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Interoffice Memorandum

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Date December 23, 2004
To Jim Brunetti
From Mark E. Fessenden
Subject Design Alternatives to Large Drop Sprinklers

Enclosed you will find our technical analysis of "Design Alternatives to Large Drop Sprinklers". The analysis has been broken down in the same categories described in NFPA 13-2002. After reviewing the data, we have selected the best suited design alternative for every application and have highlighted this option. Please review the material enclosed and disseminate to all applicable parties.

NFPA 13, 2002
Ref. Table 12.1.9.1.2 (b) CMSA Protection of Idle Wood Pallets

Sprinkler	Max. Storage Height	Max. Ceiling Height	System Type	# Sprks/Press (psi) or Density/Area	System Demand	Recommended Sprinkler	Notes
LD	20'	30'	WET	15/25	840 GPM		Table 12.1.9.1.2.(b)
ESFR Pendent (K14.0)	20' *	30'	WET	12/50	1188 GPM	ESFR-1 Pendent	Table 12.1.9.1.2.(c)
ESFR Pendent (K16.8)	20' *	30'	WET	12/35	1193 GPM	ESFR-17 Pendent	Table 12.1.9.1.2.(c)
Area/Density	20'	30' **	WET	0.6/4500	2700 GPM	ELO-231	Table 12.1.9.1.2.(a)
LD	20'	30'	DRY	25/25	1400 GPM		Table 12.1.9.1.2.(b)
Area/Density	20'	30' **	DRY	0.6/5850	3510 GPM	ELO-231	Table 12.1.9.1.2.(a) 4500 + 30%

* Actual Max. Storage Height 25'

** Actual Max. Ceiling Height is not Limited

NFPA 13, 2002

12.2.2.2.1 (a) Large Drop Design Criteria for Palletized and Solid Piled Class I - IV Stored up to 25' in Height

Storage	Commodity	Sprinkler	Max. Storage Height	Max. Ceiling Height	System Type	# Sprks/Press (psi) or Density/Area	System Demand	Recommended Sprinkler	Notes
Palletized	I, II, III	LD	25'	35'	WET	15/25	840 GPM		Table 12.2.2.2.1 (a)
	I, II	ULTRA K-17	25'	30'	WET	15/10	797 GPM		Table 12.2.2.2.1 (b)
	III	ULTRA K-17	25'	30'	WET	15/22	1182 GPM		Table 12.2.2.2.1 (b)
	I, II, III	ESFR Pendent (K14.0)	25' **	35'	WET	12/75	1455 GPM	ESFR-1 Pendent	Table 12.2.2.3.1 Protects up to Group A Plastics
	I, II, III	ESFR Pendent (K16.8)	25' **	35'	WET	12/52	1454 GPM	ESFR-17 Pendent	Table 12.2.2.3.1 Protects up to Group A Plastics
	I, II, III	ESFR Pendent (K25.2)	25' **	35'	WET	12/20	1352 GPM	ESFR-25 Pendent	Table 12.2.2.3.1 Protects up to Group A Plastics
	I, II, III	Area/Density	25'	35' **	WET	0.29/2600	754 GPM	TY-B or TY-L 8.0 K	Fig. 12.2.2.1.5.2 & 12.2.2.1.5.3 (Non-Encapsulated)
	I, II, III	LD	25'	35'	DRY	25/25	1400 GPM		Table 12.2.2.2.1 (a)
	I, II, III	Area/Density	25'	35' **	DRY	0.29/2600	754 GPM	TY-B or TY-L 8.0 K	Fig. 12.2.2.1.5.2 & 12.2.2.1.5.3 (Non-Encapsulated)
	IV	LD	20'	30'	WET	20/25	1120 GPM		Table 12.2.2.2.1 (a)
	IV	ULTRA K-17	20' *	30'	WET	15/50	1188 GPM		Table 12.2.2.2.1 (b)
	IV	ESFR Pendent (K14.0)	20' *	30'	WET	15/22	1182 GPM		Table 12.2.2.2.1 (b)
	IV	ESFR Pendent (K16.8)	20' *	30'	WET	12/50	1188 GPM	ESFR-1 Pendent	Table 12.2.2.3.1 Protects up to Group A Plastics
	IV	ESFR Pendent (K16.8)	20' *	30'	WET	12/35	1193 GPM	ESFR-17 Pendent	Table 12.2.2.3.1 Protects up to Group A Plastics
IV	ESFR Pendent (K25.2)	20' *	30'	WET	12/15	1171 GPM	ESFR-25 Pendent	Table 12.2.2.3.1 Protects up to Group A Plastics	
IV	Area/Density	20'	30' **	WET	0.295/2000	590 GPM	TY-B or TY-L 8.0 K	Fig. 12.2.2.1.5.2 (Non-Encapsulated)	
Solid Piled	I, II, III	LD	20'	30'	WET	15/25	840 GPM		Table 12.2.2.2.1 (a)
	I, II	ULTRA K-17	20' *	30'	WET	15/10	797 GPM		Table 12.2.2.2.1 (b)
	III	ULTRA K-17	20' *	30'	WET	15/22	1182 GPM		Table 12.2.2.2.1 (b)
	I, II, III	ESFR Pendent (K14.0)	20' *	30'	WET	12/50	1188 GPM	ESFR-1 Pendent	Table 12.2.2.3.1 Protects up to Group A Plastics
	I, II, III	ESFR Pendent (K16.8)	20' *	30'	WET	12/35	1193 GPM	ESFR-17 Pendent	Table 12.2.2.3.1 Protects up to Group A Plastics
	I, II, III	ESFR Pendent (K25.2)	20' *	30'	WET	12/15	1171 GPM	ESFR-25 Pendent	Table 12.2.2.3.1 Protects up to Group A Plastics
	I, II, III	Area/Density	20'	30' **	WET	.213/2000	426 GPM	TY-B or TY-L 8.0 K	Fig. 12.2.2.1.5.2 (Non-Encapsulated)
	I, II, III	LD	20'	30'	DRY	25/25	1400 GPM		Table 12.2.2.2.1 (a)
	I, II, III	Area/Density	20'	30' **	DRY	0.213/2600	554 GPM	TY-B or TY-L 8.0 K	Fig. 12.2.2.1.5.2 (Non-Encapsulated)
	IV	LD	20'	30'	WET	15/50	1188 GPM		Table 12.2.2.2.1 (a)
	IV	ULTRA K-17	20' *	30'	WET	15/22	1182 GPM		Table 12.2.2.2.1 (b)
	IV	ESFR Pendent (K14.0)	20' *	30'	WET	12/50	1188 GPM	ESFR-1 Pendent	Table 12.2.2.3.1 Protects up to Group A Plastics
	IV	ESFR Pendent (K16.8)	20' *	30'	WET	12/35	1193 GPM	ESFR-17 Pendent	Table 12.2.2.3.1 Protects up to Group A Plastics
	IV	ESFR Pendent (K25.2)	20' *	30'	WET	12/15	1171 GPM	ESFR-25 Pendent	Table 12.2.2.3.1 Protects up to Group A Plastics
IV	Area/Density	20'	30' **	WET	0.295/2000	590 GPM	TY-B or TY-L 8.0 K	Fig. 12.2.2.1.5.2 (Non-Encapsulated)	

* Actual Max. Storage Height 25'

** Actual Max. Storage Height 30'

*** Actual Max. Ceiling Height is not Limited

NFPA 13, 2002

12.2.3.2.1 (a) Large Drop Criteria for Palletized and Solid Piled of Plastic and Rubber Commodities

Storage	Commodity	Sprinkler	Max. Storage Height	Max. Ceiling Height	System Type **	# Sprks/Press (psi) or Density/Area	System Demand	Recommended Sprinkler	Notes
Palletized	Cartoned or Exposed Unexpanded Plastics	LD	20'	30'	WET	25/25	1400 GPM		Table 12.2.3.2.1 (a)
		ULTRA K-17	20' *	30'	WET	15/22	1182 GPM	ULTRA K-17	Table 12.2.3.2.1 (b)
		Area/Density	20'	30'	WET	.85/2500 (open array) .85/2000 (closed array)	2125 GPM (open array) 1700 GPM (closed array)	EC-25 or K17-231	Table 12.2.3.1.6
		ESFR Pendent (K14.0)	20' *	30'	WET	12/50	1188 GPM	ESFR-1 Pendent	Table 12.2.3.3.1
		ESFR Pendent (K16.8)	20' *	30'	WET	12/35	1193 GPM	ESFR-17 Pendent	Table 12.2.3.3.1
	Cartoned or Exposed Expanded Plastics	LD	18'	26'	WET	15/50	1188 GPM		Table 12.2.3.2.1 (a)
		Area/Density	18'	26'	WET	0.9/2500 (open array) 0.9/2000 (closed array)	2250 GPM (open array) 1800 GPM (closed array)	EC-25 or K17-231	Table 12.2.3.1.6 (assuming worse-case "stable" load -Col. B)
	Solid Piled	Cartoned or Exposed Unexpanded Plastics	LD	20'	30'	WET	15/50	1188 GPM	
ULTRA K-17			20' *	30'	WET	15/22	1182	ULTRA K-17	Table 12.2.3.2.1 (b)
Area/Density			20'	30'	WET	.85/2500 (open array) .85/2000 (closed array)	2125 GPM (open array) 1700 GPM (closed array)	EC-25 or K17-231	Table 12.2.3.1.6
ESFR Pendent (K14.0)			20' *	30'	WET	12/50	1188 GPM	ESFR-1 Pendent	Table 12.2.3.3.1
ESFR Pendent (K16.8)			20' *	30'	WET	12/35	1193 GPM	ESFR-17 Pendent	Table 12.2.3.3.1

* Actual Max. Storage Height 25'

NFPA 13, 2002

12.3.2.2.1 (a) Large Drop Criteria for Single-, Double-, and Multiple-Row Racks without Solid Shelves
Class I - IV Commodity Stored up to 25'

Sheet 1 of 6

Storage	Commodity	Sprinkler	Max. Storage Height	Max. Ceiling Height	System Type	# Sprks/Press (psi) or Density/Area	System Demand	Recommended Sprinkler	Notes
Single-, Double-, Multiple-Row Racks without Solid Shelves	I - II	LD	25'	30'	WET	20/25	1120 GPM		Table 12.3.2.2.1 (a)
	I - II	ULTRA K-17	25'	30'	WET	15/10	797 GPM	ULTRA K-17	Table 12.3.2.2.1. (b)
	II	Area/Density	25'	30'	WET	0.315/2000 w/ 1 Level In-Rack Sprinklers	630 GPM + 132 GPM (Rack Sprks) = 762 GPM	TY-B or TY-L 8.0 K	Table 12.3.2.1.4
		ESFR Pendent (K14.0)	25'	30'	WET	12/50	1188 GPM	ESFR-1 Pendent	Table 12.3.2.3.1 Protects up to Group A Plastics
	I - II	ESFR Pendent (K16.8)	25'	30'	WET	12/35	1193 GPM	ESFR-17 Pendent	Table 12.3.2.3.1 Protects up to Group A Plastics
	I - II	ESFR Pendent (K25.2)	25'	30'	WET	12/15	1171 GPM	ESFR-25 Pendent	Table 12.3.2.3.1 Protects up to Group A Plastics
	I - II	LD	25'	30'	DRY	30/25	1680 GPM		Table 12.3.2.2.1 (a)
	II	Area/Density	25'	30'	DRY	0.315/2600 w/ 1 Level In-Rack Sprinklers	819 GPM + 132 GPM (Rack Sprks) = 951 GPM	TY-B or TY-L 8.0 K	Table 12.3.2.1.4
	II	Area/Density (K16.8)	25'	30'	DRY	0.8/4500	3600 GPM	K17-231	Fig. 12.3.3.1.5 (f) Note #3 Protects up to Group A Plastics

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12.3.2.2.1 (a) Large Drop Criteria for Single-, Double-, and Multiple-Row Racks without Solid Shelves
Class I - IV Commodity Stored up to 25'

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Storage	Commodity	Sprinkler	Max. Storage Height	Max. Ceiling Height	System Type	# Sprks/Press (psi) or Density/Area	System Demand	Recommended Sprinkler	Notes	
Single-, Double-, Multiple-Row Racks without Solid Shelves	I, II, III	LD	20'	30'	WET	15/25	840 GPM		Table 12.3.2.2.1 (a)	
	III	ULTRA K-17	20' *	30'	WET	15/22	1182 GPM	ULTRA K-17	Table 12.3.2.2.1. (b) Protects up to Group A Plastics	
	III	Area/Density	20'	27'	WET	0.6/2000	1200 GPM	ELO-231 or K17-231	Fig. 12.3.3.1.5 (d) Note #5 27' Max. Bldg. Height Protects up to Group A Plastics	
	III	Area/Density	20'	30'	WET	0.356/2000 w/ 1 Level In-Rack Sprinklers	712 GPM + 132 GPM (Rack Sprks) = 762 GPM		Table 12.3.2.1.4	
	III	Area/Density (K16.8)	20' *	30'	WET	0.8/2000	1600 GPM		Fig. 12.3.3.1.5 (f) Note #3 Protects up to Group A Plastics	
	III	ESFR Pendent (K14.0)	20' *	30'	WET	12/50	1188 GPM	ESFR-1 Pendent	Table 12.3.2.3.1 Protects up to Group A Plastics	
	III	ESFR Pendent (K16.8)	20' *	30'	WET	12/35	1193 GPM	ESFR-17 Pendent	Table 12.3.2.3.1 Protects up to Group A Plastics	
	III	ESFR Pendent (K25.2)	20' *	30'	WET	12/15	1171 GPM	ESFR-25 Pendent	Table 12.3.2.3.1 Protects up to Group A Plastics	
	I, II, III	LD		20'	30'	DRY	25/25	1400 GPM		Table 12.3.2.2.1 (a)
	III	Area/Density	20'	27'	DRY	0.6/2600	1560 GPM	ELO-231 or K17-231	Fig. 12.3.3.1.5 (d) Note #5 27' Max. Bldg. Height Protects up to Group A Plastics	
	III	Area/Density	20'	30'	DRY	0.356/2600 w/ 1 Level In-Rack Sprinklers	926 GPM + 132 GPM (Rack Sprks) = 1058 GPM	ELO-231	Table 12.3.2.1.4	
	II	Area/Density (K16.8)	20'	30'	DRY	0.8/4500	3600 GPM	K17-231	Fig. 12.3.3.1.5 (f) Note #3 Protects up to Group A Plastics	

* Actual Max. Storage Height 25'

NFPA 13, 2002

12.3.2.2.1 (a) Large Drop Criteria for Single-, Double-, and Multiple-Row Racks without Solid Shelves
Class I - IV Commodity Stored up to 25'

Sheet 3 of 6

Storage	Commodity	Sprinkler	Max. Storage Height	Max. Ceiling Height	System Type ****	# Sprks/Press (psi) or Density/Area	System Demand	Recommended Sprinkler	Notes
Single-, Double-, Multiple-Row Racks without Solid Shelves	I, II, III	LD	25'	35'	WET	15/25 w/1 level In-Rack sprks	840 GPM + 132 GPM (Rack Sprks.) = 972 GPM		Table 12.3.2.2.1 (a)
	III	Area/Density	25'	35'	WET	0.356/2000 w/ 1 level In-Rack Sprks	712 GPM + 132 GPM (Rack Sprks) = 762 GPM	ELO-231	Table 12.3.2.1.4
	III	ESFR Pendent (K14.0)	25' *	35'	WET	12/75	1455 GPM	ESFR-1 Pendent	Table 12.3.2.3.1 Protects up to Group A Plastics
	III	ESFR Pendent (K16.8)	25' *	35'	WET	12/52	1454 GPM	ESFR-17 Pendent	Table 12.3.2.3.1 Protects up to Group A Plastics
	III	ESFR Pendent (K25.2)	25' *	35'	WET	12/20	1352 GPM	ESFR-25 Pendent	Table 12.3.2.3.1 Protects up to Group A Plastics
	I, II, III	LD	25'	35'	DRY	25/25 w/ 1 Level In-Rack Sprks.	1400 GPM + 132 GPM (Rack Sprks) = 1532 GPM		Table 12.3.2.2.1 (a)
	III	Area/Density	25'	35'	DRY	0.356/2600 w/ 1 Level In-Rack Sprks	926 GPM + 132 GPM (Rack Sprks) = 1058 GPM	ELO-231	Table 12.3.2.1.4
	IV	LD	20'	25'	WET	15/50	1188 GPM		Table 12.3.2.2.1 (a)
	IV	ULTRA K-17	20'	25'	WET	15/22	1182 GPM	ULTRA K-17	Table 12.3.2.2.1 (b)
	IV	Area/Density	20'	25'	WET	0.579/2000 w/ 1 Level In-Rack Sprks	1158 GPM + 174 GPM (Rack Sprks) = 1332 GPM	ELO-231	Table 12.3.2.1.4
	IV	ESFR Pendent (K14.0)	20' **	25' ***	WET	12/50	1188 GPM	ESFR-1 Pendent	Table 12.3.2.3.1 Protects up to Group A Plastics
	IV	ESFR Pendent (K16.8)	20' **	25' ***	WET	12/35	1193 GPM	ESFR-17 Pendent	Table 12.3.2.3.1 Protects up to Group A Plastics
	IV	ESFR Pendent (K25.2)	20' **	25' ***	WET	12/15	1171 GPM	ESFR-25 Pendent	Table 12.3.2.3.1 Protects up to Group A Plastics

* Actual Max. Storage Height 30'

** Actual Max. Storage Height 25'

*** Actual Max. Ceiling Height 30'

**** NFPA 13 does not address CMSA design criteria for dry systems of Class IV commodity stored up to 25 ft. in height

NFPA 13, 2002

**12.3.2.2.1 (a) Large Drop Criteria for Single-, Double-, and Multiple-Row Racks without Solid Shelves
Class I - IV Commodity Stored up to 25'**

Sheet 4 of 6

Storage	Commodity	Sprinkler	Max. Storage Height	Max. Ceiling Height	System Type **	# Sprks/Press (psi) or Density/Area	System Demand	Recommended Sprinkler	Notes
Single-, Double-, Multiple-Row Racks without Solid Shelves	IV	LD	20'	30'	WET	20/50 15/75	1584 GPM 1455 GPM		Table 12.3.2.2.1 (a)
	IV	ULTRA K-17	20' *	30'	WET	15/22	1182 GPM	ULTRA K-17	Table 12.3.2.2.1. (b) Protects up to Group A Plastics
	IV	Area/Density	20'	27'	WET	0.6/2000	1200 GPM	ELO-231 or K17-231	Fig. 12.3.3.1.5 (d) Note #5 27' Max. Bldg. Height Protects up to Group A Plastics
	IV	Area/Density (K16.8)	20'	30'	WET	0.8/2000	1600 GPM	K17-231	Fig. 12.3.3.1.5 (f) Note #3 Protects up to Group A Plastics
	IV	Area/Density	20'	30'	WET	0.579/2000 w/ 1 level In-Rack Sprks	1158 GPM + 174 GPM (Rack Sprks) = 1352 GPM	ELO-231 or K17-231	Table 12.3.2.1.4
	IV	ESFR Pendent (K14.0)	20' *	30'	WET	12/50	1188 GPM	ESFR-1 Pendent	Table 12.3.2.3.1 Protects up to Group A Plastics
	IV	ESFR Pendent (K16.8)	20' *	30'	WET	12/35	1193 GPM	ESFR-17 Pendent	Table 12.3.2.3.1 Protects up to Group A Plastics
	IV	ESFR Pendent (K25.2)	20' *	30'	WET	12/15	1171 GPM	ESFR-25 Pendent	Table 12.3.2.3.1 Protects up to Group A Plastics

* Actual Max. Storage Height 25'

** NFPA 13 does not address CMSA design criteria for dry systems of Class IV commodity stored up to 25 ft. in height

NFPA 13, 2002

12.3.2.2.1 (a) Large Drop Criteria for Single-, Double-, and Multiple-Row Racks without Solid Shelves
Class I - IV Commodity Stored up to 25'

Sheet 5 of 6

Storage	Commodity	Sprinkler	Max. Storage Height	Max. Ceiling Height	System Type **	# Sprks/Press (psi) or Density/Area	System Demand	Recommended Sprinkler	Notes
Single-, Double-, Multiple-Row Racks without Solid Shelves	IV	LD	25'	30'	WET	15/50 w/ 1 Level In-Rack Sprks	1188 GPM + 176 GPM (In-Rack Sprks) = 1364 GPM		Table 12.3.2.2.1 (a)
	IV	ULTRA K-17	25'	30'	WET	15/22	1182 GPM	ULTRA K-17	Table 12.3.2.2.1. (b) Protects up to Group A Plastics
	IV	Area/Density (K16.8)	25'	30'	WET	0.8/2000	1600 GPM	K17-231	Fig. 12.3.3.1.5 (f) Note #3 Protects up to Group A Plastics
	IV	ESFR Pendent (K14.0)	25'	30'	WET	12/50	1188 GPM	ESFR-1 Pendent	Table 12.3.2.3.1 Protects up to Group A Plastics
	IV	ESFR Pendent (K16.8)	25'	30'	WET	12/35	1193 GPM	ESFR-17 Pendent	Table 12.3.2.3.1 Protects up to Group A Plastics
	IV	ESFR Pendent (K25.2)	25'	30'	WET	12/15	1171 GPM	ESFR-25 Pendent	Table 12.3.2.3.1 Protects up to Group A Plastics
	IV	LD	25'	35'	WET	20/50 w/ 1 Level In-Rack Sprks	1584 GPM + 176 GPM (In-Rack Sprks) = 1760 GPM		Table 12.3.2.2.1 (a)
	IV	Area/Density	25'	35'	WET	0.579/2000 w/ 2 level In-Rack Sprks	1158 GPM + 308 GPM (Rack Sprks) = 1466 GPM	ELO-231 or K17-231	Table 12.3.2.1.4
	IV	ESFR Pendent (K14.0)	25' *	35'	WET	12/75	1455 GPM	ESFR-1 Pendent	Table 12.3.2.3.1 Protects up to Group A Plastics
	IV	ESFR Pendent (K16.8)	25' *	35'	WET	12/52	1454 GPM	ESFR-17 Pendent	Table 12.3.2.3.1 Protects up to Group A Plastics
IV	ESFR Pendent (K25.2)	25' *	35'	WET	12/20	1352 GPM	ESFR-25 Pendent	Table 12.3.2.3.1 Protects up to Group A Plastics	

* Actual Max. Storage Height 30'

** NFPA 13 does not address CMSA design criteria for dry systems of Class IV commodity stored up to 25 ft. in height

NFPA 13, 2002

12.3.4.2.1 Large Drop Criteria for Single-, Double-, and Multiple-Row Racks without Solid Shelves
Class I - IV Commodity Stored over 25'

Sheet 1 of 1

Storage	Commodity	Sprinkler	Max. Storage Height	Max. Ceiling Height	System Type	# Sprks/Press (psi) or Density/Area	System Demand	Recommended Sprinkler	Notes
Single-, Double-, Multiple-Row Racks without Solid Shelves	I-II	LD	30'	35'	WET	20/25 w/ 1 Level In-Rack Sprks	1120 GPM + 180 GPM (Rack Sprks) = 1300 GPM		Table 12.3.4.2.1
	I-II	ESFR Pendent (K14.0)	30'	35'	WET	12/75	1455 GPM	ESFR-1 Pendent	Table 12.3.4.3.1
	I-II	ESFR Pendent (K16.8)	30'	35'	WET	12/52	1454 GPM	ESFR-17 Pendent	Table 12.3.4.3.1
	I-II	ESFR Pendent (K25.2)	30'	35'	WET	12/20	1352 GPM	ESFR-25 Pendent	Table 12.3.4.3.1
	I-II	LD	30'	35'	DRY	30/25 w/ 1 Level In-Rack Sprks	1680 GPM + 180 GPM (Rack Sprks) = 1860 GPM		Table 12.3.4.2.1
	I-II	Area/Density	30'	35'	DRY	0.37/2600 w/ 2 Levels In-Rack Sprks	962 GPM + 300 GPM (Rack Sprks) = 1262 GPM	ELO-231 Upright	Table 12.3.4.1.3 Assuming Multiple Row Racks and Encapsulated
	III-IV	NFPA 13 does not address CMSA design criteria for Class III or Class IV commodity stored in excess of 25 ft. in height							

NFPA 13, 2002

12.3.3.2.1 (a) Large Drop Criteria for Single-, Double-, and Multiple-Row Racks without Solid Shelves
Plastic Commodity Stored up to 25'

Sheet 1

Storage	Commodity	Sprinkler	Max. Storage Height	Max. Ceiling Height	System Type	# Sprks/Press (psi) or Density/Area	System Demand	Recommended Sprinkler	Notes	
Single-, Double-, Multiple-Row Racks without Solid Shelves	Cartoned unexpanded plastic	LD	20'	25'	WET	15/50	1188 GPM		Table 12.3.3.2.1 (a)	
		ULTRA K-17	20' *	25'	WET	15/22	1182 GPM	ULTRA K-17	Table 12.3.3.2.1. (b)	
		Area/Density	20'	25'	WET	0.6/2000	1200 GPM	ELO-231 or K17-231	Fig. 12.3.3.1.5 (d) Note #5	
		ESFR Pendent (K14.0)	20' *	30'	WET	12/50	1188 GPM	ESFR-1 Pendent	Table 12.3.3.3.1	
		ESFR Pendent (K16.8)	20' *	30'	WET	12/35	1193 GPM	ESFR-17 Pendent	Table 12.3.3.3.1	
		ESFR Pendent (K25.2)	20' *	30'	WET	12/15	1171 GPM	ESFR-25 Pendent	Table 12.3.3.3.1	
		LD	20'	30'	WET	30/50	2376 GPM		Table 12.3.3.2.1 (a)	
		ULTRA K-17	20' *	30'	WET	20/75	1940 GPM	1182	ULTRA K-17	Table 12.3.3.2.1. (b)
		Area/Density	20'	27'	WET	15/22	1200 GPM	1182	ELO-231 or K17-231	Fig. 12.3.3.1.5 (d) Note #5 (27' Max. Clg)
		ESFR Pendent (K14.0)	20' *	30'	WET	12/50	1188 GPM	1188 GPM	ESFR-1 Pendent	Table 12.3.3.3.1
		ESFR Pendent (K16.8)	20' *	30'	WET	12/35	1193 GPM	1193 GPM	ESFR-17 Pendent	Table 12.3.3.3.1
		ESFR Pendent (K25.2)	20' *	30'	WET	12/15	1171 GPM	1171 GPM	ESFR-25 Pendent	Table 12.3.3.3.1
		LD	25'	30'	WET	15/50 w/ 1 Level In-Racks Sprks	1188 GPM + 176 GPM In-Racks Sprks = 1364 GPM			Table 12.3.3.2.1 (a)
		ULTRA K-17	25'	30'	WET	15/22	1182	ULTRA K-17	Table 12.3.3.2.1. (b)	
		ESFR Pendent (K14.0)	25'	30'	WET	12/50	1188 GPM	ESFR-1 Pendent	Table 12.3.3.3.1	
		ESFR Pendent (K16.8)	25'	30'	WET	12/35	1193 GPM	ESFR-17 Pendent	Table 12.3.3.3.1	
		ESFR Pendent (K25.2)	25'	30'	WET	12/15	1171 GPM	ESFR-25 Pendent	Table 12.3.3.3.1	
		LD	25'	35'	WET	30/50 w/ 1 Level In-Rack Sprks	2376 GPM + 176 GPM In-Rack Sprks = 2552 GPM			Table 12.3.3.2.1 (a)
						20/75 w/ 1 Level In-Rack Sprks	1940 GPM + 176 GPM In-Rack Sprks = 2116 GPM			
		ESFR Pendent (K14.0)	25'	35'	WET	12/75	1455 GPM	ESFR-1 Pendent	Table 12.3.3.3.1	
		ESFR Pendent (K16.8)	25'	35'	WET	12/52	1454 GPM	ESFR-17 Pendent	Table 12.3.3.3.1	
		ESFR Pendent (K25.2)	25'	35'	WET	12/20	1352 GPM	ESFR-25 Pendent	Table 12.3.3.3.1	
		Area Density	25'	35'	WET	0.3/2000 w/ 2 Levels In-Rack Sprks	600 GPM + 308 GPM In-Rack Sprks = 908 GPM	TY-B or TY-L 8.0 K	Fig. 12.3.3.1.5 (f)	

* Actual Max. Storage Height 25'

** Actual Max. Ceiling Height is not Limited

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12.3.3.2.1 (a) Large Drop Criteria for Single-, Double-, and Multiple-Row Racks without Solid Shelves
Plastic Commodity Stored up to 25'

Sheet 2

Storage	Commodity	Sprinkler	Max. Storage Height	Max. Ceiling Height	System Type	# Sprks/Press (psi) or Density/Area	System Demand	Recommended Sprinkler	Notes
Single-, Double-, Multiple-Row Racks without Solid Shelves	Exposed unexpanded plastic	LD	20'	25'	WET	15/50	1188 GPM		Table 12.3.3.2.1 (a)
		ULTRA K-17	20' *	25'	WET	15/22	1182 GPM	ULTRA K-17	Table 12.3.3.2.1. (b)
		Area/Density	20'	25'	WET	0.6/2000	1200 GPM	ELO-231 or K17-231	Fig. 12.3.3.1.5 (d) Note #5
		ESFR Pendent (K14.0)	20' *	30'	WET	12/50	1188 GPM	ESFR-1 Pendent	Table 12.3.3.3.1
		ESFR Pendent (K16.8)	20' *	30'	WET	12/35	1193 GPM	ESFR-17 Pendent	Table 12.3.3.3.1
		LD	20'	30'	WET	30/50 20/75	2376 GPM 1940 GPM		Table 12.3.3.2.1 (a)
		ULTRA K-17	20' *	30'	WET	15/22	1182	ULTRA K-17	Table 12.3.3.2.1. (b)
		Area/Density	20'	27'	WET	0.6/2000	1200 GPM	ELO-231 or K17-231	Fig. 12.3.3.1.5 (d) Note #5 (27' Max. Clg)
		ESFR Pendent (K14.0)	20' *	30'	WET	12/50	1188 GPM	ESFR-1 Pendent	Table 12.3.3.3.1
		ESFR Pendent (K16.8)	20' *	30'	WET	12/35	1193 GPM	ESFR-17 Pendent	Table 12.3.3.3.1
		LD	25'	30'	WET	15/50 w/ 1 Level In-Racks Sprks	1188 GPM + 176 GPM In-Racks Sprks = 1364 GPM		Table 12.3.3.2.1 (a)
		ULTRA K-17	25'	30'	WET	15/22	1182	ULTRA K-17	Table 12.3.3.2.1. (b)
		ESFR Pendent (K14.0)	20' *	30'	WET	12/50	1188 GPM	ESFR-1 Pendent	Table 12.3.3.3.1
		ESFR Pendent (K16.8)	20' *	30'	WET	12/35	1193 GPM	ESFR-17 Pendent	Table 12.3.3.3.1
		LD	25'	35'	WET	30/50 w/ 1 Level In-Rack Sprks 20/75 w/ 1 Level In-Rack Sprks	2376 GPM + 176 GPM In-Rack Sprks = 2552 GPM 1940 GPM + 176 GPM In-Rack Sprks = 2116 GPM		Table 12.3.3.2.1 (a)
ESFR Pendent (K14.0)	25'	35'	WET	12/75	1455 GPM	ESFR-1 Pendent	Table 12.3.3.3.1		
ESFR Pendent (K16.8)	25'	35'	WET	12/52	1454 GPM	ESFR-17 Pendent	Table 12.3.3.3.1		
Area Density	25'	35'	WET	0.3/2000 w/ 2 Levels In-Rack Sprks	600 GPM + 308 GPM In-Rack Sprks = 908 GPM	TY-B or TY-L 8.0 K	Fig. 12.3.3.1.5 (f)		

* Actual Max. Storage Height 25'

** Actual Max. Ceiling Height is not Limited

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Ref. Table 12.4.2(c) Large Drop Sprinklers and Specific Application Control Mode Sprinkler Protection for Rubber Tires

Piling Method	Sprinkler	Pile Height	Ceiling Height ⁽¹⁾	Syst. Type	# Sprks/Press Density/Area	System Demand	Recommended Sprinkler	Notes
Rubber tire storage, on-side or on-tread, in palletized portable racks, or open portable racks, or fixed racks without solid shelves	LD	25'	32'	WET	15/75	1455 GPM		Table 12.4.2(c)
	ESFR Pendent (K14.0)	25'	30'	WET	12/50	1188 GPM	ESFR-1 Pendent	Table 12.4.2 (d)
	ESFR Pendent (K16.8)	25'	30'	WET	12/35	1193 GPM	ESFR-17 Pendent	Table 12.4.2 (d)
	ESFR Pendent (K25.2)	25'	30'	WET	12/15	1171 GPM	ESFR-25 Pendent	Table 12.4.2 (d)

(1) Tests were based on deflector to storage clearance of 5' to 7'

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Table 12.6.2.2 Large Drop Protection for Roll Paper Storage

Storage Height (ft)	Clearance (ft)	System Type	Sprinkler	Heavyweight (# Sprks/Pressure; psi)					Mediumweight (# Sprks/Pressure; psi)					Tissue All Arrays	
				Closed Array	Standard Array		Open Array		Closed Array	Standard Array		Open Array			
					Banded or Unbanded	Banded	Unbanded	Banded		Unbanded	Banded or Unbanded	Banded	Unbanded		Banded
20'	< 10	WET	LD	15/50 (1188 GPM)	15/50 (1188 GPM)	15/50 (1188 GPM)	15/50 (1188 GPM)	N/A	15/50 (1188 GPM)	15/50 (1188 GPM)	15/50 (1188 GPM)	N/A	N/A	25/75 2425 GPM (Closed or Standard Array Only)	
20'	< 10	WET	Area/Density	0.3/2000 (600 GPM)	0.3/2500 (750 GPM)	0.3/3000 (900 GPM)	0.45/3500 (1575 GPM)	0.45/4000 (1800 GPM)	0.3/2500 (750 GPM)	0.45/3000 (1350 GPM)	0.6/3000 (1800 GPM)	0.6/3000 (1800 GPM)	0.6/3000 (1800 GPM)	0.75/3000 (2250 GPM)	
20	10	WET	ESFR-25	12/15 psi (1171 GPM)	12/15 psi (1171 GPM)	12/15 psi (1171 GPM)	12/15 psi (1171 GPM)	12/15 psi (1171 GPM)	12/15 psi (1171 GPM)	12/15 psi (1171 GPM)	12/15 psi (1171 GPM)	12/15 psi (1171 GPM)	12/15 psi (1171 GPM)	N/A	
20'	10	WET	ESFR-1	50 psi (1188 GPM)	50 psi (1188 GPM)	50 psi (1188 GPM)	50 psi (1188 GPM)	50 psi (1188 GPM)	50 psi (1188 GPM)	50 psi (1188 GPM)	50 psi (1188 GPM)	50 psi (1188 GPM)	50 psi (1188 GPM)	50 psi (1188 GPM)	N/A
20'	< 10	DRY	LD	25/50 (1980 GPM)	25/50 (1980 GPM)	25/50 (1980 GPM)	N/A	N/A	25/50 (1980 GPM)	25/50 (1980 GPM)	25/50 (1980 GPM)	N/A	N/A	N/A	
20	10	DRY	Area/Density	0.3/2600 (780 GPM)	0.3/3250 (975 GPM)	0.3/3900 (1170 GPM)	0.45/4550 (2048 GPM)	0.45/5200 (2340 GPM)	0.3/3250 (975 GPM)	0.45/3900 (1755 GPM)	0.6/3900 (2340 GPM)	0.6/3900 (2340 GPM)	0.6/3900 (2340 GPM)	0.6/3900 (2340 GPM)	N/A
26'	<34'	WET	LD	15/50 (1188 GPM)	15/50 (1188 GPM)	15/50 (1188 GPM)	15/50 (1188 GPM)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
30'	15'	WET	ESFR-25	12/50 (2138 GPM)	12/50 (2138 GPM)	12/50 (2138 GPM)	12/50 (2138 GPM)	12/50 (2138 GPM)	N/A	N/A	N/A	N/A	N/A	N/A	