

## Appendix C

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

The following contains additional information and recommendations bearing the same number as the text of the *Flammable and Combustible Liquids Code* to which they apply:

**C-4-4** The preferred method of storage of liquids in buildings is in cutoff rooms or in attached buildings rather than in inside rooms because of fire department accessibility and the advantages of providing explosion venting where needed.

**C-4-6.2 (a)** Sprinkler system densities and areas of application presented in this appendix are based upon limited test data and fire experience. Design criteria in this appendix do not apply to storage in plastic drums. (See *Appendix D* for additional information on this subject.)

(b) For design criteria for specific installations, insurance engineers, fire protection consultants, and other knowledgeable persons should be consulted.

(c) **Palletized and Solid Pile Storage.** For protected storage of liquids, as specified in Table 4-6.1(a), automatic sprinkler protection should be provided in accordance with Table C-4-6.2(a).

(d) **Rack Storage.** In protected storage of liquids arranged, as specified in Table 4-6.1(b), automatic sprinkler protection should be provided in accordance with Tables C-4-6.2(b) and C-4-6.2(c), as applicable, except that racks with solid shelves should be provided with in-rack sprinklers at every tier or level.

**C-4-6.2.1 (a)** Automatic aqueous film forming foam (AFFF)-water sprinkler systems for container storage of liquids has been shown to be an acceptable method for providing fixed protection. (See *Appendix D* for additional information on this subject.)

(b) For design criteria for specific installations, insurance engineers, fire protection consultants and other knowledgeable persons should be consulted.

(c) Rack storage of liquids in containers [drums of 55 gal (208.1 L) capacity] stored on-end on wood pallets on conventional double-row racks to a maximum height of storage of 25 ft (7.62 m) should be provided protection in accordance with Table C-4-6.2.1.

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Table C-4-6.2(a) Automatic Sprinkler Protection for Solid Pile and Palletized Storage of Liquids in Containers and Portable Tanks

Storage Conditions	Class Liquid	Container Size and Arrangement	Ceiling Sprinkler Design and Demand				Minimum Hose Stream Demand (gpm)	Minimum Duration Sprinklers & Hose Streams
			Density gpm/sq ft	Area (sq ft)		Maximum Spacing		
				High Temp.	Ord. Temp.			
IA		5 gal. or less, with/without cartons, palletized or solid pile	0.30	3000	5000	100 sq ft	750	2 hrs
		flammable aerosols in cartons, palletized or solid pile	0.30	6000	10,000	100 sq ft	1000	
		containers greater than 5 gal., on end or side, palletized or solid pile	0.60	5000	8000	80 sq ft	750	
IB, IC, & II		5 gal. or less, with/without cartons, palletized or solid pile	0.30	3000	5000	100 sq ft	500	2 hrs
		containers greater than 5 gal., on pallets or solid pile, one high	0.25	5000	8000	100 sq ft		
II		containers greater than 5 gal., on pallets or solid pile, more than one high on end or side	0.60	5000	8000	80 sq ft	750	2 hrs
		portable tanks, one high	0.30	3000	5000	100 sq ft	500	2 hrs

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10/17/84  
50-400-02

NUCLEAR REGULATORY COMMISSION

Deskset No. 50-400 Official Exh. No. 9

In the matter of Sheraton Harris

State \_\_\_\_\_ IDENTIFIED ☒

Applicant \_\_\_\_\_ RECEIVED ☒

Intervenor \_\_\_\_\_

Cont'g Off'r \_\_\_\_\_

Contractor \_\_\_\_\_ DATE 10-17-84

Other \_\_\_\_\_ Witness \_\_\_\_\_

Reporter WRS



Table C-4-6.2(a) Continued

Storage Conditions		Ceiling Sprinkler Design and Demand					
Class Liquid	Container Size and Arrangement	Density gpm/ sq ft	Area (sq ft)		Maximum Spacing	Minimum Hose Stream Demand (gpm)	Minimum Duration Sprinklers & Hose Streams
			High Temp.	Ord. Temp.			
II	portable tanks, two high	0.60	5000	8000	80 sq ft	750	2 hrs
	5 gal. or less, with/without cartons, palletized or solid pile	0.25	3000	5000	120 sq ft	500	1 hr
	container greater than 5 gal., on pallets or solid pile, on end or sides, up to three high	0.25	3000	5000	120 sq ft	500	1 hr
III	container greater than 5 gal., on pallets or solid pile, on end or sides up to 18 feet high	0.35	3000	5000	100 sq ft	750	2 hrs
	portable tanks, one high	0.25	3000	5000	120 sq ft	500	1 hr
	portable tanks, two high	0.50	3000	5000	80 sq ft	750	2 hrs

- Notes: (1) See Table 4-6.1(a) and Section 4-6 for additional information pertaining to protected palletized or solid piling of liquids.  
 (2) Minimum hose stream demand includes small hand hose (1½ inches) required in 4-7.1.3.  
 (3) The design area contemplates the use of wet pipe systems. Where dry pipe systems are required, it introduces a possible delay which needs to be compensated for by increased areas of application (plus 30 percent).

SI Units: 1 gal = 3.785 L; 1 sq ft = 0.0929 m²; 1 ft = 0.3048 m.

Table C-4-6.2(b) Automatic Sprinkler Protection Requirements for Rack Storage of Liquids in Containers of Five Gallon Capacity or Less,\* in Cartons on Conventional Wood Pallets or Without Cartons but Strapped to Pallets

\*Flammable Aerosols Not Included

Class Liquid	Ceiling Sprinkler Design & Demand			In-Rack Sprinkler Arrangement and Demand				Minim. Hose Stream Demand (gpm)	Minim. Duration Sprinkler & Hose Stream
	Density gpm/ sq ft	Area (sq ft) High Temp.	Ord. Temp.	Max. Spacing	Racks up to 9 ft. (2.7m) deep	Racks over 9 ft. (2.7m) to 12 ft. (3.7m) deep	Minim. Nozzle Pressure		
I (max. 25' height)	0.40	3000	5000	80 sq ft/bd.	a) ord. temp. sprinklers 8 feet apart horizontally b) one line sprin- klers above each level of storage c) locate in longi- tudinal flue space, staggered vertical d) shields req'd where multilevel	a) ord. temp. sprinklers 8 feet apart horizontally b) two lines sprin- klers above each level of storage c) locate in trans- verse flue spaces, staggered vertical and within 20 in. of aisle d) shields re- quired where multilevel	30 psi.	a) 8 sprin- klers if only one level b) 6 sprin- klers ea. on two levels if only two levels c) 6 sprin- klers ea. on top 3 levels, if 3 or more levels d) hydraulic- ally most re- mote	750 2 hrs

Table C-4-6.2(b) Continued

Class Liquid	Ceiling Sprinkler Design & Demand				In-Rack Sprinkler Arrangement and Demand				Minim. Hose Stream Demand (gpm)	Minim. Duration Sprinkler & Hose Stream
	Density gpm/sq ft	Area (sq ft)	High Temp.	Ord. Temp.	Max. Spacing	Racks up to 9 ft. (2.7m) deep	Racks over 9 ft. (2.7m) to 12 ft. (3.7m) deep	Minim. Nozzle Pressure	Number of Sprinklers Operating	
II (max. 25' height)	0.30	3000		5000	100 sq ft/hd.	a) ord. temp. sprinklers 3 feet apart horizontally b) one line sprinklers betw. levels at nearest 10 foot vertical intervals c) locate in longitudinal flue space, staggered vertical d) shields required where multilevel	a) ord. temp. sprinklers 8 feet apart horizontally b) two lines betw. levels at nearest 10 foot vertical intervals c) locate in transverse flue spaces, staggered vertical and within 20 in. of aisle d) shields required where multilevel	30 psi.	a) hydraulically most remote — 6 sprinklers at each level, up to max. of three levels	750 2 hrs
III max.	0.25	3000		5000	120 sq ft/hd.	Same as Class II	Same as Class II	30 psi.	Same as Class II	500 2 hrs

- Notes: (1) See Table 4-6.1(b) and Section 4-6 for additional information pertaining to protected rack storage.  
 (2) Additional in-rack protection required for solid shelves, as indicated in D-4-6.2(d).  
 (3) See 4-6.3 for types of racks permitted.  
 (4) See 4-6.5 for additional information pertaining to in-rack sprinklers.  
 (5) Minimum hose stream demand includes small hand hose (1½ inches) required in 4-7.1.3.  
 (6) The design area contemplates the use of wet pipe systems. Where dry pipe systems are required, it introduces a possible delay which needs to be compensated for by increased areas of application (plus 30 percent).

SI Units: 1 gal = 3.785 L; 1 sq ft = 0.0929 m<sup>2</sup>; 1 ft = 0.3048 m; 1 in. = 25.40 mm.

Table C-4-6.2(c) Automatic Sprinkler Protection for Rack Storage of Liquids in Containers Greater Than 5 Gallon Capacity  
(See notes on following page.)

Class Liquid	Ceiling Sprinkler Design & Demand				In-Rack Sprinkler Arrangement and Demand				Minim. Hose Stream Demand (gpm)	Minim. Duration Sprinkler & Hose Stream
	Density gpm/sq ft	Area (sq ft)	High Temp.	Ord. Temp.	Max. Spacing	On-Side Storage Racks up to 9 ft.	On-End Storage (on pallets) up to 9 ft. deep racks	Minim. Nozzle Pressure	Number of Sprinklers Operating	
IA (max. 25' height)	0.60	3000		5000	80 sq ft/hd.	a) ord. temp. sprinklers 8 feet apart horizontally b) one line sprinklers above each tier of storage c) locate in longitudinal flue space, staggered vertical d) shields required where multilevel	a) ord. temp. sprinklers 8 feet apart horizontally b) one line sprinklers above each tier of storage c) locate in longitudinal flue space, staggered vertical d) shields required where multilevel	30 psi.	a) hydraulically most remote 6 sprinklers at each level	1000 2 hrs
IB, IC & II (max. 25' height)	0.60	3000		5000	100 sq ft/hd.	a) see a) above b) one line sprinklers every three tiers of storage c) see c) above d) see d) above	a) see a) above b) see b) above c) see c) above d) see d) above	30 psi.	a) see a) above	750 2 hrs
III (max. 40' height)	0.25	3000		5000	120 sq ft/hd.	a) see a) above b) one line sprinklers every sixth level (maximum) c) see c) above d) see d) above	a) see a) above b) one line sprinklers every third level (maximum) c) see c) above d) see d) above	15 psi.	a) see a) above	500 1 hr

(See over.)

SI Units: 1 gal = 3.785 L; 1 sq ft = 0.0929 m<sup>2</sup>; 1 ft = 0.3048 m; 1 in. = 25.40 mm.



## Notes to Table C-4-6.2(c)

- (1) See Table 4-6.1(b) and C-4-6.2(b) for additional information pertaining to protected rack storage.
- (2) Additional in-rack protection required for solid shelves, as indicated in C-4-6.2(d).
- (3) See 4-6.3 for types of racks permitted.
- (4) See 4-6.5 for additional information pertaining to in-rack sprinklers.
- (5) Minimum hose stream demand includes small hand hose (1½ in.) required in 4-7.1.3.
- (6) The design area contemplates the use of wet pipe systems. Where dry pipe systems are required, it introduces a possible delay which needs to be compensated for by increased areas of application (plus 30 percent).

Table C-4-6.2.1 Automatic AFFF-Water Protection (1) Requirements for Rack Storage of Liquids\* in Containers

\*Flammable Aerosols Not Included

Class Liquid	Ceiling Sprinklers Design & Demand			In-Rack Sprinkler Arrangement and Demand (4)				Hose Stream Demand (3)	Duration AFFF Supply	Duration Water Supply
	Density gpm/sq ft	High Temp.	Ord. Temp.	On-End Storage, of drums (on pallets) up to 25 ft	Minimum Nozzle Pressure	Number of Sprinklers Operating				
IA, IB, IC, II	0.30	1500	2550	a) ord. temp. sprinkler up to 10 feet apart horizontally b) one line sprinklers above each level of storage c) locate in longitudinal flue space, staggered vertically d) Shields required for multi-level	30 psi.	3 sprinklers per level		500	15 min	2 hrs

- Notes: (1) System shall be a closed head wet system with approved devices for proportioning AFFF.
- (2) Except as modified herein, in-rack sprinklers shall be installed in accordance with *Rack Storage of Materials*, NFPA 231C.
- (3) Hose stream demand includes inside hand hose (1½ inches) required in 4-7.1.3.
- (4) Maximum height of storage should be limited to 25 feet.

SI Units: 1 gal = 3.785 L; 1 sq ft = 0.0929 m<sup>2</sup>; 1 ft = 0.3048 m; 1 in. = 25.40 mm.