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TABLE 13.5.5.3(B)

PALLETIZED/SOLID-PILE STORAGE OF IGNITABLE LIQUIDS IN METAL CONTAINERS LARGER THAN 25 L UP TO AND INCLUDING 230 L (see Note)

UP TO AND INCLUDING 230 L (see Note) Ceiling sprinkler protection design criteria ^a										
Liquid type/ Flash point	ceiling height	Drum orientation	Maximum storage	Relieving-style drum required	Protection	Response/nominal	Sprinkler type		Number of activating	
ľ	m		(No drums)	Yes/No	type	rating/orientation	K US imp	<i>K</i>	– sprinklers @ kPa	
Any	9.1	On-end	1 high	No	Water	SR/141°C/Any	≥11.2 ^{d,e}	≥16.1 ^{d,e}	50 @ 50	
					Foam-water	SR/141°C/Any	≥11.2 ^{d,e}	≥16.1 ^{d,e}	30 @ 50	
			2 high	Yes	Water	SR/141°C/Any	11.2 ^d	16.1 ^d	50 @ 50	
							14.0	20.2	50 @ 120	
							16.8	23.5	50 @ 90	
							25.0	36.3	50 @ 50	
					Foam-water	SR/141°C/Any	$\geq 11.2^{d}$	≥16.1 ^d	30 @ 50	
			3 high	Yes	Foam-water ^a	SR/141°C/Any	11.2 ^d	16.1 ^d	16 @ 110	
							14.0	20.2	30 @ 70	
							≥16.8 ^d	≥23.5 ^d	30 @ 50	
Any	9.1	On-end	4 high	Yes	Foam-water	SR/141°C/Any	11.2 ^d	16.1 ^d	30 @ 200	
							14.0	20.2	30 @ 120	
							16.8	23.5	30 @ 90	
							25.0	36.3	30 @ 50	
		On-side	1 high	No ^b	Water	SR/141°C/Any	≥11.2 ^{d,e}	≥16.1 ^{d,e}	50 @ 50	
			3 high	No ^b	Water	SR/141°C/Any	11.2 ^d	16.1 ^d	50 @ 200	
							14.0	20.2	50 @ 120	
							16.8	23.5	50 @ 90	
							25.0	36.3	50 @ 50	

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	Maximum		Maximum	imum Relieving-style rage drum required Protec rums) Yes/No type	Ceiling sprinkler protection design criteria ^a							
Liquid type/ Flash point	ceiling	D • • • •				Response/nominal	Sprinkl	er type	Number of			
	height m	Drum orientation	storage (No drums)		Protection	temperature	K factor ^c		activating			
			· · · ·		type	rating/orientation	K US imp	K	@ kPa			
≥93°Cª	9.1	On-end	4 high	Yes	Water SR/141°C/Any	SR/141°C/Any	11.2 ^d	16.1 ^d	50 @ 200			
						14.0	20.2	50 @ 120				
		On-side 6 high					16.8 23.5 25.0 36.3	50 @ 90				
								36.3	50 @ 50			
			6 high	No ^b	Water	SR/141°C/Any	11.2 ^d 16.1 ^d	16.1 ^d	50 @ 200			
						14.0 20.2	20.2	50 @ 120				
							16.8	23.5	50 @ 90			
							25.0	36.3	50 @ 50			

LEGEND:

SR = Standard response

QR = Quick response

^a For liquids with flash points \geq 260°C in containers >150 L, see Clause 13.3.5.2.

^b A relieving-style drum shall not be used when drums are stored on-side. This storage arrangement will allow relieving-style drums to empty if the plugs open.

^c Unsaturated polyester resin (UPR) mixtures with less than 50% or less styrene may be protected palletized to 3 relieving-style drums high without a foam-water sprinkler system.

^d If a foam-water sprinkler system is used, Km11.5 (K8) ceiling sprinklers may be used, provided an equivalent flow is provided from the sprinklers.

^e The Km28.0 (K19.6) sprinkler shall not be used

^f This Table shall be applied in accordance with Clause 13.5.5.4.

TABLE 13.5.5.3(B) (continued)

13.5.5.4 Metal containers of 25 L or less

Rack storage shall be protected in accordance with Table 13.5.5.4(A) or 13.5.5.4(B).

Palletized or solid-pile storage shall be protected in accordance with Table 13.5.5.4(B) or 13.5.5.4(C).

Table 13.5.5.3(B) shall only be applied to the storage of relieving-style metal containers and liquids with a boiling point above 38°C.

Shelf storage shall be protected in accordance with Table 13.5.5.4(D).

NOTE: Shelves to be limited to no more than a 0.6 m deep (dimension from aisle face to back of shelf) and non-combustible construction. Back-to-back shelves should be separated with a non-combustible partition. Shelves lacking this partition should be treated like a single-row rack.

C13.5.5.4 Protecting any size metal container filled with an ignitable liquid requires adequate water to cool the container to prevent its violent rupture or the creation of a jet fire. Palletized storage arrangements significantly limit the ability of ceiling sprinkler discharge to provide cooling to containers that are at the bottom of the storage array. Full-scale fire testing has shown that standard response, small orifice sprinklers (i.e. smaller than $K_m 16.0$ (K11.2 US imp) cannot provide adequate protection for palletized arrays of small metal containers regardless of the liquid's flash point.

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TABLE 13.5.5.4(A)RACK STORAGE OF IGNITABLE LIQUIDS IN METAL CONTAINERS UP TO AND INCLUDING 25 L
WITH AISLES A MINIMUM OF 2.4 m WIDE

				Ceiling sprinkler protection design criteria				In-rack sprinkler protection criteria				
Flash point	Maximum	Maximum			Sprink	ler type	Number of			Sprinkler	type	
OR liquid	height	storage height	Packaging	Response/nominal	K factor		activating	Layout	Response/nominal	K factor		Design flow ^{a,d}
type	type m		type	temperature rating/orientation	K US imp	K _m	sprinklers @ kPa	Figure	temperature rating/orientation ^b	K US imp	Km	L/min
Any	Any	Any	Uncartoned and/or cartoned	SR/68°C/Any	≥11.2 °	≥16.1°	20 @ 50	Scheme A– balanced at th	A—The ceiling design and the Scheme A design shall t the point of connection and allow simultaneous oper-			n shall be s operation
					11.2 ^b	16.1 ^b	50 @ 200					
					14.0	20.2	50 @ 120		QR/68°C	≥8.0 ≥1		
			Uncartoned and/or cartoned	SK/68°C/Any	16.8	24.2	50 @ 90	13.5.6(E)(a)			≥11.5	
					25.2	36.3	50 @ 50					
Any	9.1	7.6		QR/68°C/Any	25.2EC	36.3EC	26 @ 150	13.5.6(D)(a) 13.5.6(E)(a)				170
				SR/141°C/Any	≥11.2 ^{b, c}	≥16.1 ^{b,c}	30 @ 50	13.5.6(F)(b)				
				QR/68°C/Any	≥11.2 ^{b,c}	≥16.1 ^{b,c}	30 @ 50					
			Cartoned	QR/68°C/Any	25.2EC	36.3EC	26 @ 50					
			omy	SR/High/Any	≥11.2 ^{b,c}	≥16.1 ^{b,c}	30 @ 50					
			Uncartoned	SR/68°C/Any	≥11.2 ^{b,c}	≥16.1 ^{b,c}	30 @ 50	13.5.6(G)				1
Water- miscible 9.1		7.6	and/or cartoned	QR/68°C/Any	25.2EC	36.3EC	13.5.6(H) 15 @ 50 13.5.6(I)(a) 13.5.6(I)(b)		QR/68°C	≥5.6	≥8.0	114

LEGEND:

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SR = Standard response

QR = Quick response

EC = Extended coverage

^a The in-rack sprinkler water demand shall be based on the simultaneous operation of the most hydraulically remote sprinklers as follows:

(a) Eight (8) sprinklers where only one level of in-rack sprinklers is installed.

(b) Twelve (12) sprinklers (six on each level) where two levels of in-rack sprinklers are installed.

(c) Eighteen (18) sprinklers (six on top three levels) where more than two levels of in-rack sprinklers are installed.

(d) The minimum flow from each sprinkler as provided in Table 13.5.5.4(C).

^b If a foam-water sprinkler system is used, use of Km11.5 (K8 US imp) ceiling sprinklers may be used, provided an equivalent flow is provided from the Km11.5 (K8 US imp) sprinklers.

^c The Km28.0 (K19.6 US imp) sprinkler shall not be used.

^d A minimum discharge pressure of 70 kPa shall be provided for all in-rack sprinkler designs.

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TABLE 13.5.5.4(B)

IGNITABLE LIQUIDS IN RELIEVING STYLE METAL CONTAINERS UP TO AND INCLUDING 25 L, EXCLUDING IGNITABLE LIQUIDS WITH BOILING POINT BELOW 38°C

				Ceiling	g sprinkler prote	ction de	esign c	riteria	In-rack sprinkler protection criteria							
Storage	Minimum aisle width	Maximum ceiling height	n Maximum storage height		Response/ nominal	Sprin ty	ıkler pe	Number of	Layout	Response/ nominal	Sprin typ	kler e	Design			
ment m				Packaging type	temperature	K factor ^a activating sprinklers		temperature	K factor		110 W					
	m	m	m	.,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	rating/ orientation	K US imp	Km	@ kPa	Figure	rating/ orientation	<i>K</i> US imp	Km	L/min			
			7.6			14.0 20.2 12 @ 520										
				Uncartoned	QR/68°C/	16.8	23.5	12 @ 360	13.5.6(J)(a) or 13.5.6(J)(b)		>0	≥11.5	170			
		10		cartoned	pendent	22.4	32	12 @ 350		QK/08 C	28.					
						25.2	36.3	12 @ 280								
						14.0	20.2	12 @ 340								
Single and	2.4			Conton o di on los	QR/68°C/	16.8	2.5	12 @ 240	13.5.6(J)(c)		200	≥11.5 1	114			
racks				Cartoned only	pendent	22.4	32	12 @ 170	or 13.5.6(J)(d)	QIV08 C	≥0.0	211.5	114			
						25.2	36.3	12 @ 140								
		0.1	6			14.0	20.2	12 @ 520								
				Conton o di on los	QR/68°C/	16.8	23.5	12 @ 360		Nama						
		9.1		Cartoned only	pendent	22.4	32	12 @ 350		None						
						25.2	36.3	12 @ 280								
		9.1				14.0	20.2	12 @ 520	13.5.6(K)(a)				170			
			6	Uncartoned		16.8	23.5	12 @ 360	and 13.5.6(K)(b) or 13.5.6(K)(c) and 13.5.6(K)(d)	QR/68°C		≥11.5				
Multiple- row racks	None			and/or	QR/68°C/ pendent	22.4	32	12 @ 350			≥8.0					
10w racks				cartoned		25.2	36.3	12 @ 280								

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				Ceiling sprinkler protection design criteria					In-ra	In-rack sprinkler protection criteria										
Storage	Minimum aisle width	IinimumMaximumsle widthceilingbeightbeight		Maximum ceiling beight	Maximum ceiling height	Maximum ceiling height	Maximum ceiling height	Maximum ceiling height	Maximum ceiling height	Maximum storage height		Response/ nominal	Sprin ty	nkler pe	Number of	f Layout nominal			Sprinkler type	
arrange- ment		neight	neight	Packaging type	temperature	K fac	ctor ^a	activating sprinklers		temperature	K fac	factor								
	m	m	m	cy p c	rating/ orientation	K US imp	Km	@ kPa	Figure	rating/ orientation	<i>K</i> US imp	Km	L/min							
	Multiple- row racks					14.0	20.2	12 @ 340	13.5.6(K)(e)											
		10				16.8	23.5	12 @ 240	and 13.5.6(K)(f)			riteria ikler pe Design flow ^b k_m L/min ≥ 11.5 170								
Multiple- row racks			7.6	Cartoned only	QR/68°C/ pendent	22.4	32	12 @ 170	or	QR/68°C	2 ≥8.0	≥11.5	170							
10.0.100.00					Ĩ	25.2	36.3	12 @ 140	13.5.6(K)(g) and 13.5.6(K)(h)											
			3.7	Uncartoned		14.0	20.2	12.@ 520												
						16.8	23.5	12.@ 360		Nono										
				cartoned		22.4	32	12.@ 350		None										
Dollatizad		10			QR/68°C/	25.2	36.3	12.@ 280												
Falletizeu		10	2.4		pendent	14.0	20.2	12.@ 340												
				Cartoned only		16.8	23.5	12.@ 240		None										
				Caltoned only		22.4	32	12.@ 170		none										
						25.2	36.3	12.@ 140												

TABLE13.5.5.4(B) (continued)

LEGEND:

SR = Standard response

QR = Quick response

EC = Extended coverage

^a The Km28.0 (K19.60 US imp) sprinkler shall not be used.

^b A minimum discharge pressure of 70 kPa shall be provided for all in-rack sprinkler designs.

NOTE: The in-rack sprinkler water demand shall be based on the simultaneous operation of the most hydraulically remote sprinklers as follows:

- (a) Eight (8) sprinklers where only one level of in-rack sprinklers is installed.
- (b) Twelve (12) sprinklers (six on each level) where two levels of in-rack sprinklers are installed.
- (c) Eighteen (18) sprinklers (six on top three levels) where more than two levels of in-rack sprinklers are installed.

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TABLE 13.5.5.4(C)

PALLETIZED/SOLID PILE STORAGE OF IGNITABLE LIQUIDS IN METAL CONTAINERS UP TO AND INCLUDING 25 L

	Maximum	Maximum		Ceiling sprinkler protection design criteria						
Liquid type/	ceiling	storage	Packaging type	Response/nominal	Sprink	Number of activating				
Flash point	height	height		temperature	K fa					
	m			rating/orientation	K US imp	Km	@ kPa			
			Uncartoned and/or cartoned		14.0	20.2	50 @ 120			
		3.7		QR/68°C/Any	16.8	24.2	50 @ 90			
					≥22.4	≥32.0	50 @ 50			
Any	9.1				11.2 (see Note)	16.1 (see Note)	50 @ 200			
			Cartoned	SR/68°C/Any	14.0	20.2	50 @ 120			
			only		16.8	24.2	50 @ 90			
					25.0	36.3	50 @ 50			
				QR/141°C/Any	25.0EC	36.3EC	26 @ 150			

LEGEND:

SR = Standard response

QR = Quick response

EC = Extended coverage

NOTE: If a foam-water sprinkler system is used, K_m 11.5 (K8 US imp) ceiling sprinklers may be used, provided an equivalent flow is provided from the sprinklers.

TABLE 13.5.5.4(D)

SHELF STORAGE OF IGNITABLE LIQUIDS IN METAL CONTAINERS UP TO AND INCLUDING 25 L

Ceiling sprinkler protection design criteria Maximum Maximum ceiling storage Sprinkler type Number of Liquid type/ **Response/nominal** height height activating **Flash** point K factor temperature sprinklers rating/orientation K US imp Km @ kPa m m 11.2^{a,b} 16.1 a,b SR/68°C/Any 50 @ 50 <93°C 9.1 2.1 QR/68°C/Any 25.2EC 36.3EC 26 @ 50 11.2^{a,b} 16.1 a,b SR/141°C/Any 30 @ 50 11.2 a,b 16.1 a,b 30 @ 120 SR/68°C/Any ≥93°C or 9.1 4.6 water-miscible QR/68°C/Any 25.2EC 36.3EC 15 @ 50

LEGEND:

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SR = Standard response

QR = Quick response

EC = Extended coverage

^a If a foam-water sprinkler system is used, Km11.5 (K8 US imp) ceiling sprinklers may be used, provided an equivalent flow is provided from the sprinklers.

^b The Km28.0 (K19.6 US imp) sprinkler shall not be used.

13.5.5.5 Protection of plastic, composite (plastics-metal), or other combustible containers

13.5.5.5.1 General

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Storage of all ignitable liquids in plastic, composite (plastics-metal), glass, or other combustible packing shall be protected in accordance with Table 13.5.5.1(A).

Palletized storage arrays of empty composite IBCs in buildings up to 9 m high shall be protected as follows:

- (a) Up to 3 high composite IBCs with plastic pallets shall be protected using $K_m 28.0$ (K19.6 US imp), quick response, pendent sprinklers arranged to provide a discharge pressure of 220 kPa over 12 sprinklers.
 - (b) Up to 3 high composite IBCs with wooden or steel pallets shall be protected using $K_{\rm m}28.0$ (K19.6 US imp), quick response, pendent sprinklers arranged to provide a discharge pressure of 120 kPa over 12 sprinklers.

C13.5.5.1 Proven protection schemes for liquid-packaging combinations that are tied only to Table 13.5.5.1(A) are not currently available. The recommended protection will not prevent the consumption of all of the liquid stored in the cut-off room or building, but it may prevent structural failure of the roof and walls by cooling the structures. For large containers, the quantity of liquid in a single container greatly increases the potential for a spill fire that will activate all of the sprinklers in the cut-off room or building. The addition of a foam-water sprinkler system has not been shown to improve any of the protection line items tied only to Table 13.5.5.1(A).

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Ceiling sprinkler protection design criteria Maximum Maximum Container Ceiling Sprinkler type storage Liquid type/ Storage **Response/nominal** Number of activating size ceiling height sprinkler height Flash point arrangement temperature rating/ K factor sprinklers system type orientation @ kPa \mathbf{L} KUS imp Km m m 11.2 16.1 Entire room @ 520 14.0 20.2 Entire room @ 330 16.8 24.2 SR or QR/68°C/Any Entire room @ 230 Any 32.0 Entire room @ 130 22.4 25.2 36.3 Entire room @ 100 9.1 1.5 Any Palletized 11.2 16.1 Entire room @ 350 <93°C 14.0 20.2 Entire room @ 220 Deluge or SR or QR/68°C/Any 24.2 16.8 Entire room @ 150 foam-water 32.0 Entire room @ 80 22.4 25.2 36.3 Entire room @ 70 <4 No options. Use criteria for palletized storage Rack storage ≥4 In accordance with Clause 13.6.5.7 and Table 13.6.5.7(A). If liquid-package combination is not covered in Table 13.6.5.7(A) Rack storage the criteria for palletized storage shall be used 11.2 16.1 Entire room @ 200 14.0 20.2Entire room @ 130 Palletized 9.1 1.5 SR or QR/68°C/Any Any 16.8 24.2 Entire room @ 90 >25 ≥22.4 ≥32.0 Entire room @ 50 Water-In accordance with Clause 13.5.5.6 and Table 13.5.5.6(A), or Clause 13.5.5.7 and Table 13.5.5.7(C), for Groups 1, 2, 3 and 4 miscible water-miscible liquids (defined in Clause 13.2.15) Rack storage liquids If liquid-package combination is not covered by Table 13.5.5.7(A) the criteria for palletized storage shall be used In accordance with Clause 13.5.5.7 and Tables 13.5.5.7(C) and 13.5.5.7(E) for Groups 1, 2, 3 and 4 water- miscible liquids (defined in Clause 13.2.14) ≤25 Water-miscible liquids that are not included in one of the groups or Tables 13.5.5.7(B) and 13.5.5.7(E) shall be protected using the criteria provided for water-miscible liquids in containers >25 L in this Table

TABLE 13.5.5.1(A)

IGNITABLE LIQUIDS IN PLASTIC OR GLASS CONTAINERS

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		Storage		Maximum	Ceiling sprinkler system type	Ceiling	sprinkler	protection	design criteria
Liquid type/ Flash point	Container size		Maximum ceiling height	storage height		Response/nominal	Sprink	ler type	Number of activating
	т	arrangement				orientation			<i>a</i> kPa
	L		III	111			AUS imp	Λm	
			1	1		•	1		
	>25	Palletized	9.1	1.5	Any	SR or QR/68°C/Any	11.2	16.1	Entire room @ 200
							14.0	20.2	Entire room @ 130
>0290							16.8	24.2	Entire room @ 90
and							≥22.4	≥32.0	Entire room @ 50
<260°C		Rack storage In accordance with Clause 13.5.5.7 and Table 13.5.5.7(A). If liquid-package combination is not covered by Table 13.5 the criteria for palletized storage shall be used							
	≤25	In accorda 13.5.5.7(D). If	nce with Clause 1 liquid-package co	3.5.5.7 (requipond) and the second se	irements for sto not covered by	rage of liquids with flash Tables 13.5.5.7(B) or 13.	points at or 5.5.7(D) the	above 93° e criteria fo	C) and Table 13.5.5.7(B) or r containers >25 L shall be used
>2(0%)	<150				See Clause 13.3	3.4 to determine protection	n criteria		
≥260°C	≥150		Se	ee Clauses 13.	.3.5.2, 13.3.5.3,	13.3.5.5 and 13.3.5.6 to a	letermine d	esign criteri	ia

TABLE13.5.5.5.1(A)(continued)

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LEGEND: SR = Standard response

QR = Quick responseThe $K_m 28.0$ (K19.6 US imp) sprinkler shall not be used.