Edition



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An International Standards-Making Organization



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The Board of Directors reaffirms that the National Fire Protection Association recognizes that the toxicity of the products of combustion is an important factor in the loss of life from fire. NFPA has dealt with that subject in its technical committee documents for many years.

There is a concern that the growing use of synthetic materials may produce more or additional toxic products of combustion in a fire environment. The Board has, therefore, asked all NFPA technical committees to review the documents for which they are responsible to be sure that the documents respond to this current concern. To assist the committees in meeting this request, the Board has appointed an advisory committee to provide specific guidance to the technical committees on questions relating to assessing the hazards of the products of combustion.

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NFPA 231E

Recommended Practice for the

Storage of Baled Cotton

1996 Edition

This edition of NFPA 231E, *Recommended Practice for the Storage of Baled Cotton*, was prepared by the Technical Committee on General Storage and acted on by the National Fire Protection Association, Inc., at its Fall Meeting held November 13-15, 1995, in Chicago, IL. It was issued by the Standards Council on January 12, 1996, with an effective date of February 2, 1996, and supersedes all previous editions.

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

This edition of NFPA 231E was approved as an American National Standard on February 2, 1996.

Origin and Development of NFPA 231E

In the early 1900s, a group of marine underwriters formulated regulations to reduce the frequency of excessive fire loss in baled cotton facilities. In 1916, following a joint conference with the cotton industry, guidelines were established under the title "Specifications and Standards" (also known as "Marine Standards").

From 1947 through 1969, the sponsorship was through the Cotton Warehouse and Inspection Service (dissolved in 1969). In 1967, interested insurance rating bureaus were added as sponsors, and, in 1969, to prevent conflicts with various rating bureau schedules, the word "Standards" was replaced with "Recommended Good Practices"; however, since 1939, the booklet has been commonly referred to as the "Blue Book."

Numerous revisions have been made over the years to keep current, the last made in 1973. Early in 1978, the committee for the "Blue Book" requested that the NFPA consider a standard on baled cotton storage and handling based on the "Blue Book" recommended practices. The NFPA Correlating Committee for Storage expanded the scope to include all fibers in baled form, which were covered in NFPA 44, *Storage of Combustible Fibers*, which was withdrawn many years ago.

Little data was found on fire experience for baled fibers, other than cotton, and that data was largely empirical in nature.

Therefore, NFPA 231E was developed by consensus of a test group formed in 1978 and made up of the cotton warehousing, cotton processing, and insurance industries, under the auspices of the Technical Committee on General Storage, and is limited to cotton fiber in baled form, with the intent to convert to a standard as field experience becomes available to further substantiate its content.

The 1989 edition was a reconfirmation of the 1984 edition.

The 1996 edition incorporates a number of editorial changes to improve the user friendliness of the document. In addition, the terminology has been updated to reflect current practices.

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

Committee Scope: This Committee shall have primary responsibility for documents on safeguarding general warehousing and commodities stored indoors or outdoors against fire. This Committee does not cover storage specifically covered by other NFPA standards.

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NFPA 231E

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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 Chapter 7 and Appendix C.

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 None of the provisions outlined should be considered mandatory; however, it is recommended that property owners follow these recommended practices as a minimum means of limiting firespread by the application of the storage methods specified, by the separation of major storages using fire walls or clear spaces, and by the provision of an adequate means of extinguishment.

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

1-1.4 There is no intent to restrict new technologies or alternative arrangements that offer protection features superior to those outlined.

1-2 General.

1-2.1 Cotton fiber is readily ignitable and burns freely and, when stored in relatively large quantities, poses 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 industry-accepted packaging materials and bound by steel, synthetic or wire bands, or wire. The bale surfaces normally are ragged in appearance due to the loose fibrous material not confined by the binding or wrapping. Frequently, this ragged appearance is further aggravated by sampling, which exposes additional fibrous material and can contribute to the rapid spread of fire.

Bale storage in relatively large quantities can pose severe fire control problems due to the potential flashover and the large area of involvement that could overcome even a well designed and supplied sprinkler system; therefore, this recommended practice takes into consideration limits on the number of bales per building or fire division and the size of storage blocks.

Where the bales are tiered or piled in buildings or outdoors, the loose surface fibers are easily ignited in the presence of an ignition source and the fire can spread rapidly over the entire mass or body of the material; this commonly is called "flashover." Fire then can burrow into the bale interiors making detection and extinguishment diffi-

cult, particularly in large mass storage. A quick, hot fire then can ensue and spread beyond the control of ordinary extinguishing methods.

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

If adequate sprinkler protection is lacking, if tiers or piles are too large or high, if aisle separation is not properly maintained, or if the bales are otherwise improperly arranged, damage to the section, building, or area of involvement will be more severe, if not totally destructive.

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 sources such as vehicle exhausts and incinerators.
- (d) Miscellaneous sources such as cutting and welding, electrical and mechanical faults, and smoking.

1-3 Definitions. Unless expressly stated elsewhere, for the purpose of this document, the following definitions apply:

Approved.* Acceptable to the authority having jurisdiction.

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

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; can also include linters (lint removed from the cottonseed) and motes (residual materials 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 bale within which a fire has been packed as a result of a process, with ginning being the most frequent cause.

Flameover. A fire that spreads rapidly over the exposed linty surface of the bales. In the cotton industry, the common term is "flashover" and has the same meaning.

Flashover. See Flameover.

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

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

Naked Bale. A bale secured with wire or steel straps without wrapping.

Racks. Any combination of vertical, horizontal, and diagonal members that supports stored materials. Some rack structures use solid shelves. Racks can be fixed or portable.

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

Tiered Storage. An arrangement in which bales are stored directly on the floor or ground, usually on dunnage where stored outdoors, and two or more bales high.

Yard Storage. An arrangement in which bales are stored outdoors in any open area. See Section 5-2 for additional definitions that apply to yard storage only.

Chapter 2 Building Construction

2-1 Construction.

2-1.1 Buildings used for the storage of baled cotton that is stored and protected in accordance with this recommended practice may be permitted to be of any of the types described in NFPA 220, *Standard on Types of Building Construction*.

2-1.2 Buildings that are equipped, or that are to be equipped, with automatic sprinkler protection also should meet the recommendations of Chapter 4.

2-2 Emergency Smoke and Heat Venting. The 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 cut off by fire walls or separation.

2-3.1.1 Fire divisions or clear spaces between buildings should be in accordance with NFPA 80A, *Recommended Practice for Protection of Buildings from Exterior Fire Exposures*.

2-3.1.2 Baled cotton storage generally has a fire load in excess of 15 lb/ft² (73 kg/m²), 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 for at least 4 hours (based on NFPA 251, *Standard Methods of Tests of Fire Endurance of Building Construction and Materials*; ASTM E 119, *Standard Methods for Fire Tests of Building Construction and Materials*; and UL 263, *Standard for Safety Fire Tests of Fire Resistance of Building Construction and Materials*). 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 Type 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 the monitors or the roof structure adjoins a fire wall, the parapet should extend not less than 7½ 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 end or side wall or should be "teed" at the ends 10 ft (3.1 m) from each side of the wall or should be "elled" 20 ft (6.1 m) and of an equivalent fire rating.

(b) For noncombustible construction [Type II (000)] other than that outlined in 2-3.2(c), parapets should be at least 2½ ft (0.75 m) above the roof. If intersecting side walls are other than masonry, such wall construction should conform to the specifications of 2-3.2(a).

(c) For noncombustible construction [Type II (222-111)] having masonry walls and with roofs of concrete, gypsum, or Class 1 (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 (443-332)] parapets are not necessary.

2-3.3 Fire walls should be free of openings. Where openings are necessary, the number should be kept to the minimum necessary, and each side should be protected by an approved and listed 3-hour-rated fire door, installed in accordance with NFPA 80, *Standard for Fire Doors and Fire Windows*. 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 closes both doors simultaneously.

2-3.4 Substantial guards of a size to protect fire doors from damage or obstruction should be provided.

Chapter 3 Storage Arrangements

3-1 General.* This chapter applies to buildings protected by a sprinkler system in accordance with Chapter 4, or to those not so protected. The tier heights, block sizes, and aisle widths outlined may be permitted but represent recommended maximum and minimum limitations. Fire experience and fire tests of high-piled commodities have shown that lower pile heights, smaller block sizes, and wider aisles result in a substantial delay in firespread and in providing for manual fire fighting. Automatic sprinkler effectiveness is also improved substantially, with a reduction in water demand and a decrease in the quantity of goods damaged.

3-2 Storage Blocks.

3-2.1 Storage blocks, tiered or untiered, or on racks, should be limited to 700 bales of compressed cotton or 350 bales of flat cotton. (See 3-3.4 for a permitted variation and also Table A-1-3 for typical cotton bale types and approximate sizes.)

3-2.2 The height of tiered or rack storage should be limited to a nominal 15 ft (4.6 m). Rack storage, as used in this document, contemplates baled cotton in a skeleton steel pipe or tubular frame, without shelving, and is limited to a single- or double-row configuration not in excess of two bales deep. Any variation could create a serious handicap to automatic sprinklers that is beyond the design capability and should be referred to the authority having jurisdiction.

3-2.3 Rack storage should not extend over aisles or doorways.

3-2.4 Racks should not be loaded beyond their design capacity and should be designed for seismic conditions in areas where seismic resistance for buildings is required.

3-3 Aisles.

3-3.1 Aisles should be provided and maintained to minimize the spread of fire and to allow convenient access for fire fighting, removal of storage, and salvage operations.

3-3.2 At least one main aisle, 12 ft (3.7 m) or more in width, should be provided in each fire division and arranged to subdivide the storage into two or more approximately equal areas.

3-3.3 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 allow sprinkler water to penetrate the lower areas of storage; however, it should be noted that, for aisles less than 8 ft (2.4 m) in width, a fire can be expected to communicate readily from one block to another, especially in the case of an easily ignitable commodity such as cotton fiber.

3-3.4 Where a 15-ft (4.6-m) cross aisle is provided after every fourth or fifth tiered block, each storage block may be permitted to be increased to 800 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 recommended storage capacity, as an aid in reducing the flashover fire potential. Because of the increase in block sizes, however, it is recommended that the authority having jurisdiction be consulted prior to practicing this method.

3-3.5 Cross aisles separating each single- or double-row rack storage configuration should be at least 10 ft (3.1 m) in width.

3-3.6 Aisles should be maintained free of loose cotton fibers.

3-4 Freshly Ginned Cotton Bales. See Section 5-5.

3-5 Storage of Commodities Other than Cotton.

3-5.1 Cotton warehouses, in general, may be permitted to be used for the storage of other commodities, subject to the following:

(a) The storage of other commodities in a building may be permitted where baled cotton is not stored.

(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 where baled cotton is stored in the fire division.

(c) Any commodities that could be hazardous in combination with each other should be stored so that they cannot come in contact with each other.

3-5.2 Where 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.

3-5.3 Where commodities of different classifications are permitted and stored in the same building, whether on a seasonal or other basis, the protection should be adequate

for the most hazardous material. (For protection of other commodities, see the applicable NFPA storage standards.)

3-6 Clearances.

3-6.1 Proper clearances from lights or light fixtures should be maintained 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 located 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 the 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 as 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 A clearance of at least 3 ft (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 part of the recommendations of this document. 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. (See Section 3-5 for sprinkler protection for other than cotton fiber storage.)

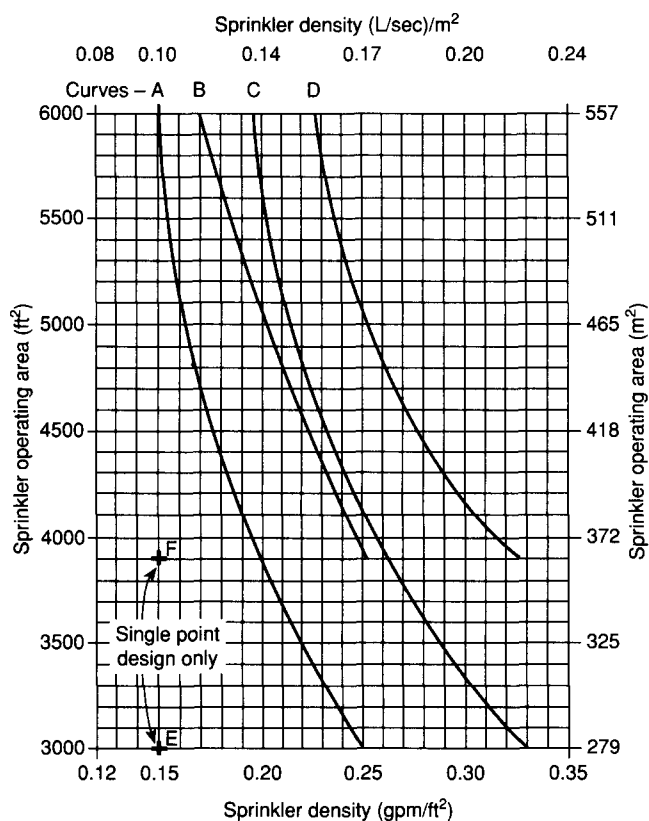
4-1.2 Automatic sprinkler systems, where provided, should be installed in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*.

Exception: Where 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. The density provided for the area of operation can be taken from any point on the selected curve. It is not necessary to meet more than one point on the selected curve.

4-1.3.1 Where roof or ceiling heights would prohibit storage above a nominal 10 ft (3.1 m), the sprinkler discharge density may be permitted to be reduced by 20 percent of that indicated in Figure 4-1.3 but should not be reduced to less than 0.15 gpm/ft² [(0.10 L/sec)/m²].

4-1.3.2 Baled storage that is not tiered can be based on the single-point design curve E for wet-pipe systems and curve F for dry-pipe systems. This untiered design density limits storage to the height of one bale, on side or on end, and would likely prohibit any future tiering without redesign of the sprinkler system.



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

Figure 4-1.3 Sprinkler system design curves.

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

4-1.3.4 Minimum sprinkler operating areas should be 3000 ft² (279 m²) for wet-pipe systems and 3900 ft² (363 m²) for dry-pipe systems; the maximum operating area should not exceed 6000 ft² (557 m²). No area credit is recommended for the use of high temperature sprinklers.

4-1.3.5* On new installations, the use of sprinkler heads in the ordinary temperature range is recommended, subject to the maximum ceiling temperatures outlined in NFPA 13, *Standard for the Installation of Sprinkler Systems*.

4-1.4 Clearance between the top of the storage and the sprinkler deflectors should be at least 18 in. (0.45 m). Building heights should 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 located 1½ ft to 4½ ft (0.45 m to 1.4 m) above the storage height.

4-2 Water Supplies.

4-2.1 The total water supply available should be sufficient to provide the recommended sprinkler discharge density over the area to be protected, plus a minimum of 500 gpm (32 L/sec) 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 2 hours.

4-2.3 Recommended water supplies contemplate successful sprinkler operation when installed. However, because of the flashover 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 in accordance with NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*.

4-4 Manual Inside Protection.

4-4.1 In buildings of 15,000 ft² (1380 m²) or larger, small hose [1½ in. (38.1 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 a maximum length of 100 ft (30.5 m) of hose. Such small hose should be supplied from one of the following:

- Outside hydrants;
- A separate piping system for small hose stations in accordance with NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*;
- Valved hose connections on sprinkler risers where such connections are made upstream of the sprinkler control valves;
- Adjacent sprinkler systems in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*.

4-4.2 Portable listed fire extinguishers should be provided in accordance with NFPA 10, *Standard for Portable Fire Extinguishers*, and as amended by this chapter. Up to ½ of the required complement of portable fire extinguishers for Class A fires may be permitted to be omitted in storage areas where fixed small hose lines are installed in accordance with 4-4.1.

4-4.2.1 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 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 and work mainly by coating the fiber with the fire retardant powder, but such chemicals do not affect a smoldering or burrowing fire beneath the surface.

4-4.2.2 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.