

ANNEX C

[Clauses 8.1.4, 9.22.10 (c), 10.3.3 and 10.5.8]

GUIDELINES FOR THE PROTECTION OF STORAGE AREAS
(ESFR SPRINKLER INSTALLATION)**C-0 INTRODUCTION**

Early suppression fast response (ESFR) sprinklers are ceiling sprinklers which have the capability of suppressing fires within storage risks. There is little room for error in the design and installation of ESFR sprinkler systems, the design principles and the operating characteristics are significantly different from standard sprinkler protection. ESFR sprinklers might be unable to cope with adverse design features and non-compliances, which might be common practice when installing standard sprinkler protection. Design and installation deviations from this standard might not just result in a reduced effectiveness, but rather in a total system failure. It is therefore essential that all the requirements of this annex are complied with, without exception, when applying ESFR protection.

C-1 ESFR sprinkler protection, prescribed under this Annex is applicable only in case of the following:

- a) For all materials under category I through IV when stored as under (*see* Fig. 4):
 - 1) Free standing or block storage.
 - 2) Post pallets with open bottoms.
 - 3) Rack storage without solid shelving.
 - 4) Slatted open shelves.
- b) Plastic and rubber commodities when stored as under:
 - 1) Free standing or block storage; and
 - 2) Rack storage without solid shelving.

C-2 Attention is drawn to various requirements stated in 7.2.7, 7.3, 7.4, 7.5, 7.6, 7.7 and 9.22 and the same shall taken care in designing ESFR sprinkler systems for storage buildings.

C-3 ESFR sprinklers shall not be used for the following areas:

- a) Rack storage involving solid shelves (*see also* C-5);
- b) Rack storage involving combustible, open-top cartons or containers;
- c) Certain materials in which fires cannot be readily controlled by sprinklers like acrylic fibre yarn or may give rise to unusual fire characteristics like tissue paper; and
- d) Buildings where automatic venting facilities are provided.

C-4 Storage methods shall have transverse and longitudinal flues as follows:

- a) Continuous for the full height of each block of storage;
- b) Vertically aligned;
- c) Free of stored goods; and
- d) Regularly spaced and having dimensions as follows:
 - 1) Transverse flues shall be at least 80 mm wide and shall be spaced at distances of not more than 3 m (*see* Fig. 10A and Fig. 10B).
 - 2) Longitudinal flues shall be at least 150 mm wide and shall be spaced at distances of not more than 3 m (*see* Fig. 10A and Fig. 10B).

C-5 Single and double row shelved racks shall comply with the following:

- a) Slatted shelves shall have shelf open areas, uniformly interspaced, of at least 50 percent of the shelf plan area. The distance between openings shall not exceed 150 mm; or
- b) Grated or mesh type shelves shall have uniform openings of at least 50 percent of the shelf plan area. The horizontal distance between openings shall not exceed 150 mm.

C-6 Sprinkler selection with regard to nominal K-factor, shank thread, temperature rating, colour coding, temperature sensitivity, etc shall be as stated in Tables 2, 3 and 4.

C-7 Spacing and location of the sprinklers shall comply with various requirements under 9.23.

C-8 Minimum pressure at any sprinkler when all the sprinklers in the design area are in operation shall be as per the values in the Tables 32, 33, 34 and 35 (*see also* 10.5.7 and 10.5.8).

C-9 Pipe sizing shall be done by full hydraulic calculations using an approved software program for the purpose (*see also* 10.5).

C-10 The design area shall be a rectangular area, consist of the most hydraulically demanding area of 12 sprinklers, consisting of four sprinklers on each of the three adjoining branch lines.

C-11 Where indicated, intermediate sprinklers shall be provided as follows (*see notes under* Tables 32 and Table 34):

- a) At least one level of intermediate sprinkler protection shall be installed.
- b) The vertical distance from the floor to the intermediate sprinklers shall be half the rack height plus or minus half the tier height.
- c) Intermediate sprinklers shall have the following properties:
 - 1) Spray pattern sprinkler;
 - 2) K-factor of 115;
 - 3) Quick response thermal sensitivity rating; and
 - 4) Temperature rating shall be within the range of 68 °C to 104 °C.
- d) Intermediate sprinklers shall be located at each longitudinal and transverse flue intersection at a maximum spacing of 1.5 m in either direction;
- e) Metal water shields of nominal diameter 75 mm shall be fitted above each intermediate sprinkler;
- f) At least eight intermediate sprinklers shall be assumed to be operating for calculation purpose; and
- g) The minimum pressure of any operating intermediate sprinkler shall be 3.5 bars.

C-12 Pumping capacity shall be calculated for the total water demand when all the 12 sprinklers at design area are in simultaneous operation and the same shall be loaded by 1 000 litre/min for hose reels and hydrants. No loading shall be required if the storage buildings are already protected by an independent and up-to-date hydrant system as per IS 13039. Table 33 shall then be used to select the appropriate pump(s).

Table 32 All the Materials Stated Under Category I through IV [Post Pallets with Open Bottoms, Rack Storage Without Solid Shelving and Slatted Open Shelves]
(Clauses C-8 and C-11)

S.No	Maximum Storage Height m	Maximum Ceiling Height m					
		7.6	9.1	9.7	10.7	12.2	13.7
		Minimum Operating Pressure in any Sprinkler (bar)					
		K-Factor = 200					
i)	6.1	3.5					6.2
ii)	7.6		3.5	4.1			
iii)	9.1				5.2		
iv)	10.6					5.2	
v)	12.2						

S.No	Maximum Storage Height m	Maximum Ceiling Height m					
		7.6	9.1	9.7	10.7	12.2	13.7
		K-Factor = 242					
vi)	6.1	2.4					4.3
vii)	7.6		2.4	2.9			
viii)	9.1				3.5		
ix)	10.6					3.5	
x)	12.2						
		K-Factor = 320					
xi)	6.1	1.7					3.5
xii)	7.6		1.7	2.1			
xiii)	9.1				2.4		
xiv)	10.6					3.1	
xv)	12.2						
		K-Factor = 360					
xvi)	6.1	1.4					3.5
xvii)	7.6		1.4	1.7			
xviii)	9.1				2.1		
xix)	10.6					2.7	
xx)	12.2						

NOTES

- 1 This table shall not apply to pre dominant or exclusive storage of plastics and rolled paper.
- 2 For building heights up to 13.7 m (last column of the table), following shall apply in addition – only for sprinklers with K-Factors 200 and 242:
 - a) One level of in-rack sprinklers shall be considered; and
 - b) Not suitable for storage on post pallets with open bottoms.
- 3 Upright sprinkler shall be permissible based on listing for the purpose.

Table 33 All the Materials Stated Under Category I through IV [Free Standing, Palletized and Solid-Piled Storage]
(Clauses C-8 and C-12)

Sl No.	Maximum Storage Height m	Maximum Ceiling Height m					
		7.6	9.1	9.7	10.7	12.2	13.7
		Minimum Operating Pressure in any Sprinkler (bar)					
		K-Factor = 200					
i)	6.1	3.5					
ii)	7.6		3.5	4.1			
iii)	9.1				5.2		
iv)	10.6					5.2	
		K-Factor = 242					
v)	6.1	2.4					
vi)	7.6		2.4	2.9			
vii)	9.1				3.5		
viii)	10.6					3.5	

Table 33 (Concluded)

		K-Factor = 320					
ix)	6.1	1.7					
x)	7.6		1.7				
xi)	9.1				2.4		
xii)	10.6					2.8	
xiii)	12.2						2.8
		K-Factor = 360					
xiv)	6.1	1.0					
xv)	7.6		1.0				
xvi)	9.1				1.4		
xvii)	10.6					1.7	
xviii)	12.2						2.8

NOTES

1 This table shall not apply to pre dominant or exclusive storage of plastics and rolled paper.

2 Upright sprinkler shall be permissible based on the listing for the purpose.

Table 34 Plastic Materials in Racks Without Solid Shelving (Un-expanded Plastic Materials Packed in Cartons)
(Clause C-8 and C-11)

SI No.	Maximum Storage Height m	Maximum Ceiling Height m					
		7.6	9.1	9.7	10.7	12.2	13.7
		Minimum Operating Pressure in any Sprinkler (bar)					
		K-Factor = 200					
i)	6.1	3.5					
ii)	7.6		3.5	4.1			
iii)	9.1				5.2		
iv)	10.7					5.2	
v)	12.2						6.2*
		K-Factor = 242					
vi)	6.1	2.4					
vii)	7.6		2.4	2.9			
viii)	9.1				3.5		
ix)	10.7					3.5	
x)	12.2						4.3*
		K-Factor = 320					
xi)	6.1	1.7					
xii)	7.6		1.7				
xiii)	9.1				2.4	2.8	
xiv)	10.7						
xv)	12.2						2.8

		K-Factor = 360					
xvi)	6.1	1.0					
xvii)	7.6		1.0				
xviii)	9.1				1.4		
xix)	10.7					1.7	
xx)	12.2						2.8

*At least one level of intermediate (in-rack) sprinklers shall be considered.

NOTES

1 Upright sprinkler shall be permissible based on listing for the purpose.

2 For un-expanded but exposed plastic materials (un-cartoned), above table can be applied for protection except that, sprinklers with K-factors 320 and 360 shall not be used.

Table 35 Plastic and Rubber Materials [Free Standing, Palletized and Solid-piled Storage]
(Clause C-8)

SI No.	Maximum Storage Height m	Maximum Ceiling Height m					
		7.6	9.1	9.7	10.7	12.2	13.7
		Minimum Operating Pressure in Any Sprinkler (bar)					
		K-Factor = 200					
i)	6.1	3.5					
ii)	7.6		3.5	4.1			
iii)	9.1				5.2		
iv)	10.6					5.2	
		K-Factor = 242					
v)	6.1	2.4					
vi)	7.6		2.4	2.9			
vii)	9.1				3.5		
viii)	10.6					3.5	
		K-Factor = 320					
ix)	6.1	1.7					
x)	7.6		1.7				
xi)	9.1				2.4		
xii)	10.6					2.8	
xiii)	12.2						2.8
		K-Factor = 360					
xiv)	6.1	1.0					
xv)	7.6		1.0				
xvi)	9.1				1.4		
xvii)	10.6					1.7	
xviii)	12.2						2.8

NOTES

1 This table shall apply to un expanded plastics packed in cartons.

2 Upright sprinkler shall be permissible based on the listing for the purpose.

3 For un-expanded but exposed plastic materials (un-cartoned), above table can be applied for protection except that sprinklers with K-factors 320 and 360 shall not be used.