FIRE PROTECTION FOR TEXTILE MILLS

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1.0 SCOPE

This data sheet covers the fire hazards and necessary protection recommendations for various textile processes that use both natural and synthetic fibers.

Storage of baled fibers is covered in Data Sheet 8-7, *Baled Fiber Storage*. Storage of plastics and rubber, storage of greige and finished goods (other than synthetic yarns), on pallets, and storage in racks is covered in Data Sheet 8-9, *Storage of Class 1, 2, 3, 4 and Plastic Commodities*.

1.1 Changes

July 2023. Interim revision. Minor editorial changes were made.

July 2022. Interim revision. The following major changes have been made:

A. Added guidance in Section 2.3.15 for nylon and polyester yarn.

B. Revised guidance on ceiling sprinkler protection for production and finishing operation areas in Section 2.3.1.2. Those areas should be protected as HC-2 occupancies.

C. Removed recommendations for portable extinguishing equipment.

D. Document has been reorganized to provide a consistent format.

1.2 Hazard

Fires may occur within enclosed equipment in opening through carding areas and outside equipment at any location in the mill. Properly designed automatic sprinkler or special protection systems will control fires within equipment.

Fires occurring outside equipment may be in loose fiber and oil mist deposits or in in-process storage. The size of a fire involving oil mist and fiber is dependent on housekeeping. A good housekeeping program with high management interest can reduce the size of a fire of this type. Poor housekeeping can result in large fires even though automatic sprinkler protection is provided.

Fires also may occur in concealed areas that may not be protected with automatic sprinkler protection and which may not be on the housekeeping list, such as above false ceilings. These fires can result in major fire and non-thermal damage occurring in the mill. Water damage caused by leakage of water through floor openings onto high value goods in storage also can greatly increase property damage.

Beyond the manufacturing occupancies associated with yarn production, the storage of finished yarn also may present a significant fire hazard. Natural yarns can be protected like a Class 3 commodity (see Data Sheet 8-1, *Commodity Classification*). Synthetic yarns (polypropylene, nylon, or polyester) cannot be classified like standard commodities, e.g., cartoned unexpanded plastic or uncartoned unexpanded plastic. Full-scale fire tests have shown these finished yarns to present a significant fire hazard resulting in storage height limitations for palletized storage and requirements for the use of in-rack sprinklers for taller rack storage. Polypropylene represents the most severe fire challenge while nylon and polyester represent much lesser fire challenges.

2.0 LOSS PREVENTION RECOMMENDATIONS

2.1 Construction and Location

2.1.1 General

2.1.1.1 Make floors water resistant above valuable storage or sensitive high value equipment.

2.1.1.2 Provide one-hour rated fire partitions with FM Approved automatic closing fire doors to separate raw material and finished goods storage from processing areas.

2.1.2 Opener Rooms

2.1.2.1 Locate opener rooms on the first floor.

2.1.2.2 Separate opener rooms from the remainder of the mill by a noncombustible fire partition.

2.1.2.3 Provide access doors to permit firefighting and cotton removal.

2.1.2.4 Provide painted lines on the floor showing the limits of the fiber laydown area and clear space.

2.1.2.5 If plant operations require some unopened bales in the opener room, separate bales from opened fiber by a minimum 10 ft (3 m) space or by a partition extending the height of the storage.

2.1.2.6 Separate laydown for each opener line by a minimum 10 ft (3 m) space, or by a minimum 6 ft (1.8 m) high sheet metal or plywood partition extending 2 ft (0.6 m) beyond sides of bales.

2.1.3 Pin Trucks

2.1.3.1 Provide noncombustible enclosures for each row of pin trucks storing acrylic yarns or blends of acrylic yarns as follows:

A. Design enclosures such that a vertical barrier is provided between each row of pin trucks.

B. Design the barrier over the storage to be approximately 24 in. (61 cm) above the top of the pin truck.

C. Design the barrier to extend 18 in. (46 cm) beyond the face of the pin truck as shown in Figure 2.1.3.1.

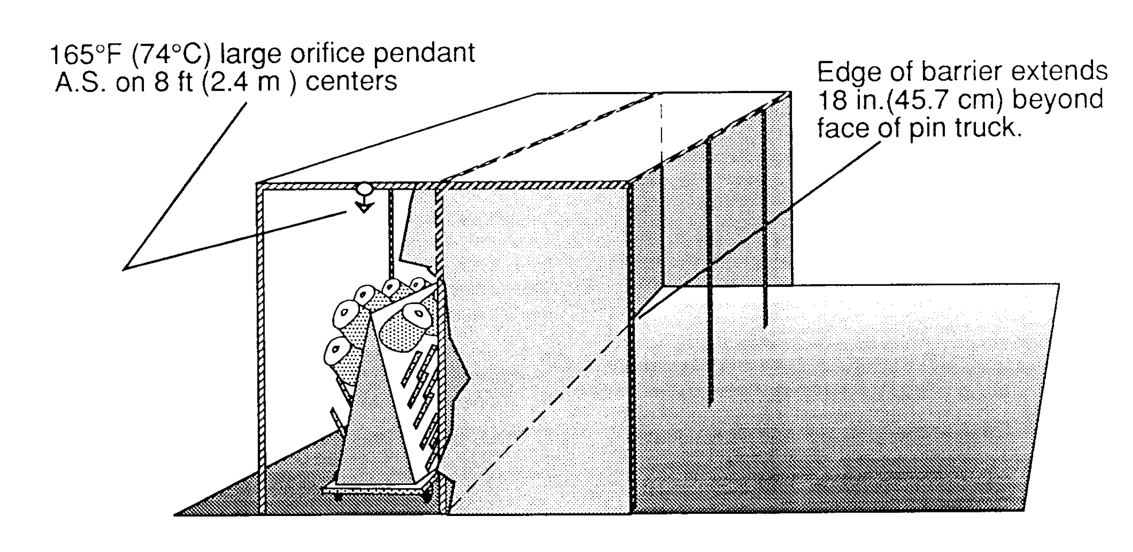


Fig. 2.1.3.1. Pin truck located within enclosure

2.1.4 Spinning

2.1.4.1 Use noncombustible insulation inside the frame.

2.1.5 Automatic Bale Openers

2.1.5.1 Separate laydown for each automatic bale opener line by a minimum 10 ft (3 m) space or by a minimum 6 ft (1.8 m) high sheet metal or plywood partition extending 2 ft (0.6 m) beyond sides of bales.

2.1.6 Pneumatic Waste Recovery and Cleaning Systems

2.1.6.1 Provide watertight joints where ducts pass through floors to reduce water damage.

2.1.7 Load Centers

2.1.7.1 Locate load centers in noncombustible rooms maintained at a positive pressure.

2.1.7.2 Load center rooms shall not be used for any other purpose.

2.1.8 Magnetic Separators

2.1.8.1 Provide a magnetic separator immediately at, or downstream of, fiber entering any pneumatic transfer system and at the following locations:

A. For automatic bale openers, provide a magnetic separator and diverter between the automatic bale opener and other downstream equipment. Magnetic humps and plates require frequent inspection and cleaning.

B. For feeder blending, provide a magnetic separator at the top of the conveyor or apron.

C. For carding, for cotton or other fiber that may contain tramp metal if fire frequency warrants, provide a magnetic separator at the bottom of each card chute.

2.1.9 Compressors

2.1.9.1 Locate compressors needed for air jet looms in noncombustible buildings or rooms.

2.2 Occupancy

2.2.1 Ventilation

2.2.1.1 HVAC Systems

2.2.1.1.1 Design HVAC systems in opening through weaving or knitting so, in the event of fire in the main plant areas or in the ventilation system, smoke will be exhausted directly to the outside.

2.2.1.1.2 Interlock electrical controls for the HVAC system to do the following:

A. Stop the supply fan

B. Close the recirculating air dampers

C. Open the exhaust damper

The exhaust fan should be kept running so that smoke-laden air will be drawn through the exhaust system to the outside.

2.2.1.1.3 Arrange HVAC controls to be on a single circuit with the switch(es). Controls can be automatically activated by fire protection equipment or manually activated by personnel in the area serviced by the ventilation system.

2.2.1.1.4 Filter all return air through a filter media capable of removing fine particles of lint before the air enters the supply air duct system.

2.2.1.1.5 Construct tunnels to be large enough for personnel entry or regular housekeeping.

2.2.1.1.6 Provide a smooth epoxy coating in tunnels to reduce lint buildup.

2.2.1.1.7 Provide sheet metal sleeves for through-the-floor openings to air return.

2.2.1.1.7.1 Arrange metal sleeves to extend above and below the floor to reduce the chance of fire spread through openings.

2.2.1.1.7.2 Provide tight fitting covers for the openings for use by the Emergency Response Team (ERT) to prevent fire spread.

2.2.1.1.8 Provide clean out openings in ducts that are not otherwise accessible for cleaning.

2.2.1.2 Exhaust Ventilation

2.2.1.2.1 For nappers, provide an exhaust ventilation system for lint removal if the operation produces lint.

2.2.2 Storage Arrangements

2.2.2.1 For nonwovens, keep fiber, in-process and finished product storage away from machinery and other potential ignition sources.

2.2.3 Housekeeping

2.2.3.1 Provide written corporate and plant policies to ensure regularly scheduled cleanings for floor, wall, ceiling, supply and return air ventilation systems.

2.2.3.1.1 Provide more frequent cleaning with mechanical devices for round, small diameter, branch feeder tunnels and ducts.

2.2.3.2 Provide written corporate and plant policies to ensure regularly scheduled cleanings for process areas including, but not limited to, the following:

- Garnett machines
- Ovens, dryers and tenter frames. For heat set ovens, cleaning schedules should be based on usage and chemicals used.
- Weaving operations, ensuring blow down of machinery at time of warp out
- Spinning operations, ensuring the removal of oil and lint deposits inside the frame and head filter

2.2.3.3 Maintain electrical systems free of lint buildup to reduce the potential for ignition. This includes cleaning inside junction boxes, buses, trays, tunnels, etc.

2.2.3.4 Provide a documented line of authority for authorizing a cleaning delay and rescheduling.

2.3 Protection

2.3.1 General

2.3.1.1 Install automatic sprinklers at ceiling level in all areas, including concealed spaces, in accordance with Data Sheet 2-0, *Installation Guidelines for Automatic Sprinklers*.

2.3.1.1.1 Install automatic sprinklers under obstructions in areas where combustibles are located if ceiling protection is unable to adequately protect the area. Alternatively, relocate combustibles to a location where they can be adequately protected by ceiling sprinklers.

2.3.1.2 Design ceiling sprinkler protection for textile plant production and finishing operation areas as an HC-2 occupancy in accordance with Data Sheet 3-26, *Fire Protection for Nonstorage Occupancies.*

2.3.1.3 Provide a water supply adequate for two hours capable of meeting the sprinkler discharge flow rate plus 250 gpm (950 L/min) for hose streams unless stated otherwise.

2.3.2 Equipment Protection

2.3.2.1 Provide protection within equipment as follows:

A. Automatic sprinkler protection or special protection in equipment containing 100 lb (45.5 kg) or more of cotton or synthetic fiber.

B. Automatic sprinkler protection and special protection in equipment containing 500 lb (227 kg) or more of cotton or synthetic fiber. Special protection systems are not a substitute for automatic sprinkler protection in equipment having this amount of fiber.

C. Automatic sprinkler protection in waste recovery system bins, filter houses, etc.

D. Automatic sprinkler protection within spinning frames where combustible insulation is used behind the spinning positions. Protection is not needed if combustible insulation is used only in the headstock and tailstock.

E. Automatic sprinkler protection over the feed conveyor.

F. Special protection for blender reserve hoppers.

2.3.2.1.1 Install automatic sprinkler protection in equipment designed to deliver at least 20 gpm (76 L/min) from 12 sprinklers using K5.6 (K80), 165°F (74°C) temperature rated, quick response sprinklers on a 100 ft^2 (9.3 m^2) spacing.

2.3.2.1.1.1 If areas are shielded by vertical partitions additional heads are needed.

2.3.2.1.1.2 If location within the equipment is such that there would be fiber accumulation the sprinklers may be installed within a recessed enclosure provided the enclosure does not interfere with the spray pattern of the automatic sprinkler.

2.3.2.2 For cotton or other fiber that may contain tramp metal provide a metal, spark, and fire diverter system downstream of all fiber input points as shown in Figure 2.3.2.2. IR detectors detect sparks and divert stock feed to the collection can. A special protection system or a water spray system can be used to extinguish fire in the collection can.

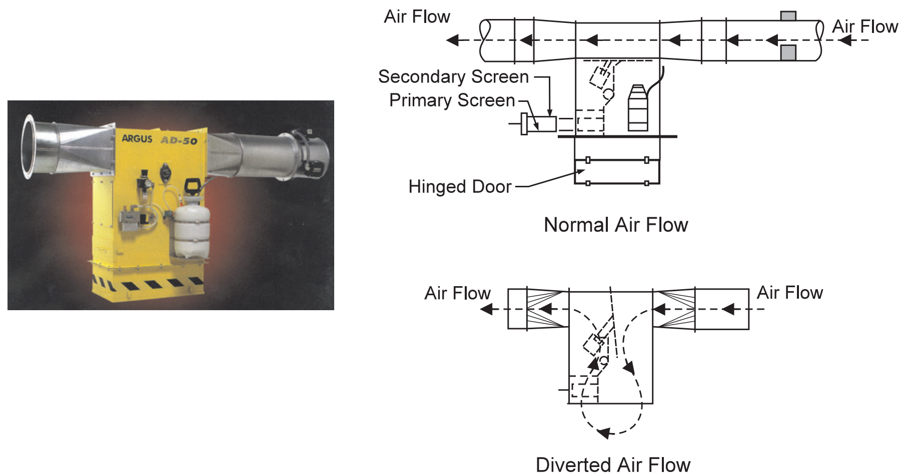


Fig. 2.3.2.2. Spark diverter. (Courtesy of ARGUS Fire Control, Charlotte, NC.)

2.3.3 Cotton and Wool Processing

2.3.3.1 Provide FM Approved special protection for cotton and wool processing in enclosed systems from opening to chute fed cards as shown in Figure 2.3.3.1.

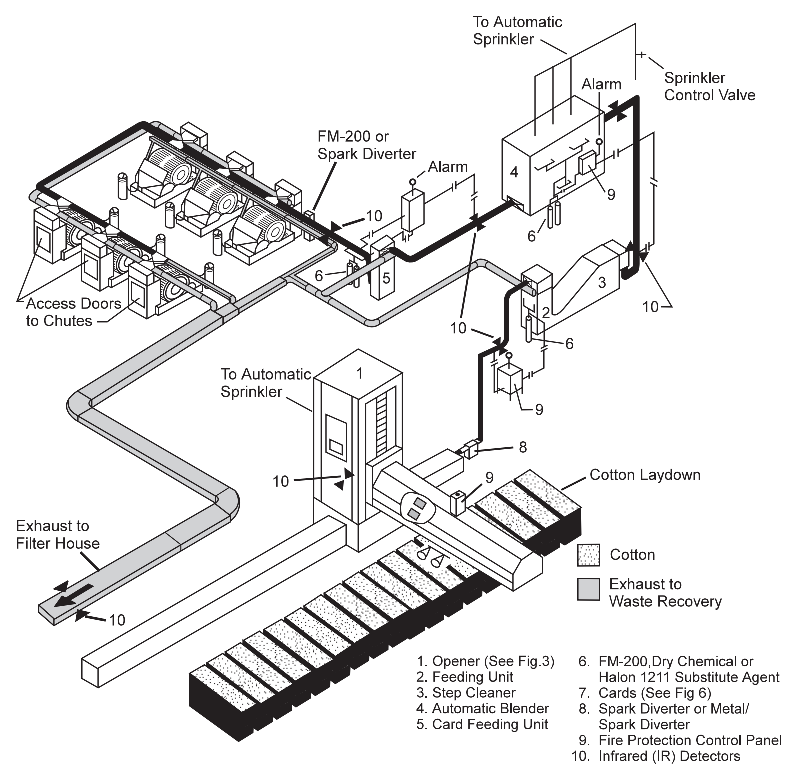


Fig. 2.3.3.1. Example of Cotton Processing Operations

2.3.3.1.1 Arrange extinguishing agent (dry chemical or a gaseous agent) to discharge into equipment downstream of the detectors, where there is fiber hold-up.

2.3.3.1.2 Have replacement agent available on site to enable protection to be restored immediately after a discharge.

2.3.3.2 Install infrared (IR) detection in the duct downstream of equipment.

2.3.3.2.1 Shut down process equipment upon fire detection to prevent fire spread.

2.3.3.2.2 Interlock exhaust fans to shut down upon fire detection if they would be likely to reduce agent concentration in the protected space.

2.3.4 Baled Fiber Warehouse

2.3.4.1 Provide automatic sprinkler protection at ceiling level as outlined in Data Sheet 8-7, *Baled Fiber Storage*, and Data Sheet 8-9, *Storage of Class 1, 2, 3, 4 and Plastic Commodities*.

2.3.5 Automatic Bale Openers

Ceiling automatic sprinkler protection can be expected to protect bales on the opener. A special protection system will be needed to prevent fire propagation to equipment downstream.

2.3.5.1 Provide a special protection system to detect a fire and discharge agent at the following locations:

A. Onto opened cotton in front of and behind the distributor for an automatic bale opener designed similar to that shown in Figure 2.3.5.1-1.

B. Into downstream equipment for an automatic bale opener designed similar to that shown in Figure 2.3.5.1-2.

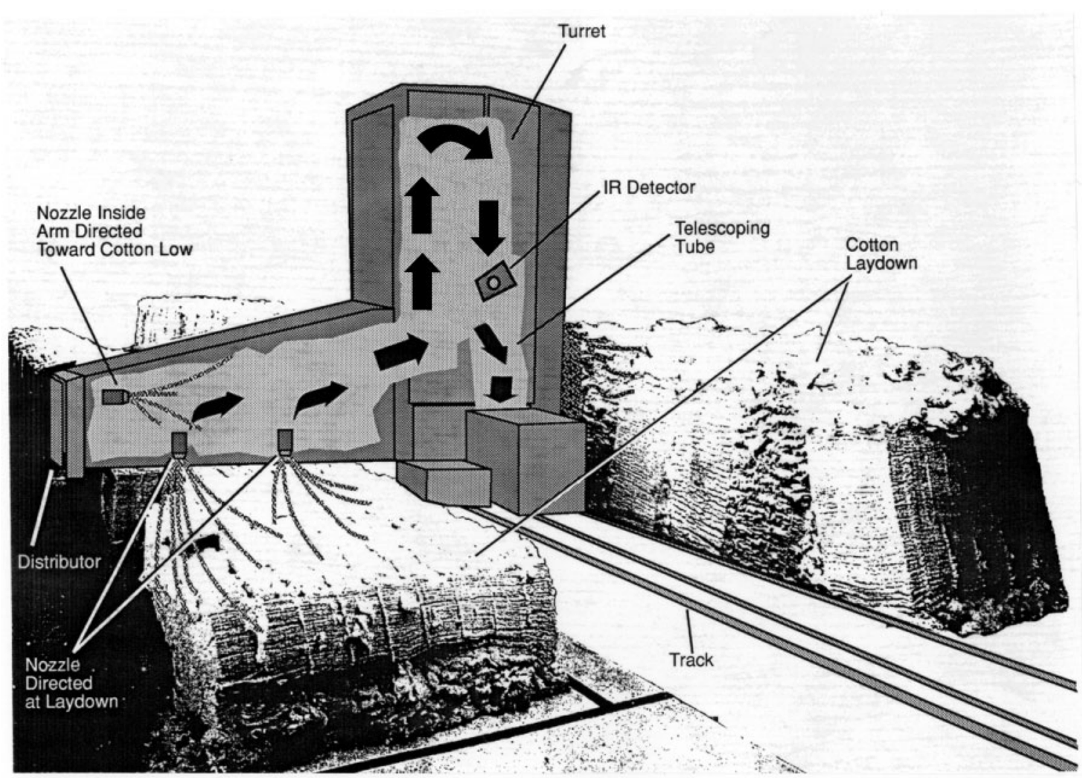


Fig. 2.3.5.1-1. Bale opener

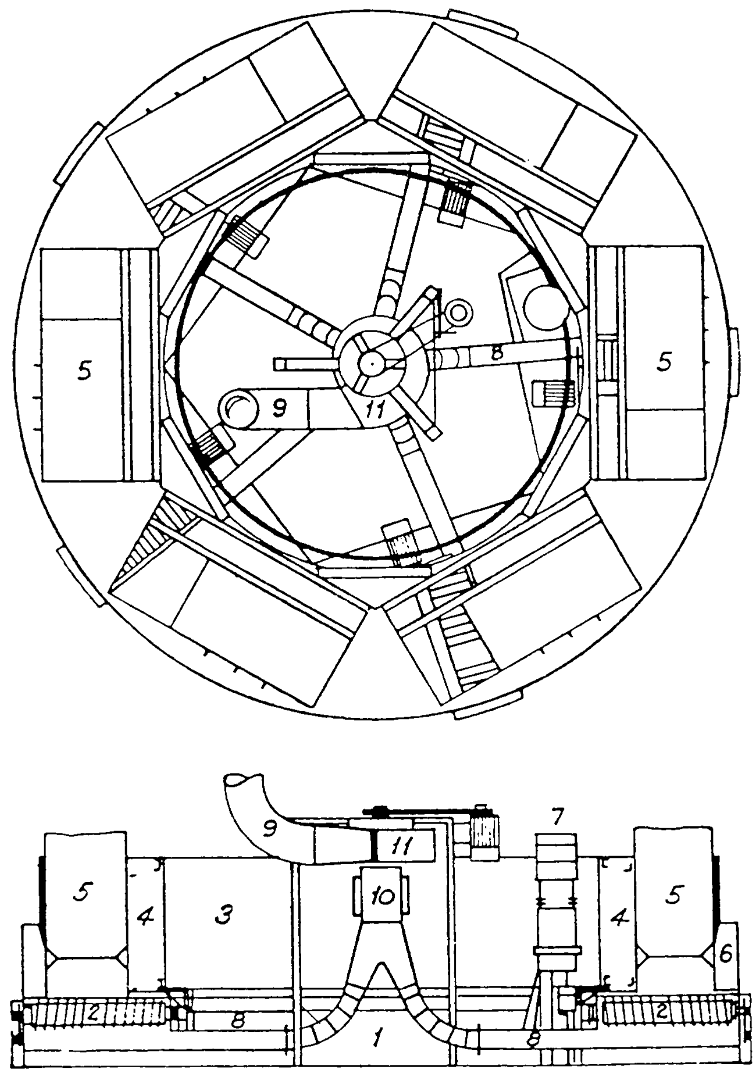


Fig. 2.3.5.1-2. Automatic bale opener

2.3.5.2 Provide IR detectors to activate the special protection system.

2.3.5.2.1 Interlock the opener to automatically shut down upon fire detection.

2.3.6 Carding

2.3.6.1 Provide a special protection system for the card line feeder (flock feeder).

2.3.6.2 Provide one of the following means of protection for the card line as shown in Figure 2.3.6.2:

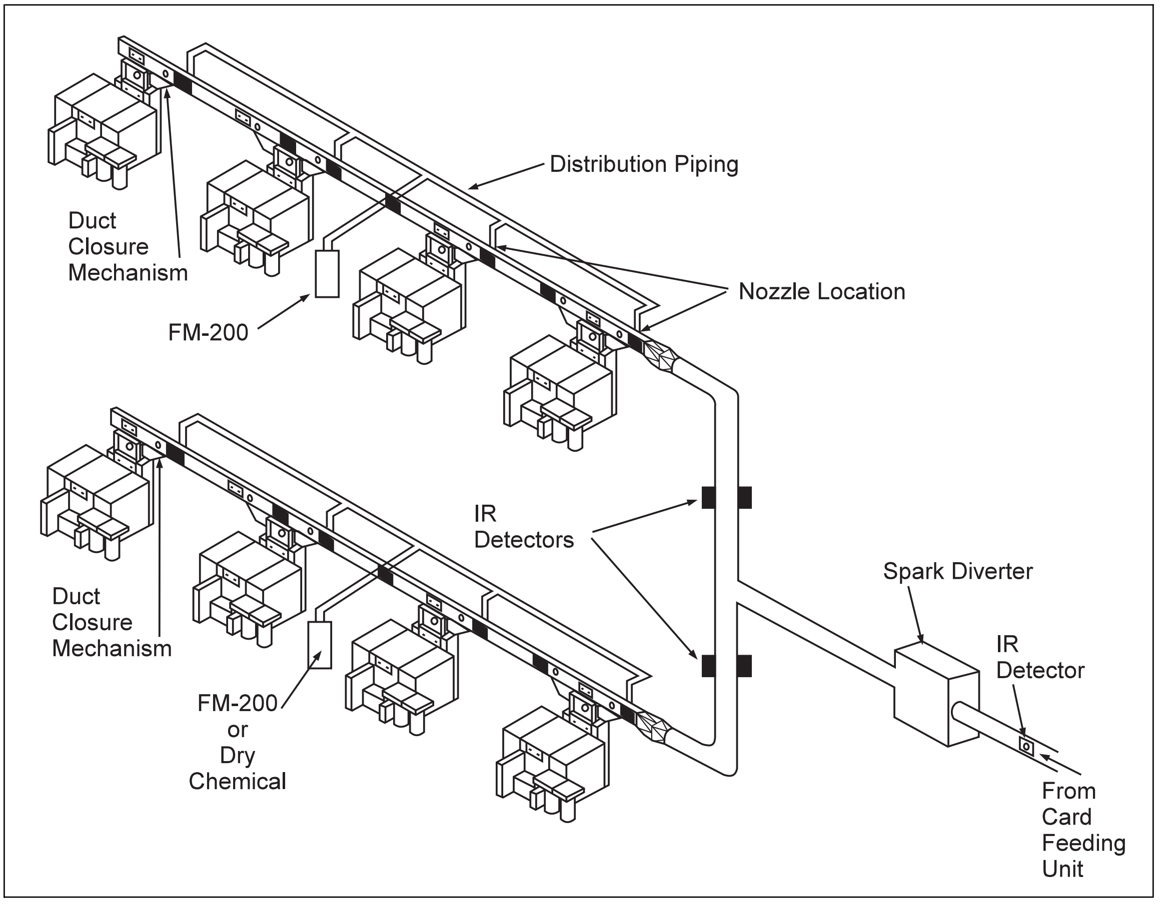


Fig. 2.3.6.2. Card line protection

A. A special protection system in the supply duct to each card line. Locate one nozzle upstream of the first four card chutes. If cards can be fed from two directions, arrange nozzles to protect card chutes in either direction activated by IR detectors or

B. A spark diverter in the supply duct to the cards activated by IR detectors.

2.3.6.3 Install the special protection system as follows:

2.3.6.3.1 Locate one nozzle upstream of the first four card chutes.

2.3.6.3.2 If cards can be fed from two directions, arrange nozzles to protect card chutes in either direction activated by IR detectors

2.3.6.4 Install IR detectors to activate the special protection system or spark diverter.

2.3.7 Warping, Beam Storage

2.3.7.1 Provide protection for beam storage as recommended in Data Sheet 8-9, *Storage of Class 1, 2, 3, 4 and Plastic Commodities.*

2.3.8 Slashing

2.3.8.1 Limit combustible build-up in the duct / hood interior to no more than 1/4 in. (6 mm) between cleanings or provide automatic sprinkler protection.

2.3.8.2 Provide automatic sprinkler protection in combustible ducts and hoods, see in accordance with Data Sheet 7-78, *Industrial Exhaust Systems.*

2.3.9 Creels

2.3.9.1 Provide sprinkler protection in the following locations:

A. In aisles between creels

B. In aisles beneath mezzanines

C. Within creels beneath mezzanines

D. Beneath mezzanine overhangs

E. In loading aisles or aisles parallel to creels when aisles are used for yarn storage

F. Below the mezzanine floor in multilevel creel racks

2.3.9.1.1 Provide automatic sprinkler protection as follows:

A. 165°F (74°C) rated, K8 (K115), quick response sprinklers. In-rack sprinklers shall be used within the creels and beneath non-solid mezzanines.

B. Space sprinklers no more than 10 ft (3 m) apart in the aisles and beneath the mezzanine overhangs

C. Space sprinklers no more than 8 ft (2.4 m) apart within the creels

D. Install sprinklers within 18 in. (45.7 cm) of the mezzanine overhang faces.

E. Coverage should not exceed 110 ft^2 (10.2 m^2) per sprinkler

F. Stagger sprinklers horizontally and vertically if more than one mezzanine level is involved

G. Design sprinkler protection to deliver 22 gpm (84 l/min) from each of the 6 most remote mezzanine sprinklers (for single level mezzanine arrangements) or the 12 most remote sprinklers (six sprinklers on two levels) if more than one mezzanine level is being protected

2.3.9.1.2 Do not include ceiling sprinkler system demand with the mezzanine sprinkler water demand if there are no combustibles between sprinklers and the edge of the mezzanine.

2.3.9.2 Include a 500 gpm (1900 l/min) allowance for hose streams.

2.3.10 Pin Trucks

2.3.10.1 Provide automatic sprinkler protection above each row of pin trucks storing acrylic yarns or blends of acrylic yarns as follows and as shown in Figure 2.1.3.1.

A. Install sprinklers 8 ft (2.4 m) on center

B. Use 165°F (74°C) rated, K8 (K115), pendent, quick response sprinklers

C. Design the system to flow a minimum of 30 gpm (114 l/min) from each of the 8 most remote sprinklers.

D. Install a separately valved connection

2.3.10.2 Include a 500 gpm (1900 l/min) allowance for hose streams.

2.3.10.3 Where pin trucks or yarn carriers are used to force air-dry yarn, provide a sprinkler water flow interlock to shut off air flow to the dryer in event of automatic sprinkler actuation.

2.3.11 Air Conditioning Systems

2.3.11.1 Protect cooling towers in accordance with Data Sheet 1-6, *Cooling Towers*.

2.3.11.2 Provide automatic sprinklers on 8 ft (2.4 m) spacing designed to discharge 22 gpm (84 l/min) from each sprinkler over V-Type or flatbed filters in the wall if ceiling protection is obstructed.

2.3.11.3 Provide automatic sprinkler protection in accordance with Section 2.3.2.1.1 at the following locations:

A. Over the filter unit in the air conditioning system where there is combustible construction or lint accumulation.

B. In waste bins

C. In waste houses, including filter units where appreciable quantities of fiber lint accumulate and over V-type or rotating drum-type filters

2.3.11.4 Provide automatically operated special protection systems (dry chemical) if cotton or other fiber may contain tramp metal.

2.3.11.4.1 Interlock the fan to automatically shut down upon activation of the special protection system.

2.3.12 Compressors

2.3.12.1 Protect compressors in accordance with Data Sheet 7-95, *Compressors*.

2.3.13 Nonwovens

2.3.13.1 Protect areas without in-process or finished product storage as outlined in Section 2.3.15.

2.3.13.2 Protect rolled nonwoven fabric and batting storage in accordance with Data Sheet 8-23, *Rolled Nonwoven Fabric Storage*.

2.3.13.2.1 Protect sheets of highloft nonwoven batting the same as rolled highloft nonwoven batting as defined in Data Sheet 8-23, *Rolled Nonwoven Fabric Storage.*

2.3.13.3 Protect sheets of nonwoven fabric on pallets up to 6 ft (1.8 m) high as unexpanded plastic in accordance with Data Sheet 8-9, *Storage of Class 1, 2, 3, 4 and Plastic Commodities*.

2.3.14 Carpet

2.3.14.1 Protect carpet racks in accordance with Data Sheet 8-30, *Storage of Carpets*.

2.3.15 Synthetic Yarns Storage

Synthetic yarns are yarns having a synthetic content of more than 50%.

2.3.15.1 Protect storage of polypropylene, polyethylene, or acrylic yarn in accordance with Table 2.3.15.1.

Table 2.3.15.1. Protection of Polypropylene, Polyethylene and Acrylic Synthetic Yarn

Protection of Polypropylene, Polyethylene and Acrylic Synthetic Yarn; No. of AS @ psi (bar)						
Storage Arrangement	Max. Storage Height, ft (m)	Max. Ceiling Height, ft (m)	Wet System, 160°F (70°C) Nominally Rated, Pendent, Quick Response Sprinklers			
			K14.0 (K200)	K16.8 (K240)	K22.4 (K320)	K25.2 (K360)
Palletized	16 (4.9)	20 (6.1)	9 @ 50 (3.5)	9 @ 35 (2.4)	9 @ 25 (1.7)	9 @ 20 (1.4)
		25 (7.6)	10 @ 50 (3.5)	10 @ 35 (2.4)	10 @ 25 (1.7)	10 @ 20 (1.4)
		30 (9.1)	15 @ 50 (3.5)	15 @ 35 (2.4)	10 @ 50 (3.5)	10 @ 40 (2.8)
		35 (10.7)			9 @ 75 (5.2)	9 @ 60 (4.1)
		40 (12.2)			12 @ 75 (5.2)	12 @ 60 (4.1)
		>40 (12.2)	• Keep palletized and install false ceiling; or • Move storage into racks and protect as UEP using a design that includes in-rack sprinklers per Data Sheet 8-9.			
	>16 (4.9)	25 (7.6)	12 @ 75 (5.2)	12 @ 52 (3.6)	9 @ 32 (2.2)	9 @ 25 (1.7)
		30 (9.1)	12 @ 100 (6.9)	12 @ 70 (4.8)	12 @ 50 (3.5)	12 @ 40 (2.8)
		40 (12.2)				20 @ 75 (5.2)
		> 40 (12.2)	• Keep palletized and install false ceiling; or • Move storage into racks and protect as UEP using a design that includes in-rack sprinklers per Data Sheet 8-9.			
Open Frame Racks	Any	25 (7.6)	12 @ 75 (5.2)	12 @ 52 (3.6)	9 @ 32 (2.2)	9 @ 25 (1.7)
		30 (9.1)	12 @ 100 (6.9)	12 @ 70 (4.8)	12 @ 50 (3.5)	12 @ 40 (2.8)
		40 (12.2)				20 @ 75 (5.2)
		>40 (12.2)	• Keep palletized and install false ceiling; or • Move storage into racks and protect as UEP using a design that includes in-rack sprinklers per Data Sheet 8-9.			
In-Process	6 (1.8)	Any	Protect per Data Sheet 3-26 using either Table 2.3.1.10 based on applicable hazard category, or per Table 2.3.3.1 for low piled storage			

2.3.15.2 Protect storage of nylon yarn in accordance with Table 2.3.15.2.

Table 2.3.15.2. Protection of Nylon Yarn

Protection of Nylon Yarn; No. of AS @ psi (bar)						
Storage Arrangement	Max. Storage Height, ft (m)	Max. Ceiling Height, ft (m)	Wet System, 160°F (70°C) Nominally Rated, Pendent, Quick Response Sprinklers			
			K14.0 (K200)	K16.8 (K240)	K22.4 (K320)	K25.2 (K360)
Palletized	16 (4.9)	20 (6.1)	12 @ 18 (1.2)	12 @ 13 (0.9)	9 @ 20 (1.4)	9 @ 20 (1.4)
		25 (7.6)	9 @ 45 (3.1)	9 @ 32 (2.2)	9 @ 20 (1.4)	9 @ 20 (1.4)
		30 (9.1)	12 @ 50 (3.5)	12 @ 35 (2.4)	12 @ 25 (1.7)	12 @ 20 (1.4)
		35 (10.7)			9 @ 75 (5.2)	9 @ 60 (4.1)
		40 (12.2)			12 @ 75 (5.2)	12 @ 60 (4.1)
		>40 (12.2)	• Keep palletized and install false ceiling; or • Move storage into racks and protect as UUP using a design that includes in-rack sprinklers per Data Sheet 8-9.			
Open Frame Racks	Any	20 (6.1)	9 @ 50 (3.5)	9 @ 35 (2.4)	9 @ 25 (1.7)	9 @ 20 (1.4)
		25 (7.6)	10 @ 50 (3.5)	10 @ 35 (2.4)	10 @ 25 (1.7)	10 @ 20 (1.4)
		30 (9.1)	15 @ 50 (3.5)	15 @ 35 (2.4)	10 @ 50 (3.5)	10 @ 40 (2.8)
		40 (12.2)			12 @ 75 (5.2)	12 @ 60 (4.1)
		>40 (12.2)	• Keep palletized and install false ceiling; or • Move storage into racks and protect as UUP using a design that includes in-rack sprinklers per Data Sheet 8-9.			
In-Process	6 (1.8)	Any	Protect per Data Sheet 3-26 using either Table 2.3.1.10 based on applicable hazard category, or per Table 2.3.3.1 for low piled storage			

2.3.15.3 Protect storage of polyester yarn in accordance with Table 2.3.15.3.

Table 2.3.15.3. Protection of Polyester Yarn

Protection of Polyester Yarn; No. of AS @ psi (bar)						
Storage Arrangement	Max. Storage Height, ft (m)	Max. Ceiling Height, ft (m)	Wet System, 160°F (70°C) Nominally Rated, Pendent, Quick Response Sprinklers			
			K14.0 (K200)	K16.8 (K240)	K22.4 (K320)	K25.2 (K360)
Palletized	16 (4.9)	20 (6.1)	12 @ 18 (1.2)	12 @ 13 (0.9)	9 @ 20 (1.4)	9 @ 20 (1.4)
		25 (7.6)	9 @ 35 (2.4)	9 @ 24 (1.7)	9 @ 20 (1.4)	9 @ 20 (1.4
		30 (9.1)	12 @ 50 (3.5)	12 @ 35 (2.4)	9 @ 20 (1.4)	9 @ 20 (1.4)
		35 (10.7)			9 @ 75 (5.2)	9 @ 60 (4.1)
		40 (12.2)			12 @ 75 (5.2)	12 @ 60 (4.1)
		>40 (12.2)	• Keep palletized and install false ceiling; or • Move storage into racks and protect as CEP using a design that includes in-rack sprinklers per Data Sheet 8-9.			
Open Frame Racks	Any	20 (6.1)	12 @ 18 (1.2)	12 @ 13 (0.9)	9 @ 20 (1.4)	9 @ 20 (1.4)
		25 (7.6)	12 @ 35 (2.4)	12 @ 24 (1.7)	10 @ 20 (1.4)	9 @ 20 (1.4)
		30 (9.1)	12 @ 50 (3.5)	12 @ 35 (2.4)	12 @ 25 (1.7)	12 @ 20 (1.4)
		40 (12.2)			12 @ 75 (5.2)	12 @ 60 (4.1)
		>40 (12.2)	• Keep palletized and install false ceiling; or • Move storage into racks and protect as CEP using a design that includes in-rack sprinklers per Data Sheet 8-9.			
In-Process	6 (1.8)	Any	Protect per Data Sheet 3-26 using either Table 2.3.1.10 based on applicable hazard category, or per Table 2.3.3.1 for low piled storage			

2.3.15.4 Include a 250 gpm (950 L/min) allowance for hose streams.

2.3.16 Ovens, Dryers, Tenter Frames

2.3.16.1 Provide automatic sprinkler protection in ovens, dryers, and exhaust stacks in accordance with Data Sheet 6-9, *Industrial Ovens and Dryers*.

2.3.16.2 Protect exhaust ducts in accordance with Data Sheet 7-78, *Industrial Exhaust Systems*.

2.3.16.3 Follow additional protection recommendations as described in Data Sheet 6-9, *Industrial Ovens*.

2.3.17 Bleaching

2.3.17.1 Provide protection for operations involving hydrogen peroxide in accordance with Data Sheet 7-80, *Organic Peroxides and Oxidizing Materials*. Mixing with any alkaline material (e.g., sodium hydroxide) can cause increased decomposition rates.

2.3.18 Heat Transfer Oil Systems

2.3.18.1 Design and protect heat transfer fluid (HTF) systems in accordance with Data Sheet 7-99, *Heat Transfer by Organic and Synthetic Fluids*. Systems may include rotating couplings and elevated holding tanks.

2.3.18.2 Provide interlocks to automatically shut down the HTF system in event of fire.

2.3.18.3 Provide automatic sprinkler protection for ovens and dryers heated by HTF systems.

2.3.19 Printing Dyes and Screen Manufacturing

2.3.19.1 Protect ignitable liquids in use in accordance with Data Sheet 7-32, *Ignitable Liquid Operations*.

2.3.19.2 Protect ignitable liquids in storage in accordance with Data Sheet 7-29, *Ignitable Liquid Storage in Portable Containers*.

2.3.19.3 Protect plastic tanks in accordance with Data Sheet 7-6, *Plastic and Plastic-Lined Tanks*.

2.3.20 Cutting and Sewing

2.3.20.1 Provide automatic sprinkler protection below tables or keep areas clear of combustibles at all times.

2.3.20.2 Provide automatic sprinkler protection below tables where combustibles are stored.

2.4 Operation and Maintenance

2.4.1 Special protection systems should be inspected and maintained in accordance with Data Sheet 4-0, *Special Protection Systems*.

2.4.2 Replace corroded sprinklers, pipes, and hangers in accordance with Data Sheet 2-81, *Fire Protection System Inspection, Testing and Maintenance*.

2.4.3 Establish a maintenance and lubrication schedule for all equipment. The maintenance schedule will vary with type of fiber processed and the equipment used. Review plant fire loss records to determine whether cleaning or equipment maintenance was a factor, and increase frequency as needed.

2.4.3.1 Lubricate equipment in accordance with manufacturer's recommendations.

2.4.4 If a keyed abort switch on special protection systems is used for equipment maintenance, have the key under the control of either the department head or maintenance personnel.

2.4.5 Safely arrange handling of dry starch. See Data Sheet 7-76, *Prevention and Mitigation of Combustible Dust Explosions and Fire*, for information on controlling dust hazards.

2.4.6 Develop a recovery plan to allow for immediate replacement or provision of an alternate system for cooling in the event of loss of a cooling tower.

2.4.7 For air conditioning systems and pneumatic waste recovery and cleaning systems, stock enough filter media to recover the largest filter.

2.4.8 Establish a program of preventive maintenance so that all electrical equipment is periodically inspected in accordance with Data Sheet 5-20, *Electrical Testing*.

2.4.8.1 Include annual IR inspections of electrical equipment in the program.

2.4.9 Remove metal bands from bales before they enter the lay down area and account for all bands.

2.5 Human Factor

2.5.1 Develop a pre-incident plan with the fire service in accordance with Data Sheet 10-1, *Pre-Incident and Emergency Response Planning*, that includes the following, if applicable:

- Emergency supervision of sprinkler control valves, fire pumps, and special protection systems
- Access and shutdown operations for air handling and tunnel systems
- Shutdown operations for conveyor systems
- Shutdown operations for heat transfer fluid systems in accordance with Data Sheet 7-99, *Heat Transfer Fluid Systems*
- Location of multi-floor cloth take-ups
- Location of baled fiber storage

2.5.2 For the HVAC system, train personnel to activate only the switch controlling the ventilation system for the area in which the fire occurs.

2.5.2.1 If an exhaust system is in operation or is started to vent smoke from the area, do not shut it off until the fire is extinguished.

2.5.2.2 If a fire occurs when the exhaust system is not in operation do not start fans until fire is extinguished.

2.5.3 Train operators to manually shutoff any cranes in the event of fire for automatic bale feeder.

2.6 Utilities

2.6.1 General

2.6.1.1 Run service for compressed air and electric power above the floor rather than in trenches.

2.6.1.1.1 Provide emergency quick connects for replacement compressors that may be needed to replace fire-damaged compressors.

2.6.1.1.2 Provide small hose with spray nozzles for weave rooms.

2.6.1.2 Design and maintain chemical bond spray guns in non-woven areas to keep overspray to a minimum. Keep the area around spray guns clear of over spray and fiber buildup.

2.6.2 Electrical

2.6.2.1 General

2.6.2.1.1 Provide FM Approved electrical equipment for use in areas containing airborne lint or dusts. Equipment should be approved to national standards. Where national standards are not available use equipment approved for Class III Hazardous locations as defined by the National Electrical Code. If FM Approved equipment is not available, equipment listed, labeled, or approved by another recognized testing laboratory is preferable to unapproved equipment. If such equipment is not available use NEMA Type 12 equipment.

2.6.2.2 Load Centers

2.6.2.2.1 Where computer programming is used for load centers, keep a copy of the program in a separate fire area. One method of doing this may be by having the vendor (installer) maintain and update software.

2.6.2.2.2 Ensure that systems that connect to the site’s industrial control systems meet the recommendations in Data Sheet 7-110, *Industrial Control Systems*.

2.6.2.2.3 Dry-type transformers are preferred. See Data Sheet 5-4, *Transformers*.

2.6.2.2.4 If ventilated dry transformers are used, locate them where they will not be exposed to lint accumulations, dust or corrosive atmospheres.

2.6.2.3 Lighting

2.6.2.3.1 Do not use temporary lighting units (e.g., drop cords, etc.). There is a greater chance that temporary units will be improperly hung and, as a result, broken.

2.6.2.3.2 Protect lighting fixtures from flying metal bands.

2.6.2.3.3 Do not install high voltage series cold-cathode fluorescent lights.

3.0 SUPPORT FOR RECOMMENDATIONS

3.1 General

The cotton or cotton blend process is the most common. Processes handling other fibers, natural and synthetic, use similar equipment and have similar hazards.

Plant interdependencies are common in the textile industry. One or more operations in the manufacturing process may take place in a different plant(s), for example yarn mills, weaving, tufting, knitting, and finishing plants.

3.1.1 Greige Goods

Greige goods are unfinished yarn or fabric. The raw material is received as natural or synthetic staple in bales. The processing involves aligning the fiber, cleaning (for materials such as cotton and wool), forming a rope-like material and then combining and twisting to produce yarn. Yarn may be the finished product of a greige goods mill, or it may be woven into a fabric that is generally shipped elsewhere for further processing.

3.1.2 Finishing Operations

Finishing of textile fabric includes mechanical, heat-related, and chemical treatments to improve specific properties of these fabrics. Mechanical treatments, such as calendaring, involve application of heat and pressure to a fabric to develop a permanent effect, such as a change in the surface appearance.

Chemical treatments involve the application of a chemical as a surface coating or one that chemically combines with the fabric. Properties that can be obtained are change in how a fabric feels (hand), pretreatment for dyeing and printing, wash and wear, water repellant, fire retardancy, etc.

Chemicals are usually applied by immersion of the fabric in an aqueous finishing formulation, squeezing the fabric to remove excess formulation, drying, and curing the finish. Most of the finishes used are water base.

3.1.3 Wool

Wool may be processed from raw (greasy) wool or wool reclaimed from used fabric. Raw wool contains fats and oils in addition to vegetable substances like twigs, straw, leaves, etc. Scoured wool is raw wool or reclaimed wool that has been cleaned and dried. Scoured wool is used for the two major systems of yarn manufacture: woolen and worsted. The woolen system produces a yarn with fibers randomly arranged. Two operations are required: carding and spinning. The yarn is used for soft bulky fabrics such as dress material, blankets, etc. The worsted system uses a longer length staple. It produces a yarn with fibers arranged parallel to each other. Several operations are involved: carding, gilling, combing, drawing, and spinning. The yarn is used to produce hard textured fabrics.

Fire tests have been run on both types of wool in bulk. Both are difficult to ignite. Once ignited, scoured wool burns steadily until consumed. Flames do not flash over the surface as they do in a cotton fire. Raw (greasy) wool is more difficult to ignite. When ignited, it tends to smolder. Fires in both types give off large quantities of dense, acrid smoke.

3.1.4 Synthetic Fibers

Synthetic fiber production is an extrusion process often using heat transfer fluid where plastic chips melted under pressure are forced through spinnerets to form filaments. Continuous filaments (partially orientated yarn) are used in the spinning process to give it proper feel.

3.1.4.1 Blending

Cloth can be 100% synthetic, 100% natural fiber (i.e., cotton or other), or a blend. Synthetics can be blended with cotton in the opener equipment, drawing frames, winding, or weaving.

3.2 Construction and Location

Older mills can be of multistory plank on timber floors and roof with brick wall construction. Concealed spaces are common below floors, within floors, above ceilings and inside walls. Floor penetrations are also common and in event of fire can result in increased water and smoke damage. Older mills are often located along rivers and flood plains.

Heavy wood timbers and planks can withstand fire exposure longer than exposed steel but will add considerable combustible loading and can result in a deep-seated fire.

Exposed steel construction, piping and electrical in bleaching and dying areas will deteriorate from exposure to moisture and caustics.

Mills are often located in small towns and rural areas with fire departments having limited resources, equipment, and training for preplanning for firefighting in large industrial sprinklered buildings.

3.3 Occupancy

3.3.1 Housekeeping

Housekeeping is critical to reducing the frequency and lowering the severity of fires in the textile industry. Loose fiber and oil mist can be airborne and will collect above the ceiling, on the ceiling, on machinery, at the floor, below the floor and inside ducts. Increased production demands can result in reduced or skipped housekeeping and increase the probability of a fire. Written corporate and plant policies on housekeeping are needed to ensure cleaning cycles are adequate, cleanings are not skipped, and spot cleaning is completed as needed.

As a general rule, the maximum deposit thickness for loose fluffy lint is 1/2 in. (13 mm) over a maximum of 500 ft^2 (46.5 m^2). Dense deposits should be limited to 1/4 in. (6 mm) and oil saturated deposits should be limited to 1/8 in. (3.2 mm).

Once cleaning schedules are established for walls, ceiling, floor, exhaust, and supply air ventilation systems, they should be adjusted based on documented inspections and observations completed between normally scheduled cleanings, i.e., some areas may need more frequent cleaning.

3.3.2 Opening Equipment

The purpose of the preparatory equipment is to open the tightly compressed cotton and remove foreign material such as motes, leaves or dirt. These are the first machines into which the fiber is introduced.

3.3.2.1 Arrangement of Opener Room

Use of automated opener equipment has resulted in more efficient use of floor area in the opener room. This equipment also results in essentially unmanned opener rooms with a corresponding increase in time to detect and manually fight a fire. Usually, on the first shift, a large enough supply of cotton and synthetic bales are brought in to last the 24-hour period. Unopened bales in storage in the opener room are wrapped with polypropylene, jute, or polyethylene and secured with metal wire or bands. They are generally well removed (by distance) from opening equipment.

Most fires caused by opening equipment result in fires in equipment downstream rather than in cotton laydown. Opening rooms are generally cleaner now than in the past due most likely to the use of automated opening equipment. The 20 ft (6 m) separation between bale laydown for feeder blending was reduced to 10 ft (3 m) for bale laydown for automatic bale openers for this reason. Wrapping of bales with polypropylene, jute or polyethylene generally results in less likelihood of fire spread across unopened bales. The loss experience has been favorable in regard to fires in opener rooms.

3.3.2.2 Blending Feeders

Blender-openers, as show in Figure 3.3.2.2-1, were the first step in the opening process and were hand-loaded. They may still be hand-loaded when synthetics are used. Where cotton is used, and in most cases where synthetics are in use, they are the second step in the process. They often are equipped with individual auxiliary cleaning sections. Their speed is low and they create little fire hazard. In many cases, these units replace vertical openers.

For this type of equipment, layers of cotton from several bales are placed on the feed apron. Cotton is drawn up the lift apron, under doffer rolls, between feed rolls, and over cleaning grids to break the matted cotton up into tufts and remove leaves, motes, etc.

Choking or excessive wrapping of fiber around bearings can be reduced by not overloading blending feeders. Keeping the hopper not over two-thirds full is the practice at most mills.

For new installations and where loss experience indicates that bale breakers or older blending feeders are a factor in recurring fires, fully enclosed opening feeders, as shown in Figure 3.3.2.2-2, offer several desirable safety features. Included are sealed bearings that are not likely to become choked by stock, enclosed hopper design that results in rapid sprinkler actuation, and an exhaust system for removing dust and fine lint.

For this type of equipment, layers of cotton from several bales are placed on the feed apron. Cotton from the layers is drawn up the lift apron and broken up into tufts by two combs before being deposited into a weigh hopper or directly onto a feed table.

3.3.2.3 Automatic Bale Openers

There are a variety of automatic bale feeders in textile mills.

In one type, fiber laydown is on the floor adjacent to the machine. In the type shown in Figure 3.3.2.3-1, the crane operates when a photocell senses that the apron needs fiber, and the crane is moved into position over a bale in front of the apron. The pickup head is lowered, peels off fiber, and the crane transports it back to the feed apron where it is dropped onto apron. Each opened fiber bale is mounted on its own pallet with rollers.

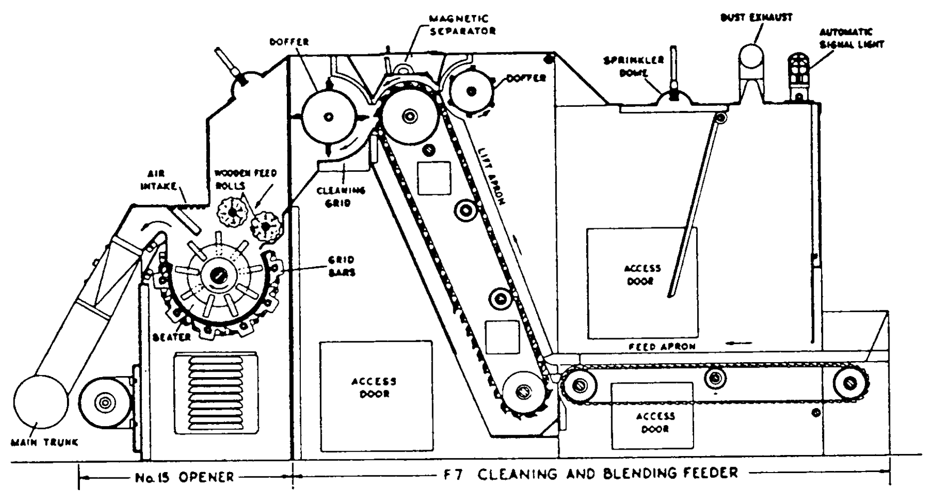
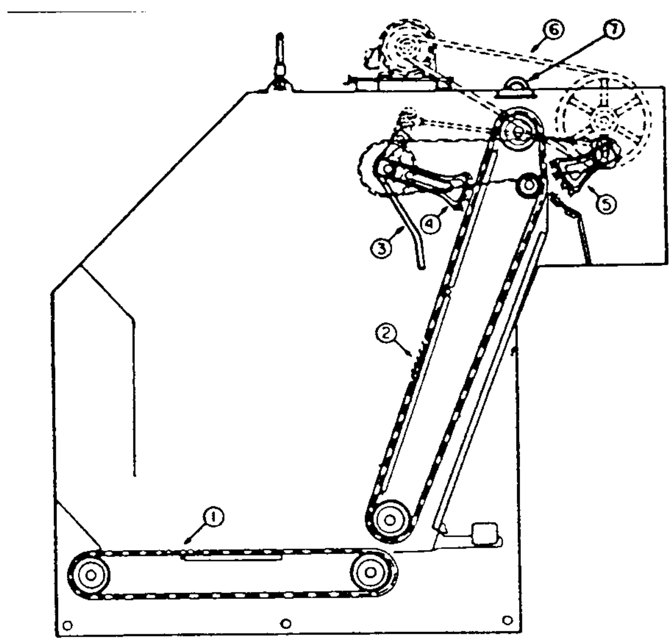


Fig. 3.3.2.2-1. Blender-opener combination



1. Variable speed feed apron.
2. Variable speed lift apron.
3. Compensator to keep constant supply to lift apron and comb.
4. High speed special aluminum comb which works between pins on lift apron.
5. Super high speed aluminum comb (to 300 strokes per min.) for maximum opening.
6. Variable speed drive.
7. Magnetic separator.

Fig. 3.3.2.2-2. Opening feeder

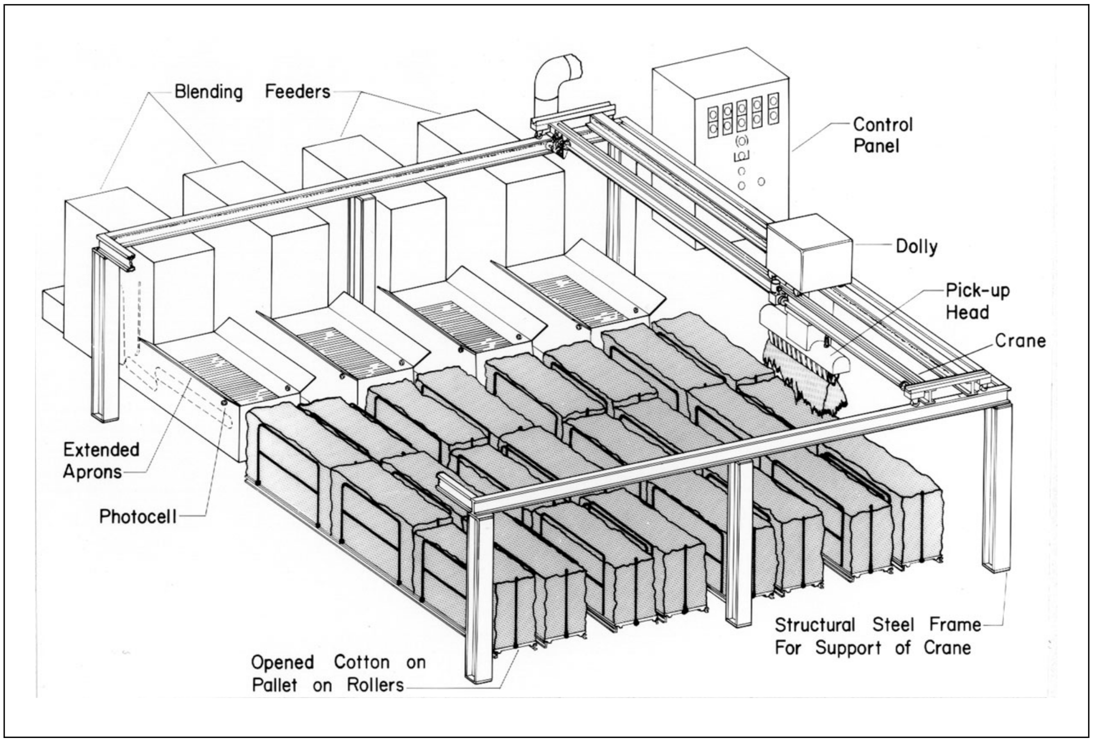


Fig. 3.3.2.3-1. Automatic bale feeder

It is often difficult to maintain a space between cotton laydown and the feed table due to cotton dropping off the crane or operators pushing bales too close to equipment. Fires start in bale laydown will probably involve blending feeders. If not quickly controlled, fires starting in blending feeders will spread to cotton laydown. Fires typically start when foreign material such as metal or stones in the bales are struck by the blades of the opening roller.

In another type, as shown in Figure 3.3.2.3-2, used bales of opened cotton are located parallel to a track. The opener travels along the track. A turret extends out over the tops of bales on one side. Opening rolls within the turret pluck cotton from the bales and it is drawn through a telescoping tube to a duct to downstream cleaning equipment. Depending on type of opener there may be as many as 90 bales on either side of the opener.

In another style opener, as shown in Figure 3.3.2.3-3, fiber bales are placed in one of several chambers on a rotating circular platform. The platform rotates slowly over a fixed subplatform containing beaters. As a bale goes over a beater, small tufts of fiber are removed from the underside of the bale, drawn into a duct and conveyed to cleaning equipment.

In another type, several opened bales of fiber are mounted on a conveyor that moves forward and backward while steel fingers penetrate the bale, pull out cotton tufts and drop it onto a conveyor belt below. Both machines essentially eliminate the need for cotton laydown. Unopened bale storage will probably be found in opener rooms using this equipment.

3.3.2.4 Vertical Openers

In some cotton mills, the vertical opener is the first equipment having rapidly rotating parts. The cotton is pneumatically conveyed upward through the machine. The arms of a vertically mounted steel beater, surrounded by adjustable steel grid bars, throw the cotton outward against the grid bars. Motes, leaves and dirt pass through the grid and are removed.

3.3.2.5 Horizontal Openers and Cleaners

The several styles of horizontal cleaners are usually fed by a lattice apron and a fluted feed roller as shown in Figures 3.3.2.5-1, 3.3.2.5-2, and 3.3.2.5-3. The beater is mounted horizontally, giving either an upward

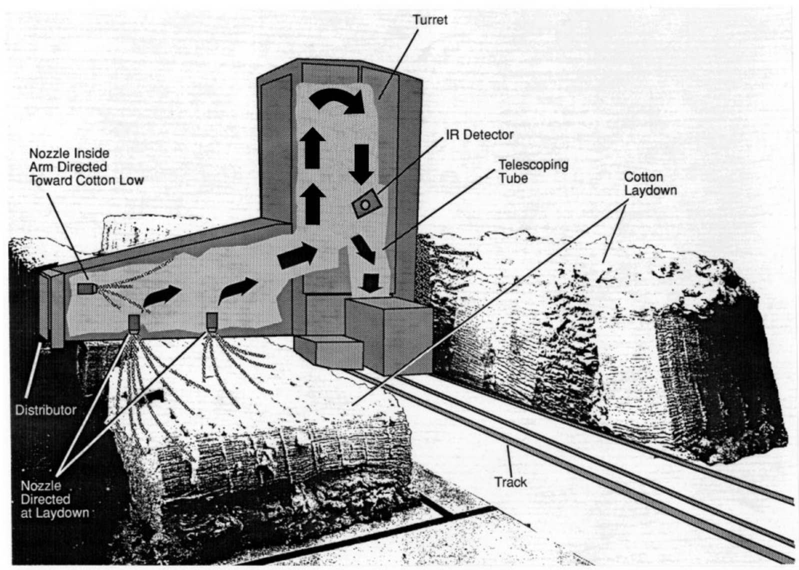


Fig. 3.3.2.3-2. Bale opener

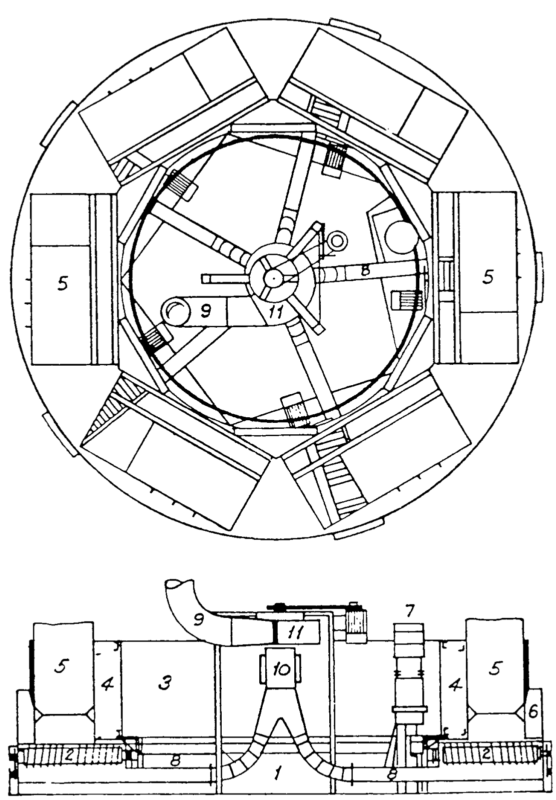


Fig. 3.3.2.3-3. Automatic bale opener

or downward stroke to the cotton held between the feed rollers. Surrounding the beater are several grid bars that remove fly, dirt or motes. Some lattice openers are equipped with supplementary beater assemblies for improved cleaning. The number of fires appears to increase rapidly with operating speed.

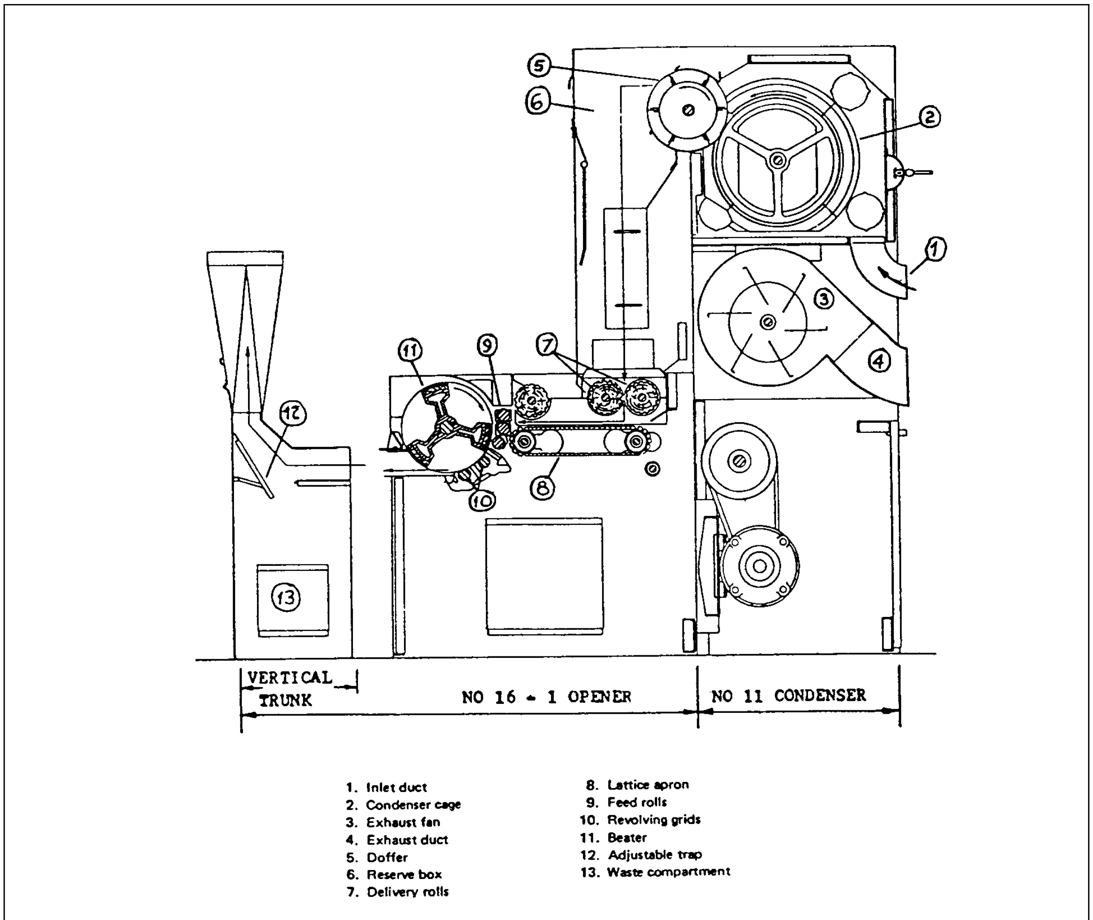


Fig 3.3.2.5-1. No. 16-1 opener with No. 11 condenser feed

For the cleaner shown in 3.3.2.5-1, cotton enters the No. 11 condenser and impinges on the face of a perforated cylinder (condenser cage). Cotton impinging on the cage is retained; impurities such as dust and trash pass through the perforations, through the exhaust fan and duct, and are filtered. The doffer strips the cotton from the surface of the cage and drops it into the reserve box. Delivery rolls ensure an even flow of stock to a short lattice apron that transports the cotton to feed rolls, revolving grids, and a beater that further cleans the fiber. Cotton is then passed into a vertical trunk where it strikes an adjustable plate or trap. Heavy particles are deflected downward, and the cotton is carried upward by the air stream.

For the cleaner shown in Figure 3.3.2.5-2, the condenser is normally used to deliver cotton to the reserve chamber of the lattice opener. Feed rolls deliver the stock to the beater. Foreign material drops into the waste compartment as the cotton is drawn over the grid bars by the action of the beater blades.

For the cleaner shown in Figure 3.3.2.5-3, stock is drawn over the grid bars by the projecting pins on the cylinders. Waste accumulates in the compartment below the grid bars.

3.3.2.6 Centrif-Air Machines

The Centrif-Air machine is somewhat similar in action to the vertical opener. The cotton enters one end of the machine and is pneumatically carried through it. The beater shaft is mounted horizontally; this is one of the few opener-cleaning machines having non-ferrous beaters or beaters protected by brass sheathing. Dirt, motes, or fly are removed from the stock through slotted openings in a screen surrounding the beater. There is a tendency for cotton to wind around the beater shaft at the discharge end of the machine.

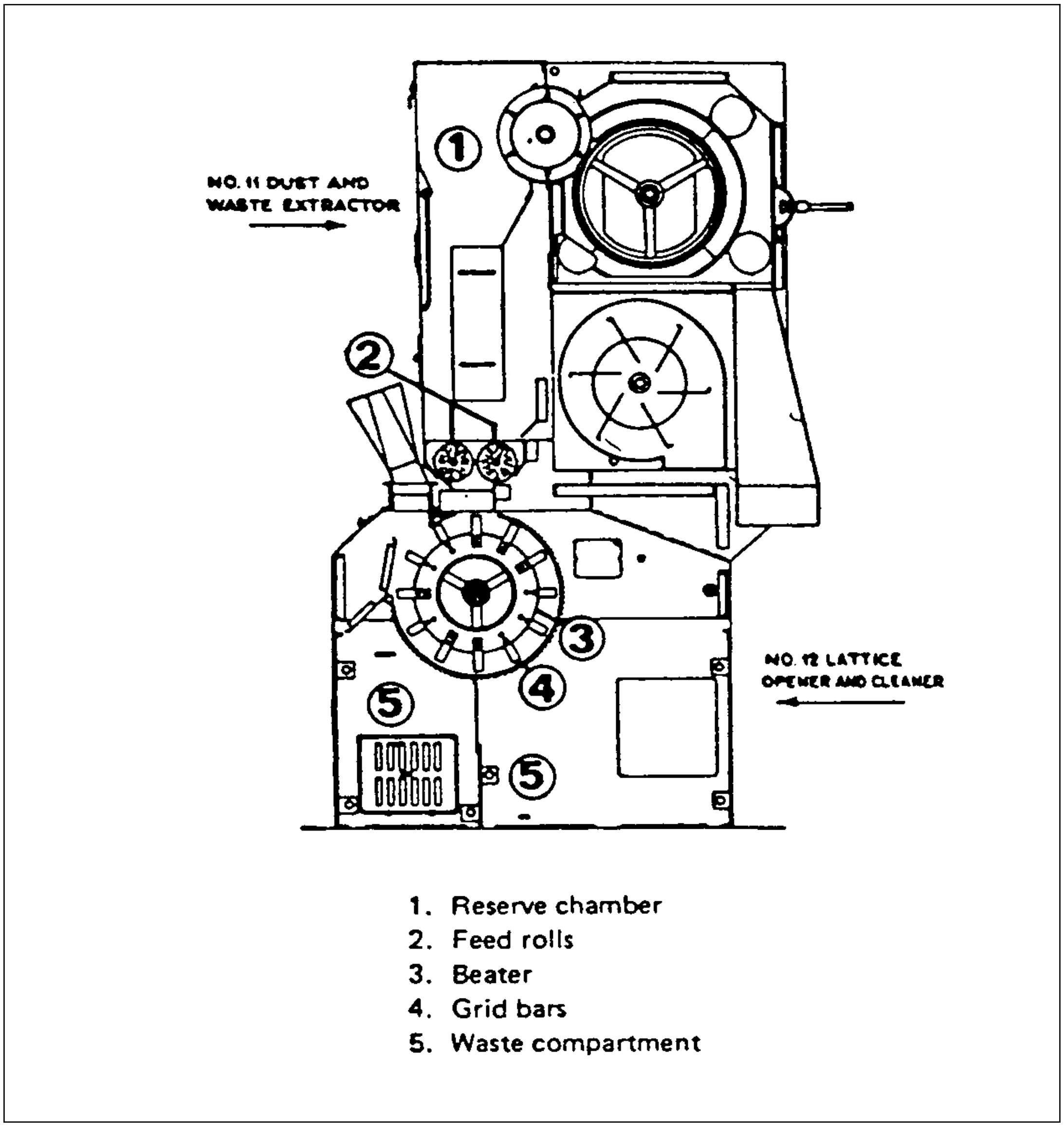


Fig. 3.3.2.5-2. Lattice opener with No. 11 condenser feed

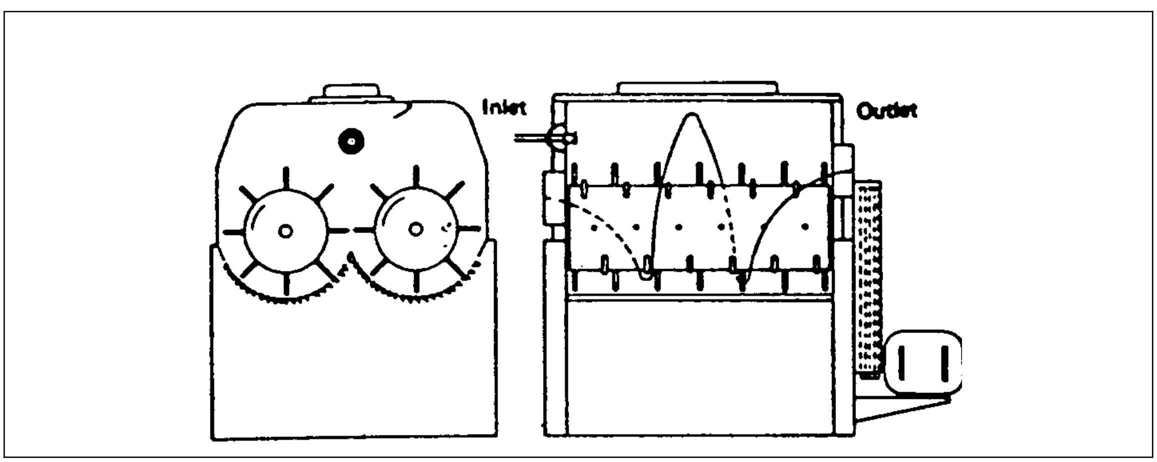


Fig. 3.3.2.5-3. Axial flow cleaner

3.3.2.7 Blending Equipment

Blending needed for uniform yarn quality can be achieved in a mixer as shown in Figure 3.3.2.7. The height of the machine and number of chambers and, therefore, the quantity of fiber varies with model of the machine. Fiber enters the machine from upstream cleaners and is conveyed into the feed duct above the chambers. The entry of fiber into the chambers is controlled by dampers that open on low level sensors. Fiber that has arrived from the upstream machine at different times is combined in the chambers. Fiber passes through opener rolls and is ducted to downstream equipment.

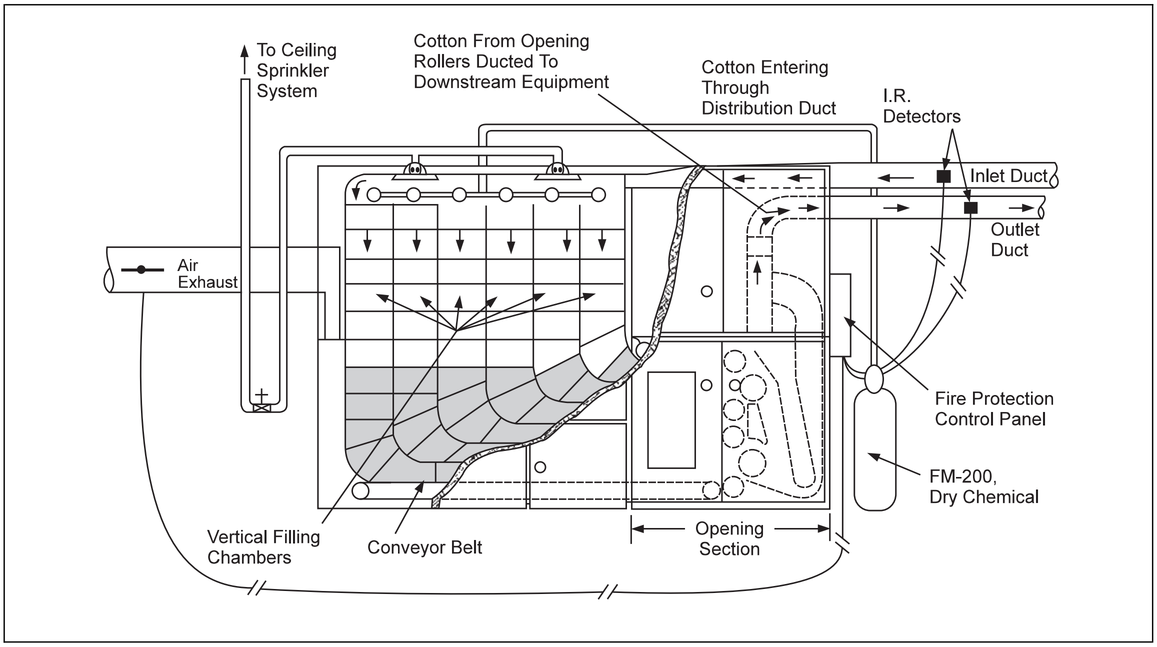


Fig. 3.3.2.7. Aeromix nks

3.3.3 Waste Recovery

Most cotton mills recover all reworkable waste from cards, combers, drawing frames, slubbers and spinning frames.

Card lap ends, if kept off the floor, can be kept relatively free of foreign material and are less hazardous than baled cotton.

Clean sliver waste is obtained from cards, combers, drawing frames and slubbers; if collected in sliver cans or boxes, it usually is free of foreign material. As sliver waste contains parallel fibers with a slight twist, it has some tensile strength. Unless broken up into small pieces, it tends to wrap around moving machine parts, causing friction fires.

The most positive method of breaking up sliver waste is to pass it through a separate waste machine having a beater section or through a garnetting machine. A less positive method is to feed the waste directly into a separate blending feeder equipped with an oscillating comb. With a setting of the comb close to the lift apron, the sliver is well broken up.

Roving and scavenger waste from slubbers, intermediates or spinning frames contains considerable twist and is accumulated in boxes or cans. This waste often contains ring travelers (usually metal).

3.3.4 Magnetic Separators

Most opener fires in cotton mills can be traced to the presence of tramp metal in raw or waste stocks. Magnetic separators, as shown in Figures 3.3.4-1 and 3.3.4-2, provide automatic means of extracting such foreign material during the preparatory process, thus protecting against mechanical damage to machinery as well as removing a possible fire cause.

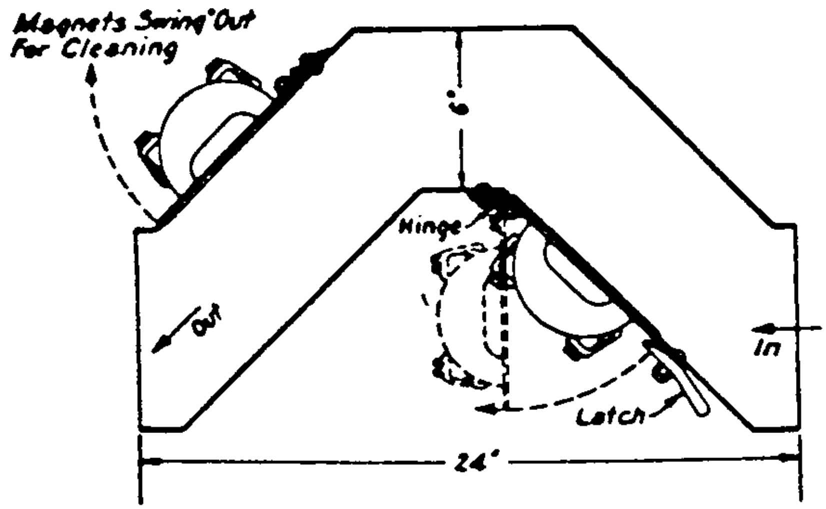


Fig. 3.3.4-1. Permanent-plate magnets and housing

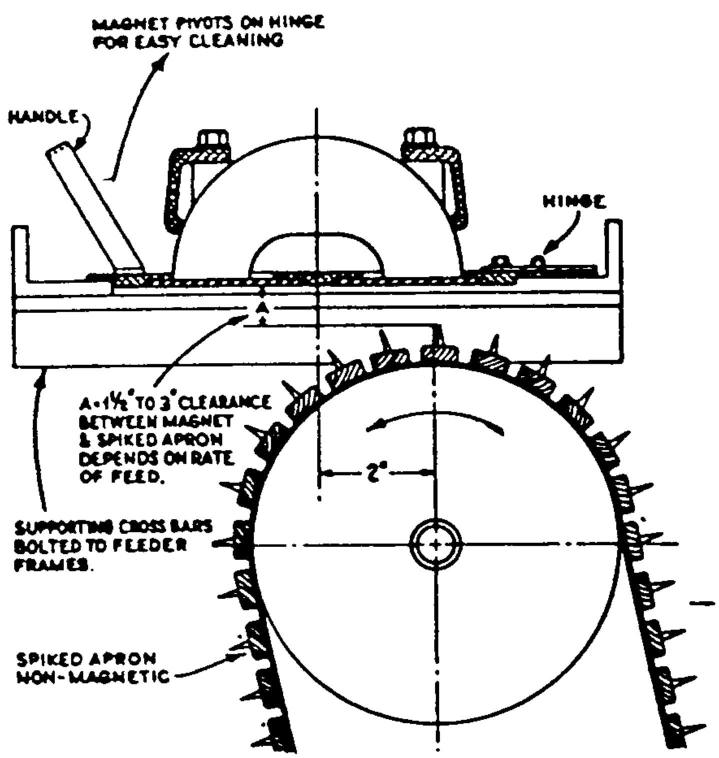


Fig. 3.3.4-2. Permanent-plate magnet above spiked lift apron

Two types of magnets are available: 1) electromagnets consisting of wire-wound pole pieces and requiring a reliable source of direct current for excitation and 2) permanent magnet units made up of several high-intensity magnets. Both styles are manufactured as either plate or pulley magnets. The permanent magnet type is used in most modern installations.

The plate type consists of two magnetic separator plates installed in angular settings for direct impingement of fibers against the magnet. The magnetic plates extend the full width of the housing and are hinged for accessibility and removal of collected debris.

The pulley type is available for installation above spiked lift aprons that feed directly to garnets, or cards where preparatory equipment does not include intervening feed tables, openers or cleaners. This installation is adaptable particularly to bedding and batt-making plants.

The use of the permanent-magnet pulley in the textile field is recommended only where a plate magnet is not applicable. Pulley magnets are designed to operate in conjunction with a belt conveyor and are continuously self-cleaning. Magnetic pulleys cannot be used with lattice or slat aprons because of the danger of wedging solid materials between the conveyor and the pulley.

3.3.5 Carding

Carding orients the fibers into a more parallel arrangement and removes short fibers. A rope-like strand (sliver) or a flat web is produced depending on whether the end product is to be a woven or a nonwoven fabric.

Sliver may be wound into a can, or several cards may be set up, in line, to deliver sliver to an endless belt. The belt may be located below or beside the card. High speed cards are widely used. Ventilation systems are necessary for high-speed cards. Lint and fly are removed from between the cylinder and flats and from the area around the feed and doffer rolls. The lint-laden air is then drawn through a duct to a filter assembly.

Essentially all cards are chute fed. Ducts and conveyors are used to transfer cotton from blenders or cleaners to flock feeders. Flock feeders then distribute stock to card condensers that serve as holding chambers to maintain a reservoir of cotton to ensure continued operation. This method of operation has generally resulted in cleaner, more lint-free work areas.

A fire starting on a card usually will be drawn through a duct to the filter bank. Unless there is quick detection and subsequent application of extinguishing agent, such a fire is likely to cause equipment damage and prolonged shutdown. High speed infrared detection is presently the most effective method of detection of flaming or smoldering cotton in a duct. The detectors usually are arranged to shut down equipment and to activate an extinguishing system in the nearest downstream equipment with fiber holdup. Equipment access is necessary to allow operators to pull smoldering fiber from equipment involved and completely extinguish a fire.

3.3.6 Drawing Through Weaving Processes

3.3.6.1 Drawing Through Slashing

Drawing mixes multiple slivers and draws the mix out to the size of the original single sliver.

Combing removes short fibers from the lap. Roving drafts the sliver to a reduced size and gives it a slight twist to increase strength.

Spinning is a texturizing process that gives the yarn strength by combining, drawing out and twisting yarns. Spinning makes warp and fill yarn for weaving, as well as yarn for knitting.

Spooling results in yarn from a warp bobbin being rewound in a cheese pattern on another warp bobbin. Warp yarn runs the length of the woven cloth.

Warping is the transfer of warp yarn from bobbins to a beam in preparation for weaving. Hundreds of bobbins are placed on metal frame racks (creel rack) and wound in parallel onto the beam.

Slashing is an operation in which warp yarn from beams is run through a tank containing a sizing solution, dried on steam or hot-air heated cylinders, and rewound on beams. The sizing strengthens, lubricates, and protects the yarn during the weaving operation.

3.3.6.2 Spinning

There are two types of spinning: ring spinning and open-end spinning. The inside surfaces of the head stock have been insulated on most frames to reduce noise from gears and electric motor drives. At least one manufacturer markets a spinning frame with insulation behind the spinning positions as shown in Figure 3.3.6.2. This spinning frame has combustible insulation in the headstock, tail stock, and behind the spinning positions. Automatic sprinkler protection is shown for the area behind the spinning positions.

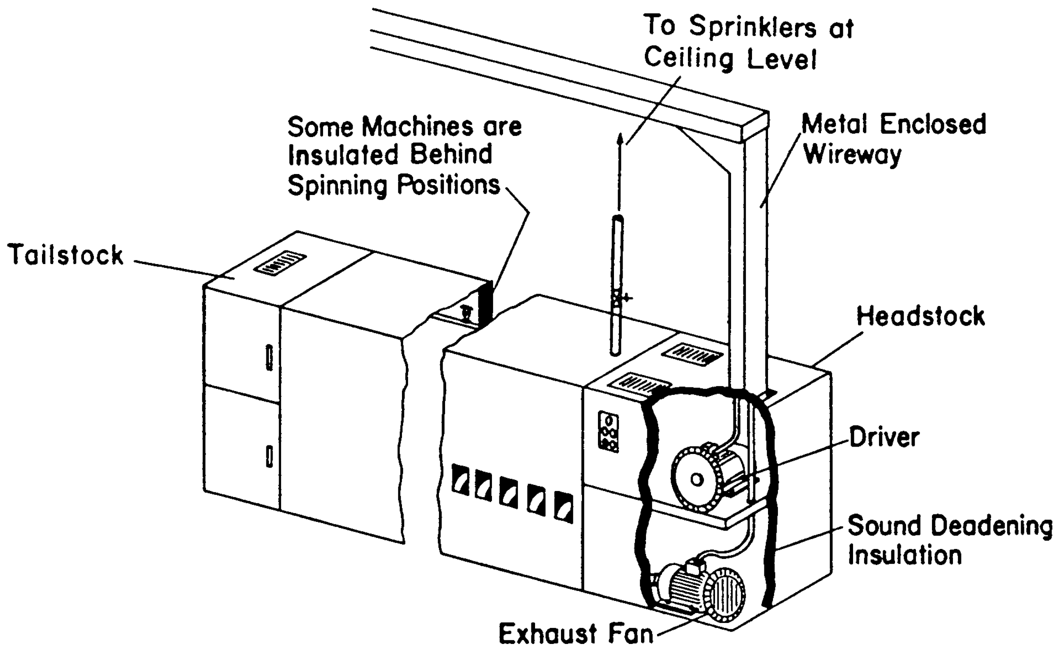


Fig. 3.3.6.2. Open-end spinning frame

Polyurethane is sometimes used for the insulation. Lint tends to accumulate on its surface, making it difficult to clean. Most spinning frames are constructed to allow location of sliver cans under the spinning frame. Sliver cans range in size from 16 to 24 in. (40.6 to 61 cm) in diameter and are approximately 3 ft (0.91 m) high. Cans are constructed of plastic or a resin impregnated fiber. The plastic used may be polyethylene or polypropylene. Most of the sliver cans used are resin impregnated fiberboard. Areas below the spinning frame are partially shielded from automatic sprinklers at ceiling level.

3.3.6.3 Weaving

Weaving interlaces one set of yarn (warp) with another set (fill) to produce the fabric. Several types of looms are available: 1) air jet, 2) water jet, 3) projectile and 4) rapier. Older looms (projectile) were equipped with large shuttles with interior packages of fill yarn. The shuttles were mechanically moved back and forth between layers of warp yarn. Modern looms, such as air jet or water jet, do not require as many manual operations as mechanical type projectile looms. This results in fewer workers increasing the time to detect a fire and reducing capability to fight a fire in an area of the mill with the highest fire frequency.

For air jet looms, a reliable air supply is as important as a reliable power supply. A spare compressor should be provided, or plans made to bring in and connect a mobile air unit. Compressed air should be piped into the weave rooms as close as possible to the looms. A shutoff valve should be provided on the pipe for each loom. A length of plastic hose is then run to the loom. Burn-through of the hose may result in spread of burning lint over several looms.

It is advisable to run services such as power cable and compressed air above the floor rather than in trenches. Trenches are more difficult to keep clean. Loss experience has indicated that a fire in a trench area will spread rapidly through the trench across cotton lint; the trench will be quickly filled with water, interrupting power to a number of looms.

Due to the high fire frequency, it is necessary to keep the building and equipment clean. Continuous cleaning is needed for floor and wall areas. The ceiling should be cleaned periodically, during plant shutdown. Looms should be cleaned on warp change.

3.3.7 Pin Trucks

Pin trucks can be found in any textile operation. Pin trucks are used to move packages or spools of yarn or thread from one process to another. A pin truck is a metal frame on wheels. Cross members are mounted on the metal frame. Rods or pins are welded to cross members. The spools or packages of thread or yarn are placed on the pins. Pin spacing depends on the size of the package or spool. There could be from 30 to 450 spools or packages of yarn per truck depending on the size of the yarn package. Pin trucks are approximately 5 ft x 2.5 ft x 5 ft high (1.5 by 0.75 x 1.5 m).

A large loss involving acrylic yarn resulted in a survey to determine types of yarn stored on pin trucks in insured plants. The results of the survey are included in Table 3.3.7. At the time of the survey few plants stored acrylic yarn on pin trucks.

Table 3.3.7. Field Survey of 96 Locations to Determine Type of Yarn Stored on Pin Trucks

Polyester	27%
Polyester-cotton blends	25%
Cotton	19%
Nylon	19%
Miscellaneous (includes acrylic, rayon, and various blends, none of which exceeds 6%)	12%

3.3.8 Creels

There are two types of creels (sometimes referred to as creel trees) used to supply yarn to carpet tufting machines. Both types are available without mezzanines, with open mezzanines, and with solid mezzanines.

3.3.8.1 Old Style Creels

These creels have posts (trees) with prongs used to hold yarn packages. The prongs are arranged in groups of four approximately 12 in. (30.5 cm) apart vertically. There may be 5 to 8 levels below and above mezzanines. If one mezzanine level is used, the total height of the yarn on the trees is about 13 to 15 ft (4 to 4.6 m) with the mezzanine being at the midpoint. There may be up to three mezzanines vertically, although most have only one. Aisles between creel tree rows are generally 36 to 52 in. (0.9 to 1.3 m) wide. The yarn is loaded and tied from these aisles. The creels, with their frame support structure, take up approximately 60 in. (1.5 m) between adjacent aisles. There may be 460 to 2880 cones of yarn per creel mezzanine unit per tufting machine. The mezzanines are most often placed side-by-side and can be several hundred feet long and approximately 40 ft (12.2 m) wide. Mezzanines have overhangs that are often used to stage yarn used for re-supply. This yarn is stored below and on mezzanine overhangs at the rear of the mezzanine. Often, yarn is also staged between mezzanines where wide aisles are sometimes maintained for this purpose.

3.3.8.2 Modern Creels

Modern creels are similar in design. They have two prongs per position. They also have a loading aisle and a separate tie aisle. The loading aisle is generally about 48 to 53 in. (122 to 135 cm) wide while the tie aisle is generally about 25 in. (64 cm) wide. Yarn is loaded onto the creels from the loading aisle and yarn ends tied together from the tie aisles as shown in Figure 3.3.8.2. This allows continuous operation of the tufting machine. The yarn is fed to the tufting machines through plastic tubing.

Automatic sprinkler protection is needed for the tie aisles. Automatic sprinkler protection is needed for loading aisles if used for storage of more than a few boxes or carts of yarn.

Fig. 3.3.8.2. Modern creel with one mezzanine, shows both loading and tie aisles

Yarn is often put into yarn carts, which are then pushed down the loading aisles for replenishing the spent yarn cones. Roller type conveyers are also used for moving yarn in corrugated cartons down the loading aisles for replenishing yarn cones. Loading aisles can vary considerably in width depending upon the individual needs of the operation. Carts and roller conveyers may be used on each mezzanine level. When roller conveyors are used, generally there will be more cartons of yarn in aisles.

Solid mezzanines have no openings except where vertical creel tree posts and framing penetrate the mezzanine decking. These openings are no more than 3 in. (7.6 cm) wide and the width of the mezzanine (front to back).

Open mezzanines have either open steel grating or planking, plywood, or steel plate with openings 4 to 60 in. (10.2 to 152 cm) wide the width of the mezzanine.

3.3.9 Air Conditioning

An air-conditioned mill has several independent conditioning systems. One system or a combination of systems is used to maintain an area at a temperature and humidity best suited to the process. Because air-conditioning systems are responsible for most of the air movement in areas they serve, they can be effectively used to limit smoke damage from fires occurring within these areas.

3.3.9.1 Cooling Towers

A cooling tower is critical to maintaining temperature and humidity in the mill and for cooling equipment such as air compressors. While cooling towers may not be needed for plant air conditioning at all times of the year, they are critical to continued operation during warm weather. The possibility of loss of a cooling tower should be considered. A recovery plan should be established to expedite replacement; or an alternate plan, such as use of public water supplies or connection of a mobile unit to maintain operation of the mill, should be developed.

3.3.9.2 Duct & Tunnel Systems

Mills constructed before air-conditioning systems have had these systems added. They may be through-the-wall, through-the-floor, or through-the-roof systems. In the through-the-wall system, air is drawn from main plant areas into an adjoining air-conditioning room. Filters are mounted in the wall between the main plant and the air-conditioning room to remove lint. Some air is exhausted, make-up air is added, the mixture is heated or cooled, humidified or dehumidified, as necessary, and returned to the room at ceiling level. In the through-the-floor system, air is withdrawn from the main plant areas through grated duct openings in the floor and filtered. Make-up air is then added, and the same process as above is followed. Through-the-roof systems are similar to through-the-wall systems except the air wash/air conditioning system is located in a penthouse on the roof.

Rectangular shaped ducts of light-gauge sheet metal are used to convey the air into and in some cases out of main plant areas. Rough edges, turning vanes, and dead air spots within ducts tend to accumulate concentrations of lint. These ducts should be cleaned regularly even if access is difficult.

In newer mills, lint-laden air is drawn into ducts through grated openings located below machinery. The air flow is such that it helps remove lint from machine surfaces. The ducts then run into side tunnels, and the side tunnels feed into main tunnels running the width of the mill. The air is then filtered and processed in the same manner as above as shown in Figure 3.3.9.2-1. The FM survey conducted at 50 mills indicated that through-the-floor systems have a better transfer efficiency since the air is taken from around the machine (technical air).

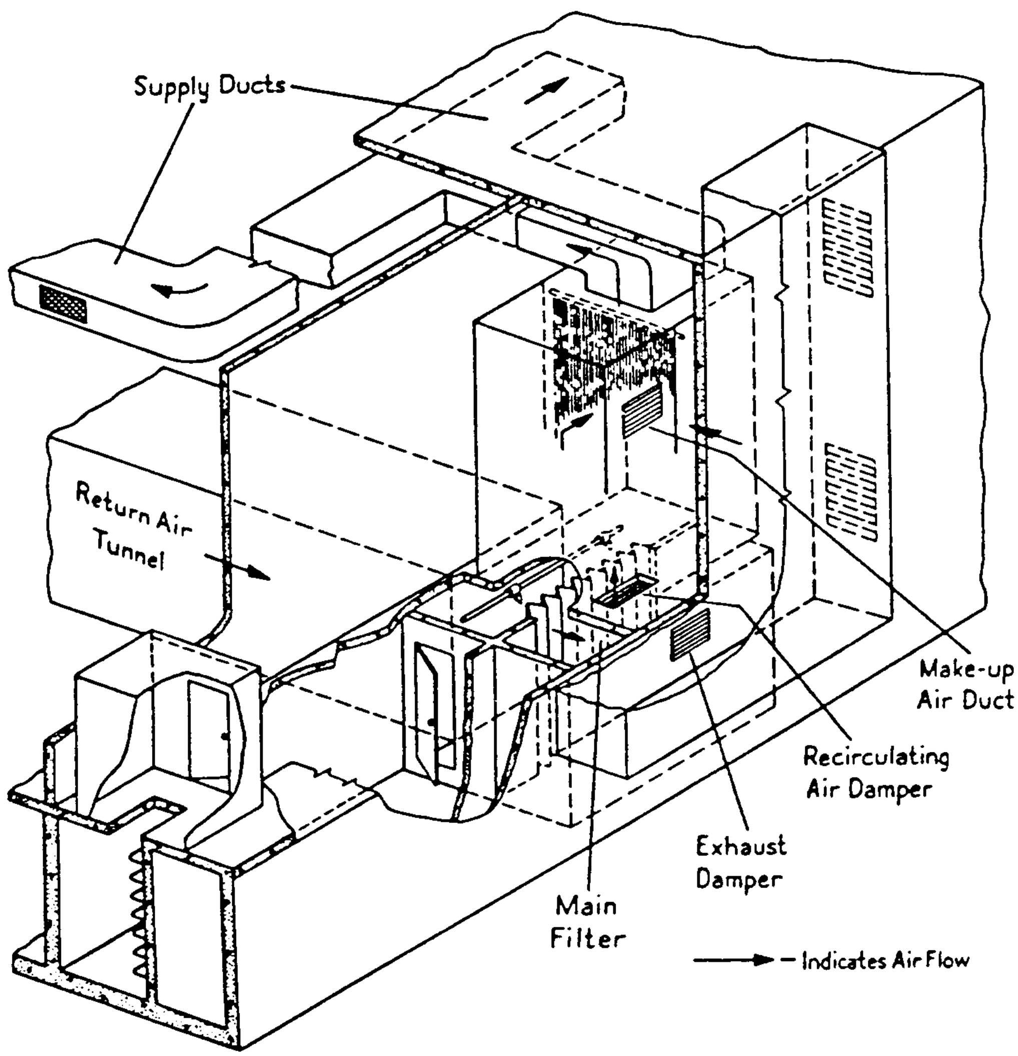


Fig. 3.3.9.2-1. Air conditioning system of a modern mill

Side and main tunnels of the return air system are of concrete construction and are part of the foundation of the mill.

The system's return air tunnels in newer mills are largely for air movement, not for lint transfer to the filter media. As a result, lint is deposited on the tunnel surfaces. Air velocity inside tunnels is low. Side tunnels are often of rectangular shape with cross sections too small to allow access for easy cleaning. In main tunnels, lint collects on lighting, conduit, and rough wall surfaces. Hand cleaning, usually done on weekends, is slow and expensive.

Supply air ducts may be part of the ceiling construction, but rectangular shaped light-gauge sheet metal ducts are most common. In some cases, suspended ceilings are located above plant areas such that supply air passes through these ceilings. FM loss prevention specialists have found heavy loadings of lint above supply air ducts and in areas above suspended ceilings. When the space above the ceiling is used for supply air, the ducts are fairly clean.

The design of some supply air ducts with ventilation openings (registers) in the side of the duct as shown in Figure 3.3.9.2-2 may result in lint accumulation in the supply air duct as shown in Figure 3.3.9.2-3. This caused by negative pressure near edges of the register which draws airborne lint into the duct. This as opposed to a design that is less likely to accumulate lint such as the one shown in Figure 3.3.9.2-4.

Regular inspection and cleaning of the supply and return ducting, including areas above suspended ceilings, is needed. Lint buildup is related to equipment enclosure, air velocity, discharge location, and pickup location rather than room air volume changes.

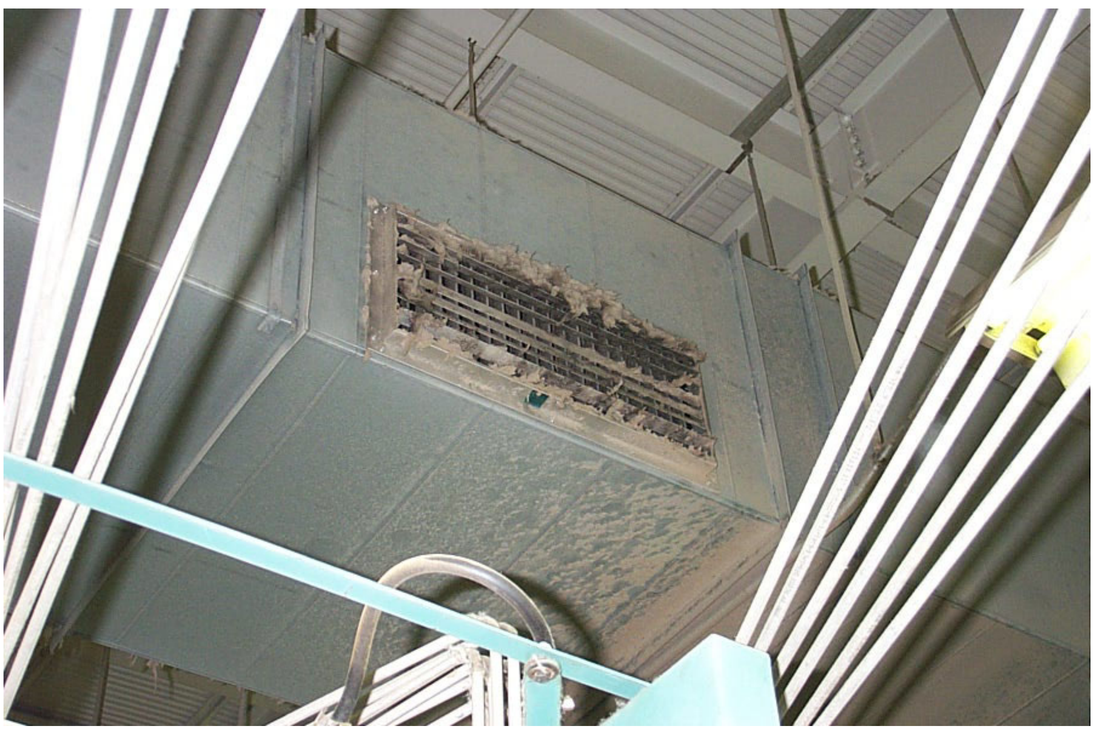


Fig. 3.3.9.2-2. Supply air duct with openings (registers) in the side of the duct

Fig. 3.3.9.2-3. Lint accumulation in supply air duct

Fig. 3.3.9.2-4. Supply air ducts with vertical drops to registers

3.3.9.3 Filter Rooms

Mills using air-conditioning systems recirculate most of the air in the main plant. The air must be filtered before it is returned. A V-type wall filter or a rotary filter assembly is used for this purpose. The filter assembly is usually located within an enclosed room of noncombustible construction.

The filter media is usually polyester or polyvinyl chloride. While this filter media is not readily ignited, lint accumulations on the upstream face will burn readily, ignite the filter and the filter will melt and burn. In some cases, polyurethane is used as filter media. Its use will contribute substantially to the heat released in a fire on the filter media, and may lead to damage of filter frames, causing lengthy shutdown for repair.

Air flow through a filter makes fire detection by heat or smoke sensing devices difficult. Infrared (IR) detection and special extinguishing systems should be considered. Automatic sprinklers are recommended. If the exhaust fan is stopped while fire is in progress, sprinklers will prevent the fire from spreading back through the ventilating tunnel(s) and into main plant areas.

3.3.10 Pneumatic Waste Recovery and Cleaning Systems

Waste handling systems are provided for opening, high speed carding, drawing, and spinning frames. Air suction points designed to remove fly, trash and dust are provided on the equipment.

The systems used at spinning and drawing frames consist of suction tubes, called “flutes,” which are located near the roll deliveries on the frame. The flutes, which replace scavenger rolls, are connected to a collecting header and a filter collector unit with a built-in motor and fan assembly. Air is continually drawn into the suction flute. Free lint and foreign materials are removed from the yarn as it emerges from the front rolls. When a thread (end) is broken, it is picked up by the suction orifice and conveyed pneumatically to the collector unit. Here it accumulates in the form of untwisted fibers ready for reprocessing.

Pneumatic waste recovery and air cleaning systems make possible better cleaning of stock in preparatory areas. A waste house is typically used for opening and cleaning equipment. In some cases, this also includes carding equipment. The waste house is an approximately 10 x 15 x 8 ft (3 x 4.6 x 2.4 m) high sheet metal-on-metal frame enclosure located in or adjacent to the opener room. It contains a condenser and a rotary drum filter. Waste laden air goes through the condenser then through the rotary filter. Waste collected on the surface of the condenser and rotary filter is doffed and ducted to a baler. The waste house is usually protected by an automatic dry chemical system actuated by IR detectors and an automatic sprinkler system.

3.3.11 Singeing

Singeing is a preparatory step in dyeing cotton. Fabric is exposed to flame from a ribbon burner to remove lint and fuzz from the surface. The gas burner usually is interlocked so the burner will swivel away, and the main gas valve will close in the event fabric stops moving.

3.3.12 Bleaching

The bleaching process whitens the fabric, removes impurities and blemishes. The cloth is treated in large tanks or vats with caustics and detergents. Diluted concentrations of hydrogen peroxide also may be used.

3.3.13 Dyeing

Dyeing can be done on either raw stock, sliver, yarn, or cloth. Generally, it is done by one of the following methods:

A. Kier

A kier is a stainless-steel vessel containing perforated spindles. The textile is packed around the spindles in baskets. The dye liquor is pumped through the spindles and textile, then collected in the bottom of the kier and recirculated. Some machines are arranged so liquor flow is in one direction only. Some are arranged so that flow can be reversed. The plate containing the spindles can be removed for loading and unloading. In some cases, the dyed textile is air dried by passing heated air through the spindles.

B. Continuous Dyeing

Most dyeing is done on a continuous dye range. Dye is applied by passing the fabric through a vat containing dye liquor and between squeeze rollers (dye pad). The fabric passes through the vat, then is drawn through a gas or IR heated dryer to reduce moisture content, and over drying cans to an oven used to fix the dye (the oven may be a hot air unit or an oil-heated contact machine). In the next step, fabric passes through a chemical pad for immersion into an alkaline or reducing solution (depending on the dye). Finally, the goods pass through 8 to 10 wash boxes and are dried and cooled by passing over can dryers and cooling cans.

C. Dyes

Most dyes used are water based. Attempts have been made to develop solvent based dyes to reduce energy consumption and increase dyeing speed. The organic solvents tried have been trichloroethane and perchloroethylene. Other organic solvent-based dyes may be used.

3.3.14 Printing

Printing is essentially a dye applied by mechanical and chemical means that results in a design or pattern on the fabric. Attempts are being made to develop dyes that can be applied as solids to reduce energy consumption and increase processing speeds. Common methods of applying water and solvent base dyes are:

A. Roller Printing

The print is transferred by passing the fabric between a cast iron cylinder and a copper print roller with a pattern or design engraved on the surface of the copper roller. The fabric absorbs print paste from the engraved areas of the print roller. A separate roller and cylinder is used for each color. Ignitable solvents may be used to clean the print rollers and other surfaces.

B. Tubular Screen Printing

Most printed textiles are produced by this method. The tubes are lightweight metal cylinders on support frames. The pattern or design is a series of small openings made in the wall of the tube by a laser or a photo sensitive chemical etching process. A dye or ink is injected into the tube and passes through these openings to transfer a pattern onto the fabric. A separate tube is used for each color and ignitable solvents may be used to clean the tubes and other surfaces.

C. Screen Printing

Print paste is transferred through a stencil to the fabric. The stencil is made of polyamide or polyester cloth stretched tightly over a metal frame. The design, originally on film, is transferred by coating the cloth with a light sensitive material, exposing the film and rinsing off the unexposed areas. The printing operation can be carried out manually (silk screening) or automatically by mechanically lifting the screen, advancing the fabric, lowering the screen and applying print paste (mechanized screen printing).

D. Paper Transfer and Digital Printing

In paper transfer printing the pattern is printed on paper and transferred to cloth using a heated roll. Digital printing is similar to ink jet printing.

3.3.15 Ovens, Dryers and Tenter Frames

Ovens and dryers are used to dry dyed fabric or cure coatings that have been applied to fabric. Tenter frames are used to control shrinkage by holding the web in two dimensions during a heating cycle.

These units may be heated directly by gas- or oil-fired burners or IR heaters, or indirectly by heat transfer oil or steam heating systems. Where heat transfer fluids are used, the fluid is usually an oil with flash point of 250-400°F (120-204°C). Oil is heated usually in an adjacent building and circulated through heat exchangers within the unit.

There may be multiple exhausts from each oven, dryer or tenter frame. The exhausts from one unit are manifolded. If several ovens, dryers or tenter frames are present, they may all be manifolded before entering pollution control equipment. The pollution control equipment may be a scrubber, a dry filter unit or an electrostatic precipitator. Where exhaust ducts from more than one dryer or tenter frame are manifolded, automatic sprinkler protection is needed in the exhaust duct to prevent fire spread from one unit to the other.

Steam suppression systems have been installed. These systems are manually operated and are designed to a wide variety of criteria. They should not be considered primary protection for the above conditions but may be effective when used in addition to automatic sprinkler protection.

3.4 Protection

The protection systems typically encountered in a mill should include: 1) automatic sprinkler systems throughout the mill at ceiling level and in equipment such as waste houses, mixers, and blenders containing large quantities of fiber and 2) special protection systems for enclosed processing of fiber. Special protection systems will normally consist of high-speed detection systems with discharge of agent into equipment to quickly control a fire in areas from opening to carding.

Protection for equipment such as compressors and cooling towers also is necessary. Compressors are essential to continued operation of air jet looms; cooling towers are needed to maintain temperature and humidity within operating limits.

Changes in production scheduling can result in overloaded and inadequately protected storage areas. Protection is needed for the worst-case storage arrangement (storage height and depth, aisle width, flue width and spacing, and aisle storage). In process storage in production areas should be protected by the applicable storage standard. Excessive storage should be relocated to a properly protected storage room or warehouse. Plastic tubs and trays have become common and need appropriate protection.

3.4.1 Special Protection Systems

Special protection systems are needed in areas of the mill where cotton is handled within enclosed systems. Examples are the early stages of processing from opening to chute fed cards. Unless special protection is provided in these areas, a fire starting in an opener could spread through cleaning and blending equipment to chute fed cards. Special protection systems consist of optical detection and an extinguishing agent.

FM-200 or dry chemical is typically used. These agents will not extinguish a deep-seated cotton fire. The fire must be detected by flame detection systems in the equipment or in the duct upstream of the equipment. Agent is discharged within 50 milliseconds and arrives at about the same time as the spark or burning ember. This temporarily provides an inert atmosphere that will prevent re-ignition. Provisions should be made on all equipment to remove fiber and extinguish residual fire with portable extinguishers.

3.4.2 Extinguishing Agents

Tests have been conducted on several extinguishing agents for protection of textile equipment. These agents include CO_2, dry chemical, Halon 1211, and FM-200. It was found that the CO_2 concentration required for effective operation is 75% with a 20 min soak time. CO_2 is not practical for most equipment since there is a substantial amount of condensation which requires extensive cleanup. Experiments have been conducted with both BC and ABC dry chemical agents. ABC leaves a corrosive residue. BC type dry chemical was one of the first agents used for special protection systems. It continues to be used for protection of waste air filtration systems since the airflow in many of these units will draw gaseous agent out. Dry chemical is also drawn out but enough remains on the filter media to control and stop the progress of the fire. Halon 1211 was the most effective agent and may still be used in some mills. Halon 1211 systems may not be permitted by regulatory authorities. FM-200 is used for new systems.

The FM-200 design concentration for internal equipment protection is 15% for 20 minutes. The agent quantity and number of nozzles used depends on the volume protected. A concentration of 0.08 lbs/ft3 (1.3 kg/m3) is used to determine adequacy of agent supply. The number of nozzles used ranges from two to twelve nozzles. The sodium bicarbonate dry chemical design concentration for protection of the filter media is typically: a) rotary drum filters less than 16 ft (4.9 m) long are protected with one 30 lb (13.6 kg) cylinder, b) rotary drum filters 16 ft (4.9 m) or longer are protected with two 30 lb (13.6 kg) dry chemical cylinders, and c) “V” filters are protected with one 30 lb (13.6 kg) cylinder.

3.4.3 Detection

Infrared detection systems are used to detect fires in ducts between process equipment. The reliability of detection depends on proper installation, maintenance, and testing. The response time from detection to discharge of agent is typically 50 to 60 milliseconds.

Ultraviolet detectors may be used for detection of fire on filter media in rooms lighted by incandescent lamps. Infrared detectors may also be used and are more sensitive to detection of embers. Lighting must be off in the room under normal operation. When entry to the room is required the detector circuit is arranged to be shut off by a keyed switch. The key is then used to operate another switch turning on the lights in the room. When the detectors are bypassed the fire protection control panel indicates a trouble condition.

The number of infrared detectors used depends on duct diameter and quantity of material transferred. Stock transfer ducts are typically 12 in. (300 mm) and 14 in. (350 mm) and have large quantities of material passing through the duct. For these ducts there would normally be three detectors positioned at 120° angles. Waste air ducts have lower quantities of material, detectors are able to “see” greater distances. The number of detectors used by one leading installer of textile fire protection equipment is shown in Table 3.4.3.

Table 3.4.3. Spacing of Detectors in Round Ducts

Type of Duct	*Duct Diameter*	*No./Location of Detectors* [Note 1]
Stock Transfer	Up to 12 in. (300 mm)	2 opposite each other
	12 to 14 in. (300 to 350 mm)	3 detectors at 120° spacing
Waste Transfer	Up to 16 in. (400 mm)	2 detectors opposite each other
	16 to 36 in. (400 to 900 mm)	3 detectors at 120° spacing
	36 to 48 in. (900 mm to 1200 mm)	4 detectors at 90° spacing
	48 to 60 in. (1200 to 1500 mm)	5 detectors

Note 1. Detectors should not be located in the bottom of the duct.

3.4.4 Protection of Creels

Figures 3.4.4-1 and 3.4.4-2 show two different configurations of protection for two different creel arrangements.

Figure 3.4.4-1 shows a modern style creel with a solid mezzanine. There are six creel trees. Automatic sprinkler protection is provided in the aisles on a 10 ft (3 m) spacing and below the overhang on 10 ft (3 m) spacing. Automatic sprinklers would be needed for loading aisles if aisles were used for storage. In this example, yarn carts and aisle conveyors are used to replenish cones on creel trees. All automatic sprinklers are 165°F (74°C) rated, 17/32 in. (13.5 mm) orifice quick response in-rack sprinklers.

Figure 3.4.4-2 shows an old-style creel with open grating. Three creel trees are shown. There typically would be several creel trees. Automatic sprinkler protection is provided in the creel tree on 8 ft (2.4 m) spacing. Sprinklers are staggered. Automatic sprinklers are also provided below the overhang on 10 ft (3 m) spacing. All automatic sprinklers are 165°F (74°C) rated, 17/32 in. (13.5 mm) orifice quick response in-rack sprinklers.

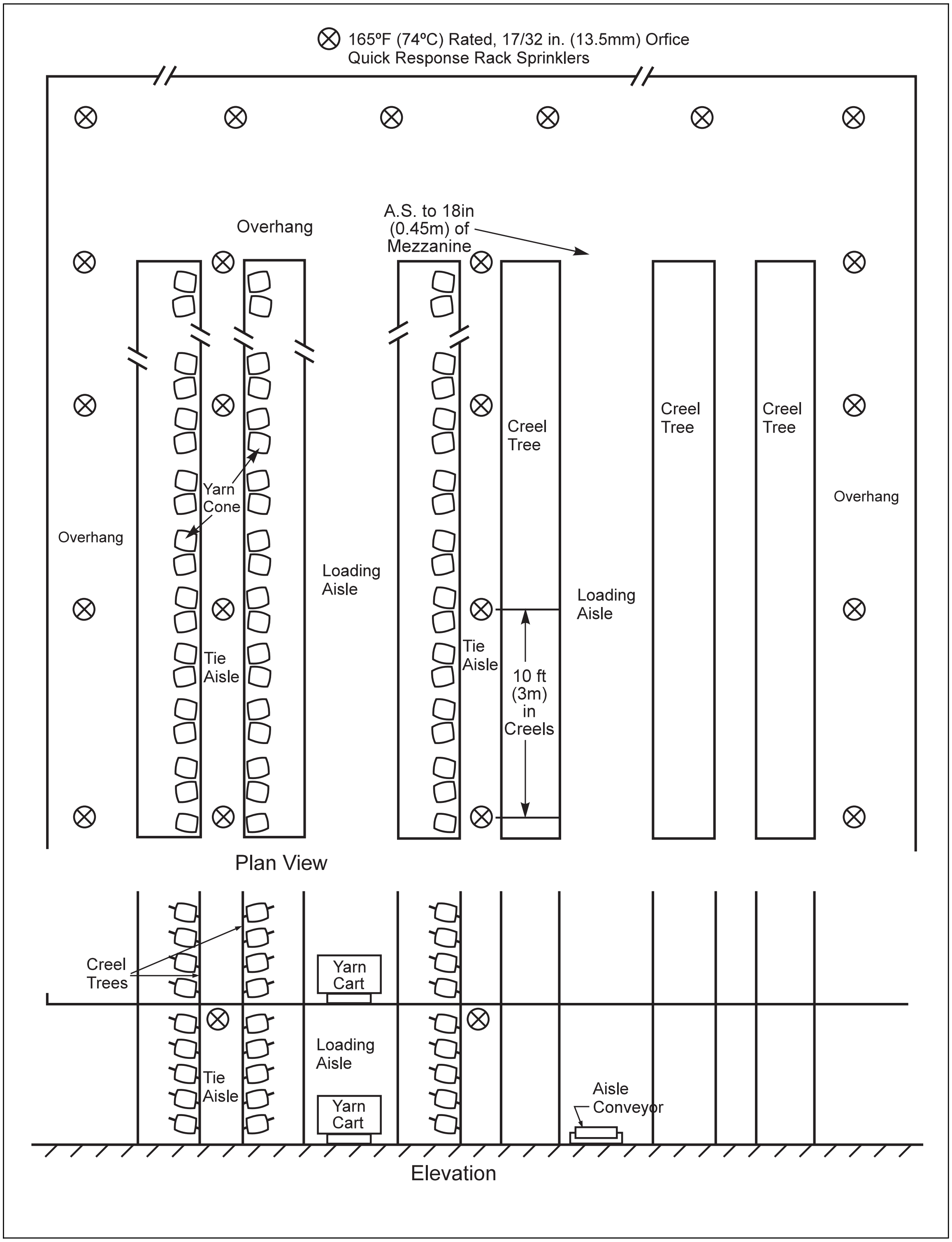


Fig. 3.4.4-1. Modern creel with a solid mezzanine

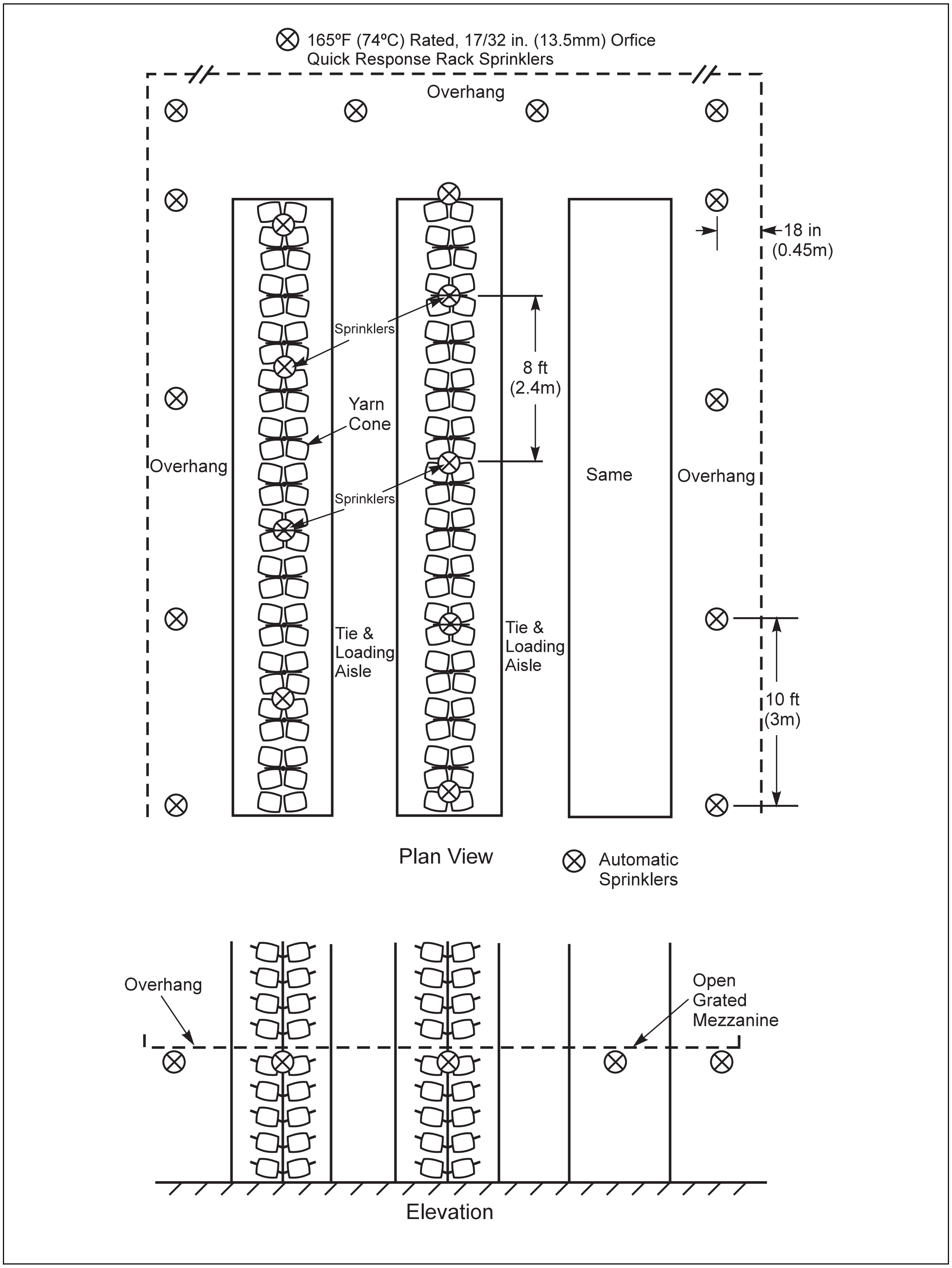


Fig. 3.4.4-2. Old style creel with an open mezzanine

3.4.5 Protection of Pneumatic Waste Recovery and Cleaning Systems

Figure 3.4.5 shows an example of protection for a waste house. Lint-laden air is filtered by a rotary drum filter and returned to the room. Waste removed from the surface of the filter is ducted to the baler through a stripper duct. IR detection is provided in the inlet duct, waste house and stripper duct. The rotary drum filter is protected by an automatic dry chemical system activated by IR system. In addition, the waste house has automatic sprinkler protection.

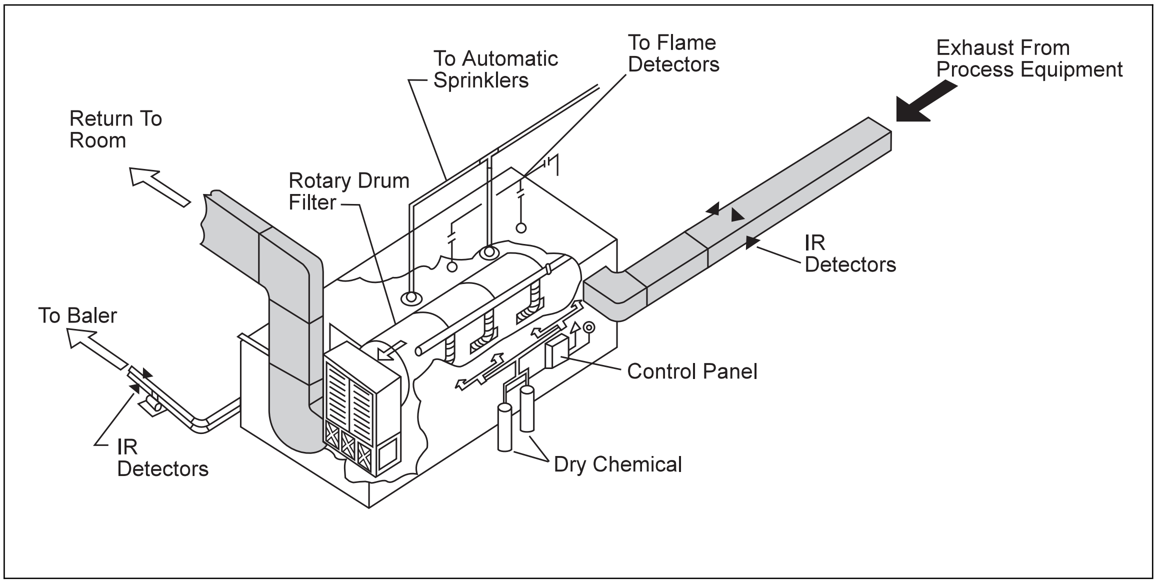


Fig. 3.4.5. Waste House

3.5 Operation and Maintenance

The area of greatest improvement has been in maintenance and lubrication of textile equipment. Mill maintenance specialists handle preventive maintenance on a scheduled basis, where the work order describing the specific activity is either automatically generated by computer or manually by a card file system. In some mills, operators are responsible for lubrication of machinery. In other mills, maintenance personnel handle both lubrication and maintenance.

Some mills evaluate fire losses by department to determine whether equipment cleaning and maintenance frequencies need to be increased.

3.5.1 Testing and Maintenance of Special Protection Systems

Few failures of special protection systems have been reported.

During the inspection, the system should be visually inspected, and the detectors tested. Agent discharge is not required. The cylinder should be replaced with a test light and the detectors activated by an infrared LED.

Some installations have been reported that are 20 to 25 years old. As systems age electrical components tend to fail. It has been reported that control panels tend to fail at a higher rate than detectors over the life of the installation.

Cartridge operated dry chemical systems are sometimes found with empty CO_2 cartridges because they were not properly charged after the last actuation. Also, cartridges have a greater chance of leaking when improperly filled. A PDG valve was developed for the FM-200 and Argus dry chemical systems. This valve is designed with a low-pressure switch that will produce a trouble signal on loss of pressure.

3.6 Human Factor

3.6.1 Fire Department Response

Textile mills are often located in rural areas serviced by fire departments that may have limited equipment, training, and personnel. Fire departments may have had little or no training in fighting fires in industrial facilities or buildings equipped with automatic sprinklers. Congested conditions, deep-seated fires and concealed spaces make firefighting difficult. The lack of adequate fire department preplanning and training can result in inefficient firefighting.

3.7 Utilities

A textile mill requires uninterrupted electric power. Electric power for mills is usually supplied directly from a local utility-owned substation to one or more load centers at the mill. From the load center, feeders extend to various control panels located throughout the plant to supply power and lighting equipment.

Modern equipment such as open-end spinning frames, air jet looms, and controls require large amounts of compressed air.

Equipment cooling and control of building atmosphere requires large amounts of compressed air.

Slashers and finishing operations require large volumes of steam capacity.

4.0 REFERENCES

4.1 FM

Data Sheet 1-6, *Cooling Towers*.
Data Sheet 2-0, *Installation Guidelines for Automatic Sprinklers*
Data Sheet 2-81, *Fire Protection System Inspection, Testing and Maintenance* .
Data Sheet 3-26, *Fire Protection for Nonstorage Occupancies*
Data Sheet 4-0, *Special Protection Systems*
Data Sheet 5-4, *Transformers*.
Data Sheet 5-20, *Electrical Testing*.
Data Sheet 6-9, *Industrial Ovens and Dryers*.
Data Sheet 7-6, *Plastic and Plastic-Lined Tanks*
Data Sheet 7-29, *Ignitable Liquid Storage in Portable Containers*.
Data Sheet 7-32, *Ignitable Liquid Operations*
Data Sheet 7-76, *Prevention and Mitigation of Combustible Dust Explosions and Fires*.
Data Sheet 7-78, *Industrial Exhaust Systems*.
Data Sheet 7-80, *Organic Peroxides and Oxidizing Materials*.
Data Sheet 7-95, *Compressors and Oxidizing Materials*.
Data Sheet 7-99, *Heat Transfer Fluid Systems*.
Data Sheet 7-110, *Industrial Control Systems*
Data Sheet 8-7, *Baled Fiber Storage*.
Data Sheet 8-9, *Storage of Class 1, 2, 3, 4 and Plastic Commodities*.
Data Sheet 8-23, *Rolled Nonwoven Fabric Storage*
Data Sheet 8-30, *Storage of Carpets*
Data Sheet 10-1, *Pre-Incident and Emergency Response Planning*

APPENDIX A GLOSSARY OF TERMS

FM Approved: References to ″FM Approved″ in this data sheet mean a product or service has satisfied the criteria for FM Approval. Refer to the *Approval Guide*, an online resource of FM Approvals, for a complete listing of products and services that are FM Approved.

Ignitable Liquid: Any iquid or liquid mixture that has a measurable flash point. The hazard of a liquid depends on its ability to sustain combustion or create a flammable vapor-air mixture above its surface. Flash point is one way of understanding if a liquid can create that flammable vapor-air mixture. For a liquid to burn in a pool, it must have a fire point as well as a flash point. Ignitable liquids include flammable liquids, combustible liquids, inflammable liquids, or any other term for a liquid that will burn.

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).

July 2023. Interim revision. Minor editorial changes were made.

July 2022. Interim revision. The following major changes have been made:

A. Added guidance in Section 2.3.15 for nylon and polyester yarn

B. Revised guidance on ceiling sprinkler protection for production and finishing operation areas in Section 2.3.1.2. Those areas should be protected as HC-2 occupancies.

C. Removed recommendations for portable extinguishing equipment

D. Document has been reorganized to provide a consistent format

April 2020. An interim revision has been made to provide guidance for the storage of synthetic yarns (Section 2.1.3.24) as a result of new research.

January 2012. Terminology related to ignitable liquids has been revised to provide increased clarity and consistency with regard to FM Global's loss prevention recommendations for ignitable liquid hazards.

January 2009. Sprinkler density and water supply recommendations for textile plant production areas were added.

September 2002. The following changes were made for this revision:

1. The need for a written corporate and plant policy on housekeeping to ensure that cleaning is conducted when scheduled. A documented line of authority is necessary to authorize a delay and rescheduling. Also guidelines on depth of deposits are included.

2. Recommendations have been made for protection of in-process storage.

3. Recommendation removed for automatic sprinkler protection for sliver cans under spinning frames due to the lack of adequate clearance. Stressed improvement in housekeeping to prevent fire exposure to sliver cans.

4. Recognition that plant interdependencies are common in the textile industry and that manufacturing operations leading to a finished product may occur in several different plants.

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