

Abschn. 3

Abschn. 5

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Abschn. 7

Industrial Building Code

Automatic Fire Extinguishing Systems

Goals of the Industrial Building Code

- Relaxation of the Building Regulations:
 - Abschn. 3 - Compartmentation > 1,600 m²
 - Abschn. 5 - Construction materials with reduced fire resistance
 - Abschn. 6
 - Abschn. 7
- Basis for relaxations:
 - reduced fire load
 - no loss of life
 - operational necessity
 - good operational fire protection (Organisation, Management)

Routes of the Industrial Building Code

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- 2 different Routes (a+b):
near future ((c))
 - a. without fire load calculation → **Fire Compartments**
 - b. with fire load calculation → **Fire Fighting Compartments**
 - c.) *with methods of “fire safety engineering”*
- Maximum areas:
 - a. without fire load calculation: 10,000 m² with sprinklers
 - b. with fire load calculation: 120,000 m² with sprinklers
 - c.) *“fire safety engineering”*: → > 120,000 m² ???

Compartmentation in Industrial Buildings

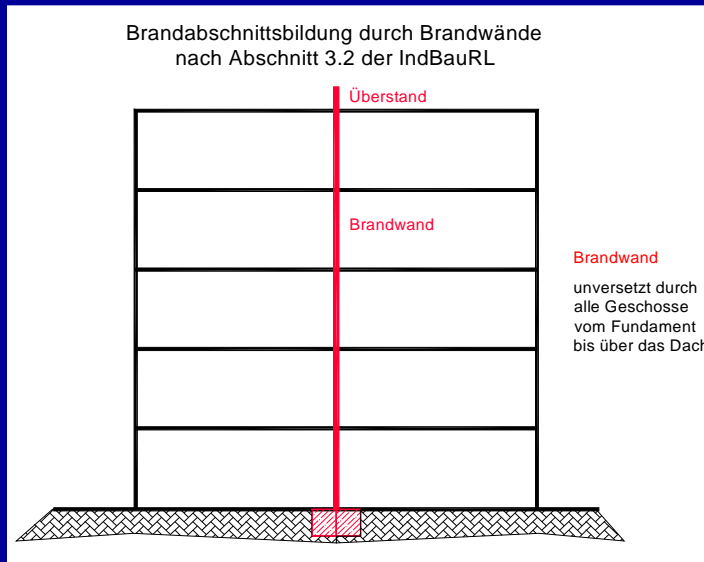
Fire Compartments: without fire load calculation

Abschn. 3

Abschn. 5

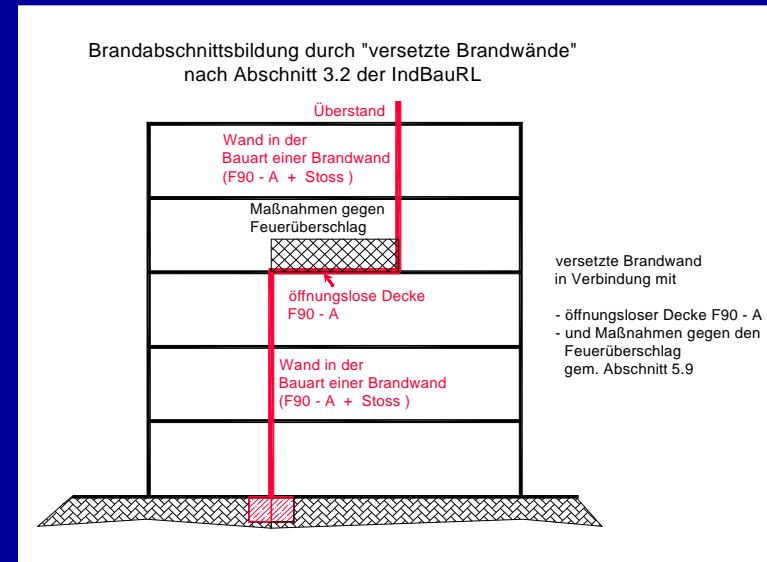
Abschn. 6

Abschn. 7



Fire wall: REI 90-M

Fire Fighting Compartments with calculation of the fire load



Fire-Fighting compartment wall: REI xy-M

Area	= 1 Floor area (applies to all storeys) ((National Building Code: max = 1600m ²))	= Sum of all storeys
Ceilings	Fire resistance (F 90 = REI 90)	Variable; can be without fire resistance or with unprotected openings
Walls	Fire wall: REI 90-M	Fire compartment wall: REI xy-M xy (min) depends on the fire load (but no reduction for a fire extinguishing system)
Application	80% to 90% of all cases	10 % to 20% of all cases

**Section 3: Safety Categories
= Classes for fire protection infrastructure**

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Safety Categories	Fire detection and alarm	Fire fighting
K1	Coincidence	Every public fire brigade
K2	Automatic fire alarm or permanent staffing (24hr / 365 days)	Every public fire brigade
K3	Automatic fire alarm or permanent staffing (24hr / 365 days)	Works fire brigade (at the scene within 5min) K3.1 Crew (full-time) K3.2 Group K3.3 2 Crews K3.4 3 Crews
K4	Fire alarm panel	Automatic fire extinguishing system

Safety-Concept of industrial buildings

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Safety-Concept of industrial buildings

Safety-factors γ :

$$V = \frac{s}{\bar{x}} \cdot 100$$

90%-Fraktile of t_a

10%-Fraktile of existing.tF

$v = 25\%$ (of t_a and existing.tF)

permitted probability of failure

	multi-storey buildings	single-storey buildings
Skb-3:	pf3 = 10^{-5} (per year)	pf3 = 10^{-4} (per year)
Skb-2:	pf2 = 10^{-4} (per year)	pf2 = 10^{-3} (per year)
Skb-1:	pf1 = 10^{-3} (per year)	pf1 = 10^{-2} (per year)

probability of initial fires

$$p1 = 5 \cdot 10^{-6} \text{ (per m}^2 \text{ and year)}$$

public fire brigade: initial fires ==>

hazards

$$p2 = 1 \cdot 10^{-1}$$

probability of failure of sprinkler-systems

$$(p3) = 1 \cdot 10^{-2} \quad ==> \alpha L$$

Section 6: Components and permitted fire compartments without fire load calculation

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Safety category	Number of above ground storeys								
	Single storey	2 storey			3 storeys		4 storeys	5 storeys	
	Fire resistance of the load-bearing and strengthening structural members								
	Without requirements	F 30	F 30	F 60	F 90	F 60	F 90	F 90	F 90
K 1	1,800 j ¹⁾	3,000	800 j ^{2,3)}	1,600 j ²⁾	2,400	1,200 j ^{2,3)}	1,800	1,500	1,200
K 2	2,700 j ¹⁾	4,500	1,200 j ^{2,3)}	2,400 j ²⁾	3,600	1,800 j ²⁾	2,700	2,300	1,800
K 3.1	3,200 j ¹⁾	5,400	1,400 j ^{2,3)}	2,900 j ²⁾	4,300	2,100 j ²⁾	3,200	2,700	2,200
K 3.2	3,600 j ¹⁾	6,000	1,600 j ²⁾	3,200 j ²⁾	4,800	2,400 j ²⁾	3,600	3,000	2,400
K 3.3	4,200 j ¹⁾	7,000	1,800 j ²⁾	3,600 j ²⁾	5,500	2,800 j ²⁾	4,100	3,500	2,800
K 3.4	4,500 j ¹⁾	7,500	2,000 j ²⁾	4,000 j ²⁾	6,000	3,000 j ²⁾	4,500	3,800	3,000
K 4	10,000	10,000	8,500	8,500	8,500	6,500	6,500	5,000	4,000

- 1) Width of the industrial building ≤ 40 m and heat vent areas (according to DIN 18 230-1) ≥ 5 %
- 2) Heat vent area (according to DIN 18 230-1) ≥ 5 %
- 3) For buildings of limited height according to §25 Sect. 1 and § 28 Sect. 1 Nr. 2 MBO the permitted area is 1 600 m²

	Green = design, layout: Usual
	Yellow = design, layout: Underestimated; compensation: smaller areas
	Red = design, layout: Underestimated; and reduction of the safety level; compensation: smaller areas

Industrial Building Code: Automatic Fire Extinguishing Systems

Safety category	Number of above ground storeys								
	Single storey	2 storey			3 storeys		4 storeys	5 storeys	
	Fire resistance of the load-bearing and strengthening structural members								
	Without requirements	F 30	F 30	F 60	F 90	F 60	F 90	F 90	F 90
K 1	1,800) ¹	3,000	800) ^{2,3}	1,600) ²	2,400	1,200) ^{2,3}	1,800	1,500	1,200
K 2	2,700) ¹	4,500	1,200) ^{2,3}	2,400) ²	3,600	1,800) ²	2,700	2,300	1,800
K 3.1	3,200) ¹	5,400	1,400) ^{2,3}	2,900) ²	4,300	2,100) ²	3,200	2,700	2,200
K 3.2	3,600) ¹	6,000	1,600) ²	3,200) ²	4,800	2,400) ²	3,600	3,000	2,400
K 3.3	4,200) ¹	7,000	1,800) ²	3,600) ²	5,500	2,800) ²	4,100	3,500	2,800
K 3.4	4,500) ¹	7,500	2,000) ²	4,000) ²	6,000	3,000) ²	4,500	3,800	3,000
K 4	10,000	10,000	8,500	8,500	8,500	6,500	6,500	5,000	4,000

Section 6: Components and permitted fire compartments (m²) without fire load calculations, single storey industrial buildings

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Safety Category		Number of storeys above ground	
		Single storey	
		Fire resistance of the load-bearing and strengthening members	
Fire protection infrastructure		Without requirements	F 30
K 1 Public fire brigade, no fire alarm		1,800) ¹	3,000
K 2 Public fire brigade, automatic fire alarm		2,700) ¹	4,500
K 3.1	Works fire brigade	3,200) ¹	5,400
K 3.2	Works fire brigade	3,600) ¹	6,000
K 3.3	Fire detection and alarm	4,200) ¹	7,000
K 3.4	Fire detection and alarm	4,500) ¹	7,500
K 4 Sprinkler system		10,000	10,000

	Green = design, layout: Usual
	Yellow = design, layout: Underestimated; compensation: smaller areas
	Red = design, layout: Underestimated; and reduction of the safety level compensation: smaller areas

1) Width of the industrial building ≤ 40 m and heat vent area (according to DIN 18 230-1) ≥ 5 %

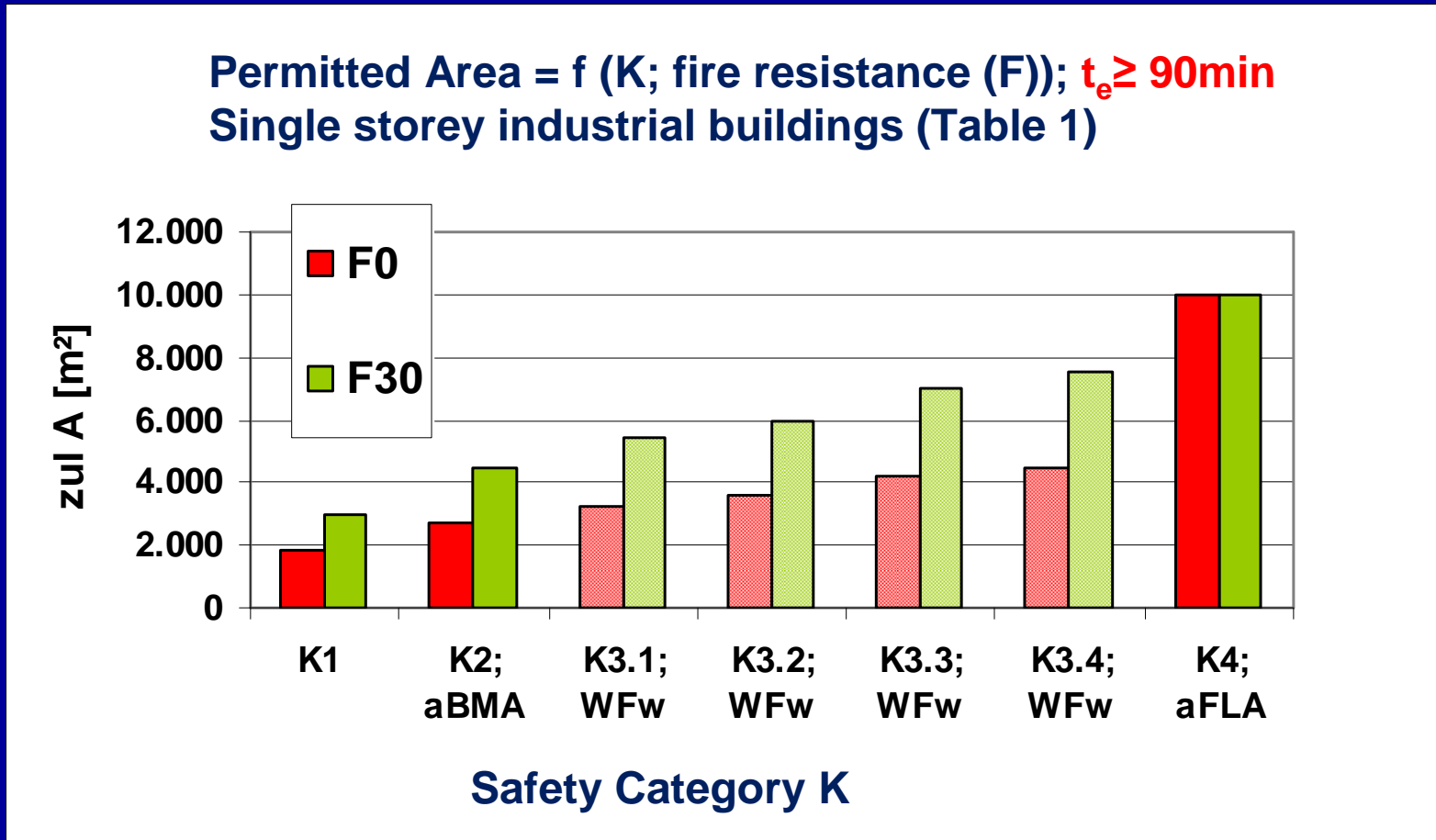
permitted fire compartments (m²) without fire load calculations, single storey industrial buildings

Abschn. 3

Abschn. 5

Abschn. 6

Abschn. 7



Section 6 Storage areas in fire-compartments

Abschn. 3

Abschn. 5

Abschn. 6

Abschn. 7

- In storage buildings and buildings with storage areas if the stored goods reach (top of the goods) above 7.5 m
an automatic **fire extinguishing system** must be installed

Storage areas in fire-fighting-compartments:

- no special rules
- dependance of fire-loads, openings, areas

Section 7: Permitted fire fighting compartment area with calculation of the fire loads

Abschn. 3

Abschn. 5

Abschn. 6

Abschn. 7

- $\text{Area} = 3.000 \text{ m}^2 \cdot F_1 \cdot F_2 \cdot F_3 \cdot F_4 \cdot F_5 \leq 60.000 \text{ m}^2$
for each floor of the fire fighting compartment
- Calculation of the fire load → equivalent fire duration (F1)

T_e	0	15	30	60	≤ 90
Factor F1	10	5	3	1.5	1.0
Intermediate values may be interpolated					

- Allowance for the fire protection infrastructure (F2)
→ Safety category (Fire extinguishing system = K4)

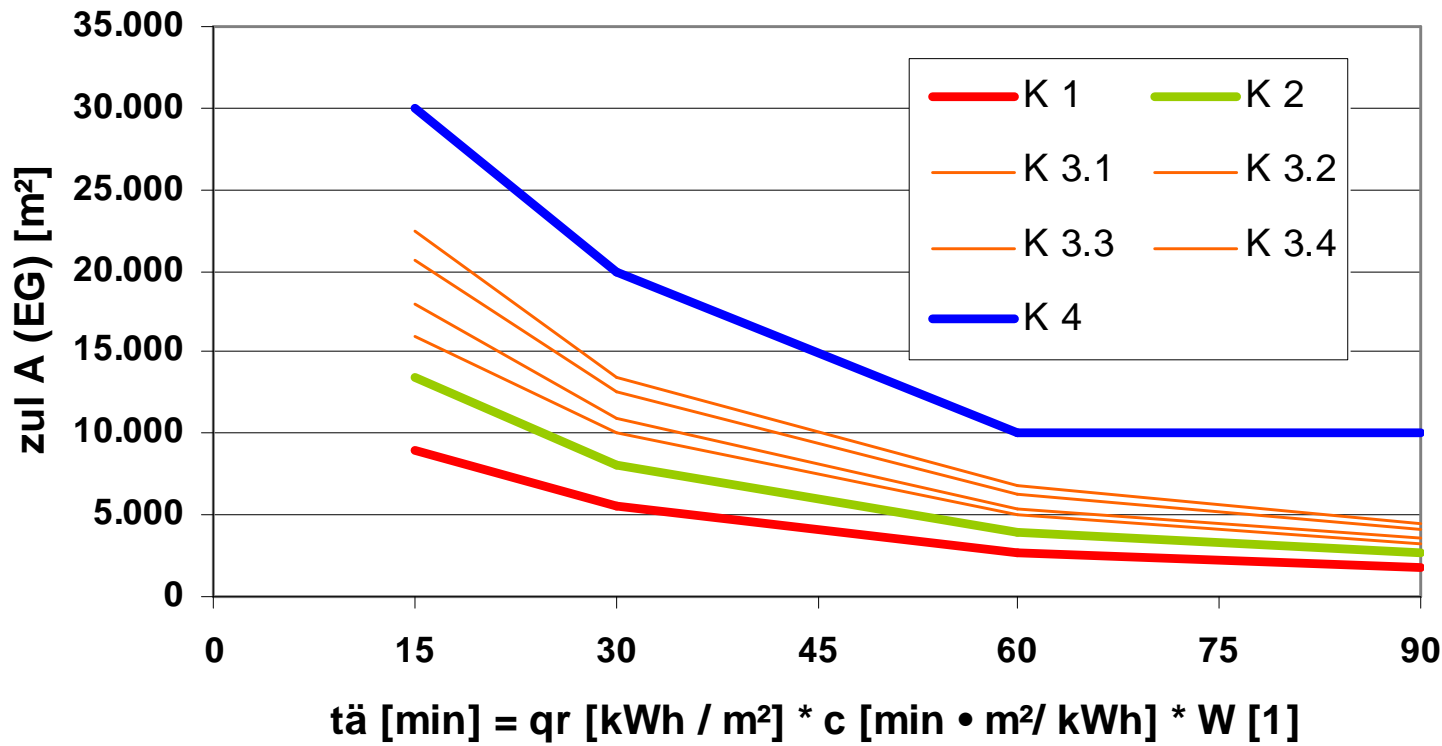
Safety Category	K 1	K 2	K 3.1	K 3.2	K 3.3	K 3.4	K 4
Factor F2	1.0	1.5	1.8	2.0	2.3	2.5	3.5

- F3, F4, F5: only apply to multi-storey industrial buildings and reduce the permitted area

Section 7: Permitted fire fighting compartment area with calculation of the fire loads single storey industrial buildings

- Abschn. 3
- Abschn. 5
- Abschn. 6
- Abschn. 7

Permitted Area = $f(K; t_e)$ **F = 0**
Single storey industrial buildings (Section 7)



Section 7: Fire protection design, layout: “F 0 = R 0”
Underestimated fire-protection of the structure
with calculation of the fire load

Abschn. 3

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Abschn. 7

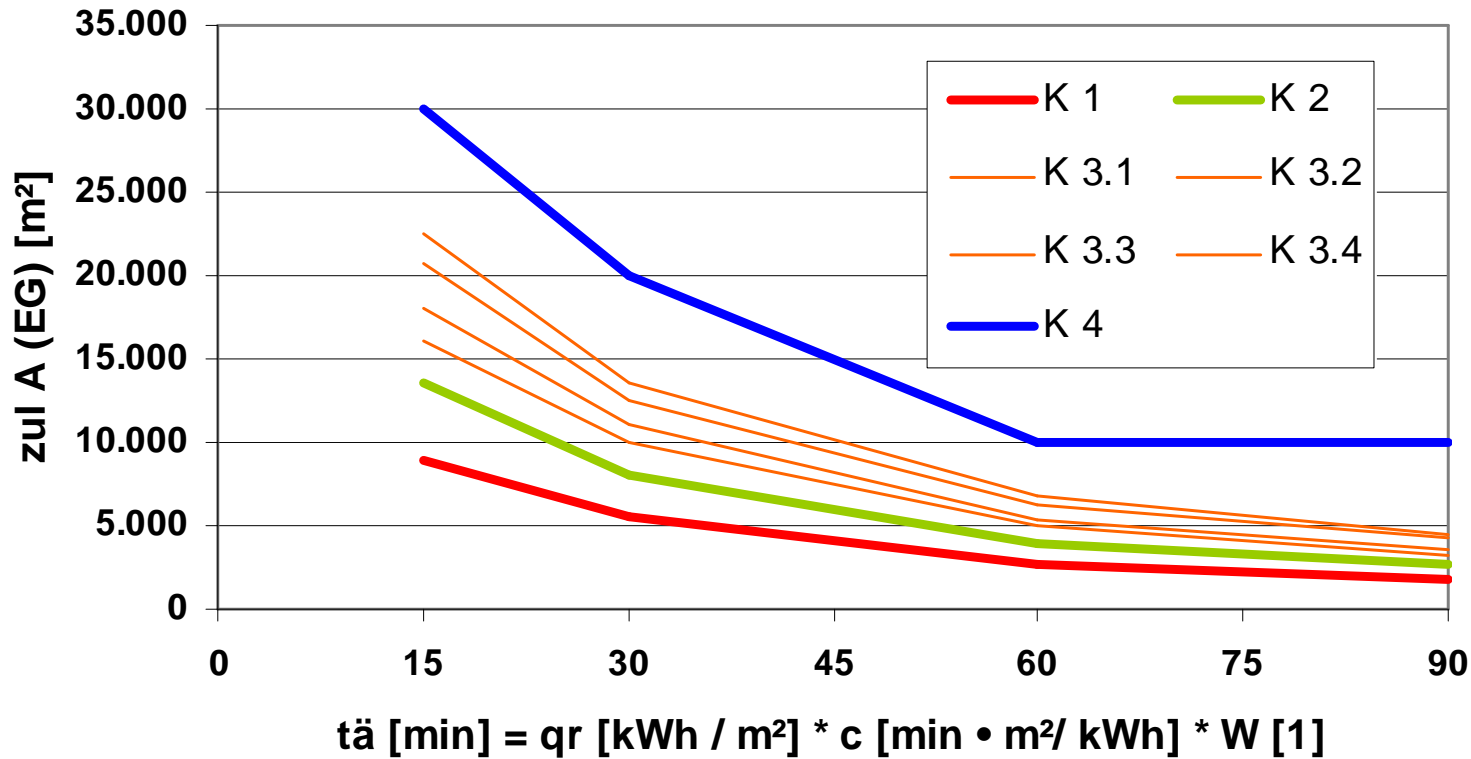
Permitted fire fighting compartment areas for single storey industrial buildings

Safety Category	Equivalent fire duration t_e in minutes			
	15	30	60	90
K 1	9,000	5,500	2,700	1,800
K 2	13,500	8,000	4,000	2,700
K 3.1	16,000	10,000	5,000	3,200
K 3.2	18,000	11,000	5,400	3,600
K 3.3	20,700	12,500	6,200	4,200
K 3.4	22,500	13,500	6,800	4,500
K 4	30,000) ¹	20,000) ¹	10,000) ¹	10,000) ¹
Minimum area of the heat vents in % as per DIN 18230-1	1	2	3	4
Permitted width of the industrial building, m	80	60	50	40
) ¹ The requirements for the heat vent areas and the width of the building do not apply to fire fighting compartments of safety category K 4.				
Intermediate values may be interpolated.				

Section 7: Fire protection design, layout: “F 0 = R 0”
Underestimated fire-protection of the structure
with calculation of the fire load

- Abschn. 3
- Abschn. 5
- Abschn. 6
- Abschn. 7

zul A = f (K, tä); F = 0
erdgeschossige Industriebauten (Abschn. 7)



Section 5: General Requirements

general benefits of sprinklers

Abschn. 3

5.1 Extinguishing water requirements:

Abschn. 5

Abschn. 6

Abschn. 7

Extinguishing water requirement according to the Industrial Building Code		
Compartment Area	Required Extinguishing Water Quantity	
	Without a Sprinkler System	With a Sprinkler System
Less than 2,500m ²	96 m ³ /hr for 2 hours	96 m ³ /hr for 1 hour
Between 2,500m ² and 4,000m ²	Between 96m ³ and 192m ³ /hr for 2 hours	96 m ³ /hr for 1 hour
Over 4,000m ²	192 m ³ /hr for 2 hours	96 m ³ /hr for 1 hour

Section 5: General Requirements

general benefits of sprinklers

Abschn. 3 5.4 Underground storeys
Abschn. 5
Abschn. 6 permitted compartment areas
Abschn. 7 (Fire compartments and fire fighting compartments)

	Without sprinkler system	With sprinkler system
1 st underground storey	1,000 m ²	3,500 m ²
2 nd and further underground storeys	500 m ²	1,750 m ²

Section 5: General Requirements

general benefits of sprinklers

Abschn. 3

5.5 Escape routes (permitted length)

Abschn. 5

Abschn. 6

Abschn. 7

	Without fire alarm system and without fire extinguishing system	With fire alarm system or with fire extinguishing system (and alarm)
Height \leq 5 m	35 m	50 m
Height between 5 m and 10 m	Interpolate	Interpolate
Height \geq 10 m	50 m	70 m

Section 5: General Requirements

general benefits of sprinklers

Abschn. 3

5.6 Smoke extraction (for areas > 1600 m²)

Abschn. 5

Abschn. 6

Abschn. 7

- Without fire extinguishing system:

- Prove existence of smoke-free layer > 2.50 m
for the fire brigade to extinguish

- With fire extinguishing system:

- natural vent area > 0.5%

- no smoke-free layer required

- the extinguishing system extinguishes

Section 5: General Requirements

general benefits of sprinklers

Abschn. 3 5.7 “Automatic fire extinguishing systems”

Abschn. 5

Abschn. 6

Abschn. 7

- Must be designed for the actual fire risk
- Must protect the entire compartment (fire compartment or fire fighting compartment)

Section 5: General Requirements

general benefits of sprinklers

Abschn. 3 5.9 Route for fire spread
Abschn. 5 vertical fire spread (facades)
Abschn. 6
Abschn. 7

	Without fire extinguishing system	With fire extinguishing system
Fire resistant wall	1.5 m	1.0 m
Protruding fire resistant plate	1.5 m	1.0 m

Section 5: General Requirements

general benefits of sprinklers

Abschn. 3 5.10 non load-bearing external walls

Abschn. 5

Abschn. 6

Abschn. 7

	Without automatic fire extinguishing system	With automatic fire extinguishing system
Single storey industrial building	B 1	B 2
Multi-storey industrial building	A	B 1

A = incombustible material

B1 = difficult to ignite material

B2 = combustible material