BALED STORAGE

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1.0 SCOPE

This data sheet provides recommendations for the protection of indoor and outdoor baled storage of wastepaper, natural or synthetic fibers, and plastics.

1.1 Hazards

Baled storage consists of dense bundles of material that save space over the alternative of loose material storage. The densely packed bundles, however, limit the ventilation through the material which can trap moisture and heat. A high moisture content in wastepaper or fiber bales can lead to spontaneous combustion due to bacterial growth and the trapped heat the bacteria produce. The presence of other ignition sources, such as lithium-ion batteries or sparks from metal banding and hot work, either within the bales or in close proximity, can also lead to fire events. Fires within baled storage tend to smolder and burrow making them very difficult to control with sprinklers or extinguish with hose streams. Sprinklers will not usually extinguish these deep-seated fires, and the pile must be pulled apart with hose streams applied to achieve final extinguishment. The burning bales produce smoke and soot that can lead to nonthermal damage throughout the space. Whether the storage is indoor or outdoor, limiting the pile size and height and providing space separation are key factors in controlling the fire and limiting any subsequent damage. Outdoor storage can be particularly challenging due to wind and its ability to spread a small fire quickly. The rapid spread creates serious exposure risks to any unprotected buildings.

1.2 Changes

April 2026. This document has been completely revised. Significant changes include the following:

A. Changed the title to Baled Storage (from Storage of Baled Waste Paper).

B. Incorporated FM Property Loss Prevention Data Sheet 8-7, *Baled Fiber Storage*, guidance making Data Sheet 8-7 obsolete.

C. Updated the protection guidance, and added automated monitor fire suppression systems as a primary protection option.

2.0 LOSS PREVENTION RECOMMENDATIONS

2.1 Introduction

2.1.1 Use FM Approved equipment, materials, and services whenever they are applicable. For a list of products and services that are FM Approved, see the *Approval Guide*, an online resource of FM Approvals.

2.2 Construction and Location

2.2.1 Construct storage facilities in accordance with the relevant FM property loss prevention data sheets. See the 1-series data sheets for guidelines relevant to the construction features of most storge facilities (e.g., Data Sheet 1-28, *Wind Design*, Data Sheet 1-12, *Ceilings and Concealed Spaces*, Data Sheet 1-15, *Roof-Mounted Solar Photovoltaic Panels*, etc.).

2.2.2 Fire protection of building columns and overhead steel is not necessary if all the protection guidelines in this data sheet are met.

2.2.3 Provide impact protection for building columns.

2.2.4 Provide a minimum one-hour rated partition between indoor baled storage and areas used for other activities.

2.2.5 Use FM Property Loss Prevention Data Sheet 7-76, *Combustible Dusts*, for recommendations pertaining to fire and explosions involving combustible dust.

2.2.6 Protect buildings and conveyors from yard storage fire exposure in accordance with FM Property Loss Prevention Data Sheet 1-20, *Protection Against Exterior Fire Exposure*.

2.3 Occupancy

2.3.1 Do not allow baled storage in the same area as finished goods, processing equipment or other combustibles.

2.3.2 Provide at least 2 ft (0.6 m) separation between baled storage and walls, barriers, steel framing, columns and sprinkler risers.

2.3.3 Establish and implement a housekeeping program to keep outdoor storage sites free of combustibles such as grass, brush, and rubbish.

2.4 Protection

2.4.1 Outdoor Storage

2.4.1.1 General

2.4.1.1.1 Protect baled storage using one of the following methods:

A. Automated monitor fire suppression system

B. Barriers with manual response

C. Space separation with manual response

2.4.1.1.2 Limit pile size for outdoor storage to 10,800 ft^2 (1,000 m^2).

2.4.1.1.3 Limit the pile height to a maximum of 20 ft (6.1 m).

2.4.1.1.4 Provide a minimum 30 ft (9.1 m) main aisle for firefighting access on at least one side of every pile.

2.4.1.1.5 Provide separation between individual storage piles based on the protection used in Section 2.4.1.1.1.

2.4.1.1.6 Provide yard hydrant protection spaced at a maximum of 300 ft (100 m) intervals.

2.4.1.1.7 Provide FM Approved infrared (IR) or video fire detection throughout the outdoor storage area.

2.4.1.2 Automated Monitor Fire Suppression System

2.4.1.2.1 Use FM Approved automated monitor fire suppression systems.

2.4.1.2.2 Design the automated monitor fire suppression system and its associated detection system in accordance with FM Property Loss Prevention Data Sheet 4-14, *Automated Monitor Fire Suppression Systems*, the manufacturer's Design, Installation and Operation Manual (DIOM) and the recommendations in this section.

2.4.1.2.2.1 Position monitors so that a minimum of two monitor nozzles can reach any given location within the baled storage.

2.4.1.2.2.2 Account for at least three automated monitors in the hydraulic design.

2.4.1.2.2.3 Provide a minimum flow rate of 300 gpm (1,140 L/min) at 100 psi (6.9 bar) per automated monitor.

2.4.1.2.3 Separate individual storage piles by a minimum of 8 ft (2.4 m) if no barriers are provided.

2.4.1.2.4 Provide at least 2 ft (0.6 m) separation between storage and both sides of barriers if barriers are used (see Section 2.4.1.3).

2.4.1.2.5 Provide a manual hose stream allowance of 250 gpm (950 L/min).

2.4.1.2.6 Provide a water supply capable of meeting the design monitor discharge flow rate plus the manual hose stream allowance for 2 hours.

2.4.1.3 Barriers with Manual Response

2.4.1.3.1 Provide barriers around three of the four sides of each storage pile.

2.4.1.3.2 Construct barriers using noncombustible materials, providing a minimum 2-hour rating. Typical wall construction using cement or cinder blocks would meet this rating.

2.4.1.3.2.1 Extend barriers a minimum of 7 ft (2.1 m) above the baled storage height.

2.4.1.3.2.2 Extend side barriers a minimum of 3 ft (0.9 m) out from the end of the storage pile where no barrier is located.

2.4.1.3.3 Provide at least 2 ft (0.6 m) of separation between storage and both sides of barriers.

2.4.1.3.4 Provide containment for fire brands, such as chicken mesh fencing over piles of paper commodity, to mitigate embers igniting adjacent piles.

2.4.1.3.5 Provide FM Approved manual monitor protection.

2.4.1.3.6 Provide a manual response plan that meets the recommendations in Section 2.5.

2.4.1.3.7 Provide an allowance of 1,000 gpm (3,790 L/min) for manual firefighting (hose streams, manual monitors, etc.).

2.4.1.3.8 Provide a water supply capable of meeting any monitor design discharge flow rate plus hose stream allowance for 2 hours.

2.4.1.4 Space Separation with Manual Response

2.4.1.4.1 Provide aisle space separation between storage piles per Table 2.4.1.4.1 based on overall pile height.

Table 2.4.1.4.1. Storage Pile Space Separation Distances

Storage Pile Heightft (m)	*Separation distanceft (m)*
5 (1.5)	30 (9.1)
10 (3.0)	35 (10.7)
15 (4.6)	40 (12.2)
20 (6.1)	45 (13.7)

2.4.1.4.2 Provide an allowance of 1,000 gpm (3,790 L/min) for manual firefighting (hose streams, manual monitors, etc.).

2.4.1.4.3 Provide a water supply capable of meeting any manual monitor discharge flow rate plus hose stream allowance for 2 hours.

2.4.2 Indoor Storage

2.4.2.1 General

2.4.2.1.1 Protect baled storage using one of the following methods.

A. Automatic sprinkler system

B. Automated monitor fire suppression system

2.4.2.1.2 Limit pile size to 1,600 ft^2 (150 m^2).

2.4.2.1.3 Limit the pile height to a maximum of 20 ft (6.1 m).

2.4.2.1.4 Maintain 8 ft (2.4 m) of aisle separation between individual storage piles and other combustibles.

2.4.2.1.5 Protect loose piles of wastepaper using the same guidance for baled wastepaper piles.

2.4.2.1.6 Protect incidental storage of baled paper as a Class 3 commodity in accordance with FM Property Loss Prevention Data Sheet 3-26, *Fire Protection for Nonstorage Occupancies*.

2.4.2.1.7 Treat baled storage that is ≥ 30% plastic by weight as solid-piled uncartoned unexpanded plastic (UUP), and protect in accordance with Data Sheet 8-9 or incidental storage in Data Sheet 3-26 if incidental storage criteria is met.

2.4.2.1.8 Protect rack storage of baled paper products as a Class 3 commodity, or as cartoned unexpanded plastic (CUP) if stored on non-FM Approved plastic pallets, in accordance with Data Sheet 8-9, *Storage of Class 1, 2, 3, 4 and Plastic Commodities*.

2.4.2.1.9 Protect rack storage of baled plastic products as an unexpanded plastic commodity in accordance with Data Sheet 8-9.

2.4.2.2 Automatic Sprinkler Protection

2.4.2.2.1 Use FM Approved storage sprinklers installed in accordance with FM Property Loss Prevention Data Sheet 2-0, *Installation Guidelines for Automatic Sprinklers*.

2.4.2.2.2 Use wet-pipe sprinkler systems unless the protected area is unheated and the temperature can fall below 40°F (4°C).

2.4.2.2.3 Use standard response, pendent or upright sprinklers.

2.4.2.2.4 Use a minimum K-11.2 (K160) sprinkler.

2.4.2.2.5 Design the automatic sprinkler system per Table 2.4.2.2.5 for baled storage of wastepaper and fibers with less than 30% plastic by weight.

Table 2.4.2.2.5. Baled Wastepaper Storage Sprinkler Design Demands

Maximum Ceiling Height, ft (m)	*Wet System* *(gpm/ft^2)/ft^2 ([mm/min]/m^2)*	*Dry System* *(gpm/ft^2)/ft^2 ([mm/min]/m^2)*
30 (9.1)	0.3/2,500 (12/230)	0.3/3,500 (12/330)
40 (12)	0.4/3,600 (16/340)	0.4/4,600 (16/430)
50 (15)	0.5/3,000 (20/280)	0.5/4,000 (20/370)

2.4.2.2.5 Provide a hose stream allowance of 1,000 gpm (3,790 L/min).

2.4.2.2.6 Provide a water supply capable of meeting the design discharge flow rate plus hose stream allowance for 2 hours.

2.4.2.3 Automated Monitor Fire Suppression System

2.4.2.3.1 Follow the recommendations for automated monitor fire suppression systems in Section 2.4.1.2.

2.4.2.3.2 Construct storage facilities using noncombustible materials.

2.5 Human Factor

2.5.1 Develop a pre-incident and emergency response plan in accordance with FM Property Loss Prevention Data Sheet 10-1, *Pre-incident and Emergency Response Planning*. Include the following in the pre-incident and emergency response plans:

- Access routes
- Contact information for the automated monitor fire suppression system
- Manual fire protection methods
- Water supply for long duration fires
- Method for moving damaged bales
- Designated location outside the facility to which damaged bales can be moved
- Final extinguishment plan

2.5.1.1 Include the local fire service in the development of pre-incident and emergency response plans.

2.5.1.2 Provide documented procedures to move baled storage during a fire event to achieve final extinguishment.

2.5.2 Develop a management of change (MOC) policy that updates standard operating procedures based on lessons learned.

2.5.3 Educate and train personnel to respond efficiently before, during and after an emergency event by conducting annual hazards training and fire drills.

2.5.4 Prevent unauthorized people from accessing property and storage areas.

2.6 Ignition Source Control

2.6.1 Strictly control all hot work operations in accordance with FM Property Loss Prevention Data Sheet 10-3, *Hot Work Management*.

2.6.2 Prohibit smoking in baled storage areas.

2.6.3 Verify incoming material is that which is expected and free of any potential ignition sources such as lithium-ion batteries. Use of IR scanning, metal detection or an equivalent method may be used.

3.0 SUPPORT FOR RECOMMENDATIONS

3.1 Baled Storage Fire Behavior

Fires in baled wastepaper or fibers are of a burrowing nature and are difficult to extinguish. Firefighting efforts may require smoldering bales to be removed from the building or relocated from yard storage to facilitate complete extinguishment. The removal may be difficult if the piles have become saturated with water from sprinklers and hoses. Waterlogged bales will fall apart if material-handling equipment such as a forklift is used. In addition, the bales produce smoke that can complicate manual, indoor firefighting.

3.1.1 Water Absorption

When baled paper and fiber are exposed to water, they will absorb the water and expand. The bales can expand up to 1.5 times their area which will significantly increase the bale's weight. This weight increase should be accounted for when transporting wet bales during emergency operations or in the rack design when bales are being stored in racks.

3.1.2 Wind Impact on Outdoor Storage

Sparks or burning fire brands from nearby fires are a potential ignition source for outside storage and combustible buildings. Separation distances between outside storage and exposed combustible buildings will not prevent fire spread when fires are driven by high winds.

3.2 Fire Fighting

Baled wastepaper and fibers are all readily combustible, having similar burning characteristics, and require the same safeguards and firefighting procedures. Fires can flash rapidly over the surfaces of bales, then travel more slowly and burrow into the pile between and into bales. Automatic sprinklers will prevent structural damage and, where piles are properly arranged and separated, will normally confine the fire to the initial pile. The sprinkler water discharged may not prevent extensive burrowing of a shielded fire within a pile. Complete extinguishment usually requires relocating smoldering bales to the outdoors. Once outdoors, water can be applied to the bales to extinguish any smoldering fires. The bales can be broken apart to extinguish any deep-seated fires within.

3.3 Water Supply Design

Large-scale fire testing of baled storage showed fire within the pile of bales burrows and spreads. Due to the burrowing nature, sprinkler protection alone will not be able to achieve final extinguishment. Understand that automatic sprinklers, especially for indoor storage, are provided to reduce the flames and protect the building; so that firefighting efforts can effectively dismantle the pile, applying hose streams as needed, to achieve final extinguishment. The first two hours of firefighting are critical in gaining control, after which water usage will typically decrease for the remainder of the expected long duration fire event. Baled storage fires can last for days. A 2-hour water supply is considered a reasonable amount of time to support initial on-site operations. The 2-hour duration will allow the firefighting efforts to begin and continue while additional water (should it be needed) is brought to the site from preplanned sources specified in the emergency response plan.

3.5 Loss History

A recent 10-year study of FM losses showed 28 fire losses involving baled storage. Table 3.5 shows the loss history of indoor and outdoor baled storage.

Table 3.5. Loss Hisory of Baled Storage Fires

Description	*Percent of Losses*	*Percent of Total U.S. Dollars*
Outdoor	61	24
Indoor	39	76
Totals	100	100

3.5.1 Illustrative Losses

3.5.1.1 Indoor Baled Wastepaper Storage Fire

Wastepaper bales were being unloaded and transferred to storage areas when spontaneous heating within a bale caused it to ignite. Flames from the burning bale ignited ceiling-level paper dust deposits which quickly spread, dropping embers onto the baled storage below. Automatic sprinkler protection operated; and manual response efforts removed bales from the fire zone, relocating them outside the building. Once outside, the bales were pulled apart with hose streams applied to extinguish any flames and cool hot spots. A total of 67 sprinklers operated during the 42 hours it took to remove the burning bales from the building.

3.5.1.2 Yard Storage Fire with Excessive Storage Height and Pile Size

A fire started outside in yard storage of baled cardboard. The yard storage was over full capacity, exceeding storage height and pile size limitations and filling aisles. Since the yard was not provided with detection, local authorities were the first to alert the security guard of the fire. Even with the initial delay in detection, the fire service responded promptly to the incident. However, dry, windy conditions, along with lack of adequate aisles, allowed the fire to spread throughout the storge yard. The fire burned through the entire inventory of approximately 10,000 tons of baled cardboard.

3.5.1.3 Yard Storage Fire with Automated Monitor Fire Suppression

A fire broke out in the storage yard of baled wastepaper protected by an automated monitor fire suppression system. The fire was quickly detected by the automated monitor fire suppression system, which positioned the monitor and began water application to the fire zone. During the suppression efforts, a second fire ignited due to embers. This fire was also quickly detected and suppressed by a second automated monitor employed to discharge water.

4.0 REFERENCES

4.1 FM

Data Sheet 1-12, *Ceilings and Concealed Spaces*
Data Sheet 1-15, *Roof-Mounted Solar Photovoltaic Panels*
Data Sheet 1-20, *Protection Against Exterior Fire Exposure*
Data Sheet 1-28, *Wind Design*
Data Sheet 2-0, *Installation Guidelines for Automatic Sprinklers*
Data Sheet 3-26, *Fire Protection for Nonstorage Occupancies*
Data Sheet 8-9, *Storage of Class 1, 2, 3, 4 and Plastic Commodities*
Data Sheet 10-1, *Pre-Incident and Emergency Response Planning*

APPENDIX A GLOSSARY OF TERMS

Automated monitor: Monitors with integrated detection and control equipment to allow for remote operation or self-targeting operation. These monitors have the capability to detect, locate and accurately deliver water to the fire location without the need for any on-site human intervention.

Baled storage: Storage of materials in large, compressed packages or bundles that are held together using metal or plastic ties. Bales can be wrapped in burlap or plastic film.

Loose piles: Storage of materials in unorganized mounds. The storage is not compacted or baled.

Manual monitor: Monitors that are fixed in place or operated by manual means to supplement automatic sprinkler protection and help achieve final extinguishment.

APPENDIX B DOCUMENT REVISION HISTORY

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

April 2026. This document has been completely revised. Significant changes include the following:

A. Changed the title to Baled Storage (from Storage of Baled Waste Paper).

B. Incorporated FM Property Loss Prevention Data Sheet 8-7, *Baled Fiber Storage*, guidance making Data Sheet 8-7 obsolete.

C. Updated the protection guidance, and added automated monitor fire suppression systems as a primary protection option.

October 2013. Interim Revision. The following changes were made:

A. The terms “standard sprinkler (aka, control mode density area [CMDA],” “large drop sprinkler (aka, control mode specific application [CMSA])” have been replaced with “storage sprinkler.” This terminology is consistent with other FM Global data sheets.

B. All ceiling-level sprinkler protection options are now given as a number of sprinklers at a minimum operating pressure (e.g., 25 sprinklers @ 7 psi [3.4 bar]).

January 2002. The following changes were made:

1. Section 2.1.1.2 has been amended to include recommendations for baled waste paper pile size and aisle width between piles and other combustibles.

2. Section 2.1.1.4 has been amended to include additional guidance for determining density and area recommendations.

January 2000. This revision of the document has been reorganized to provide a consistent format.

May 1998. Revised, supersedes the 1977 edition.

August 1977. Data Sheet completely revised.