Risk Management

Chapter 2

MKEP1643

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1. Introduction to LPS Standard
2. Risk Management - Need and economic justification for LPS
3. Risk Assessment
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1. Introduction to LPS Standard

Definitions

Definitions

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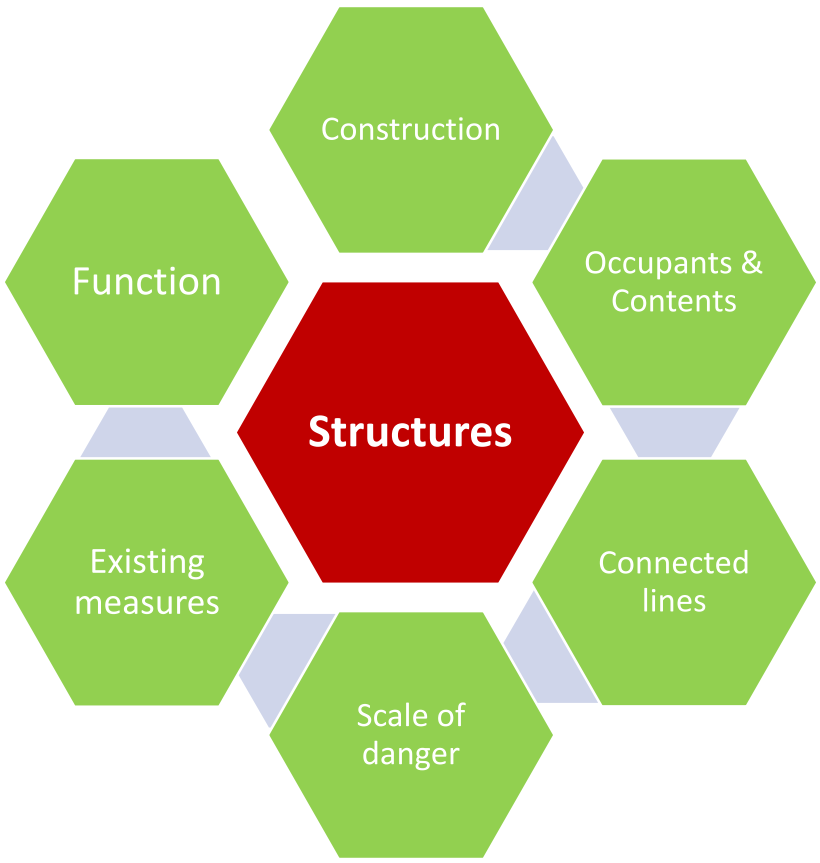

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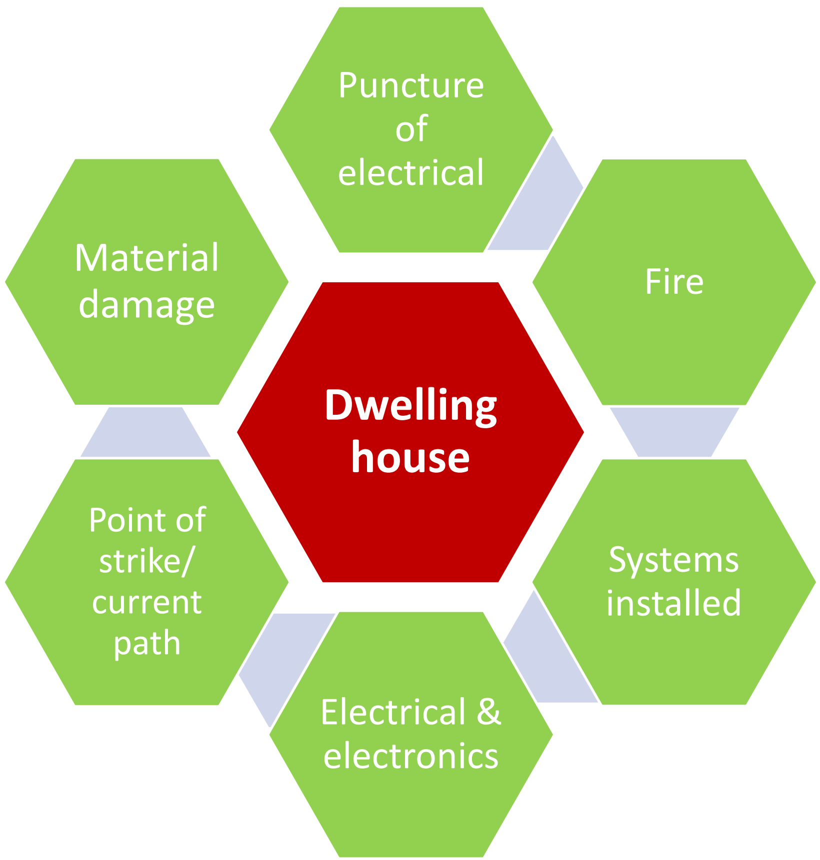

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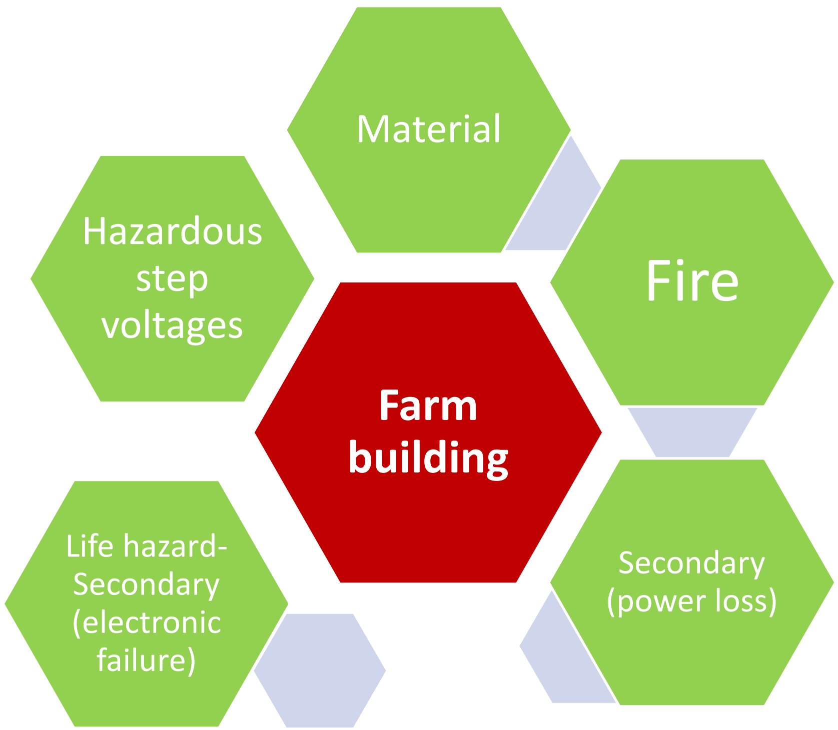

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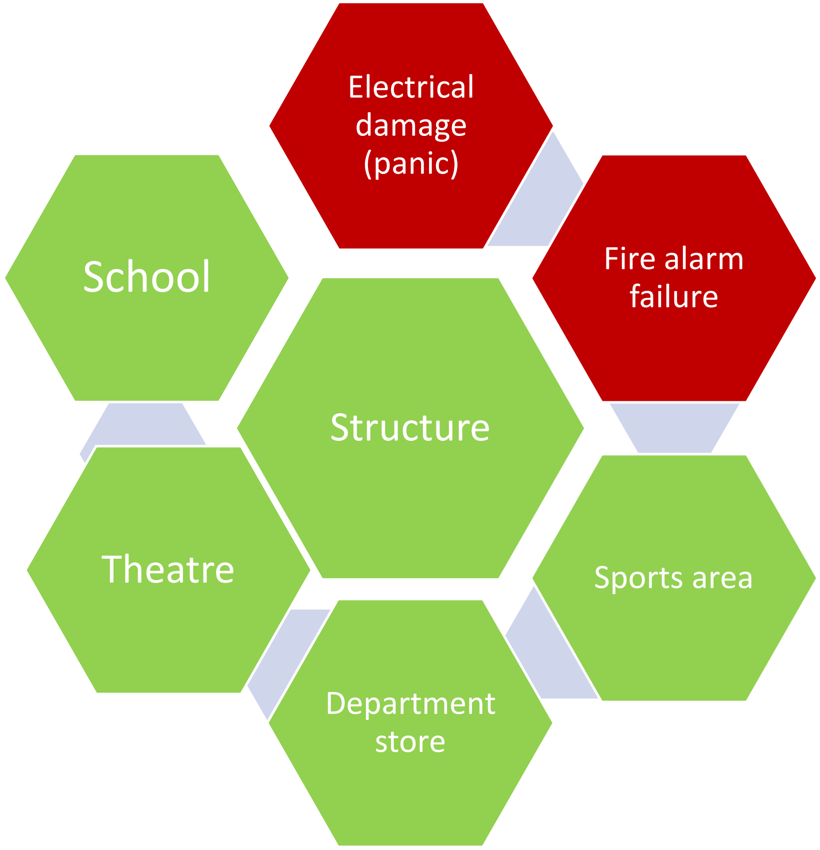

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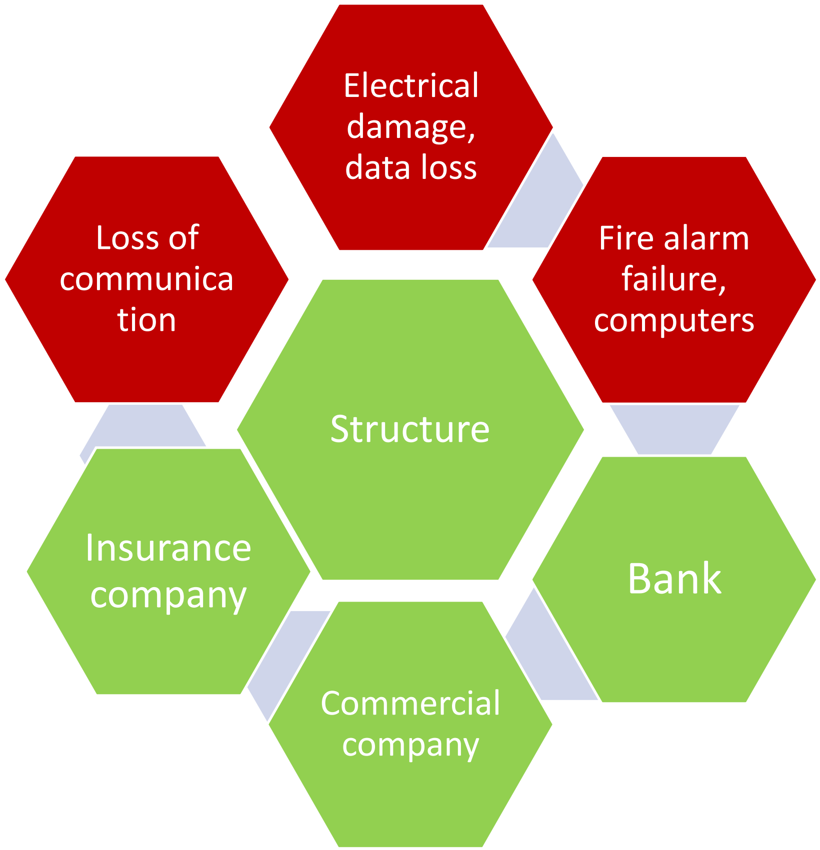

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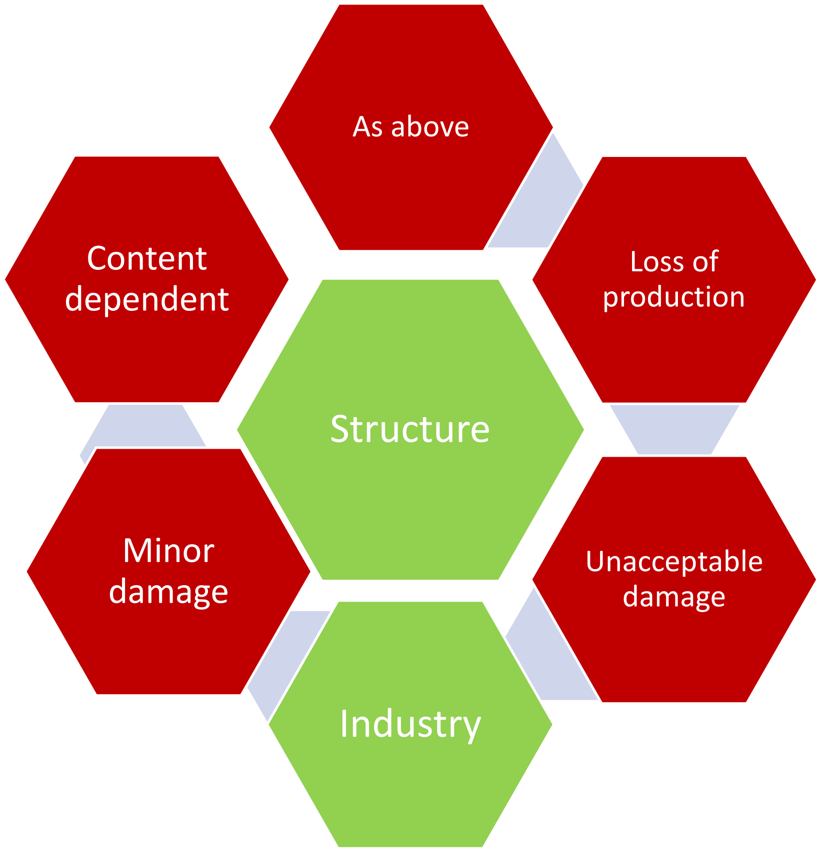

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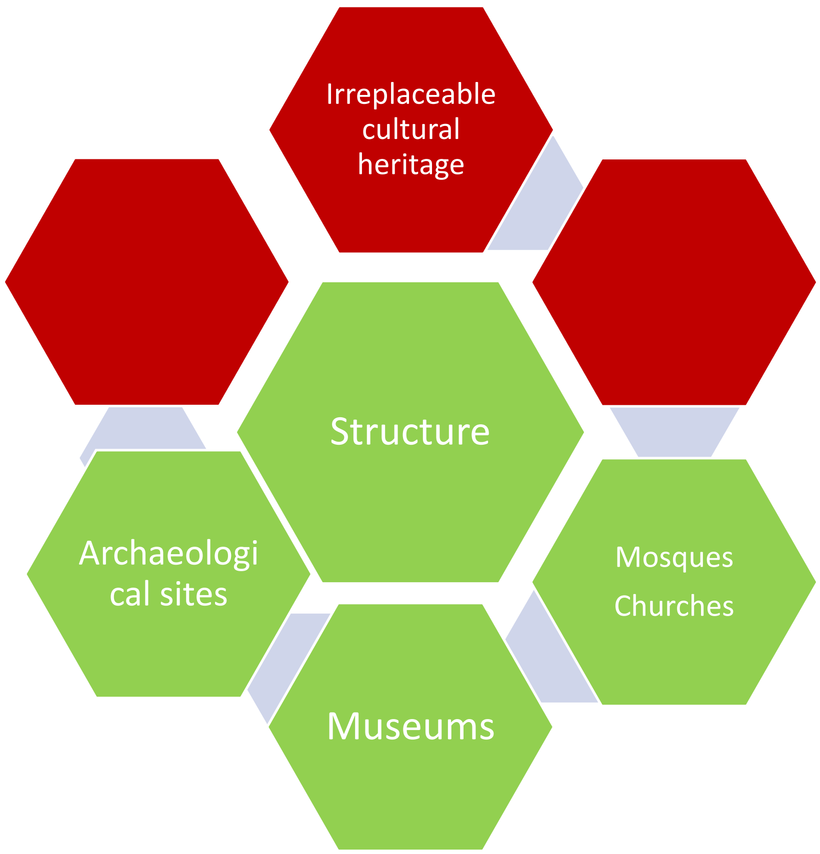

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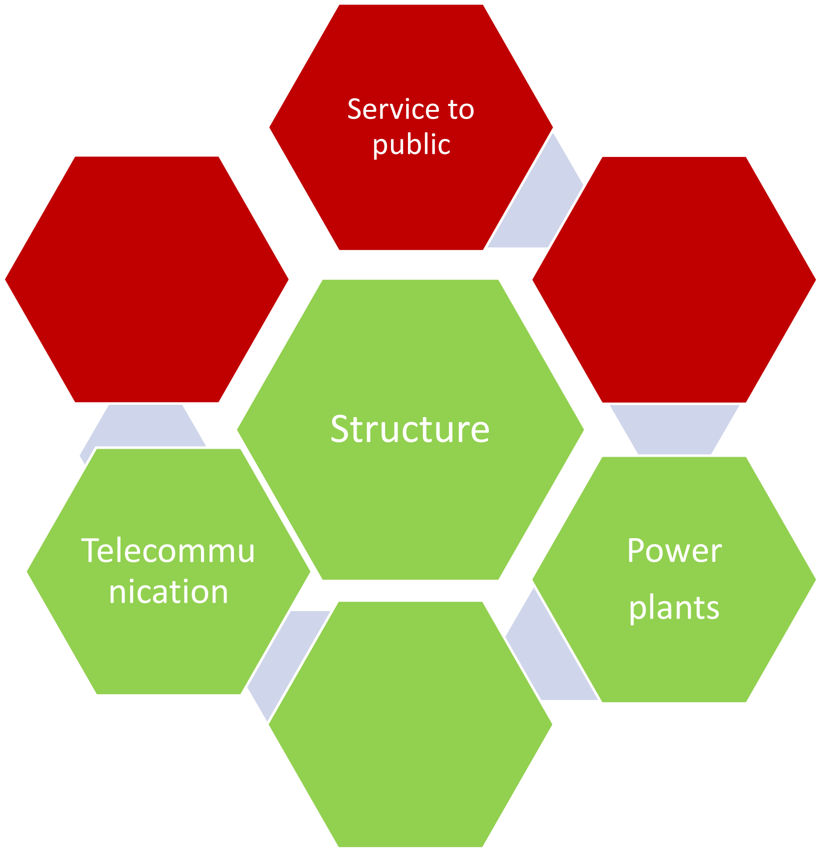

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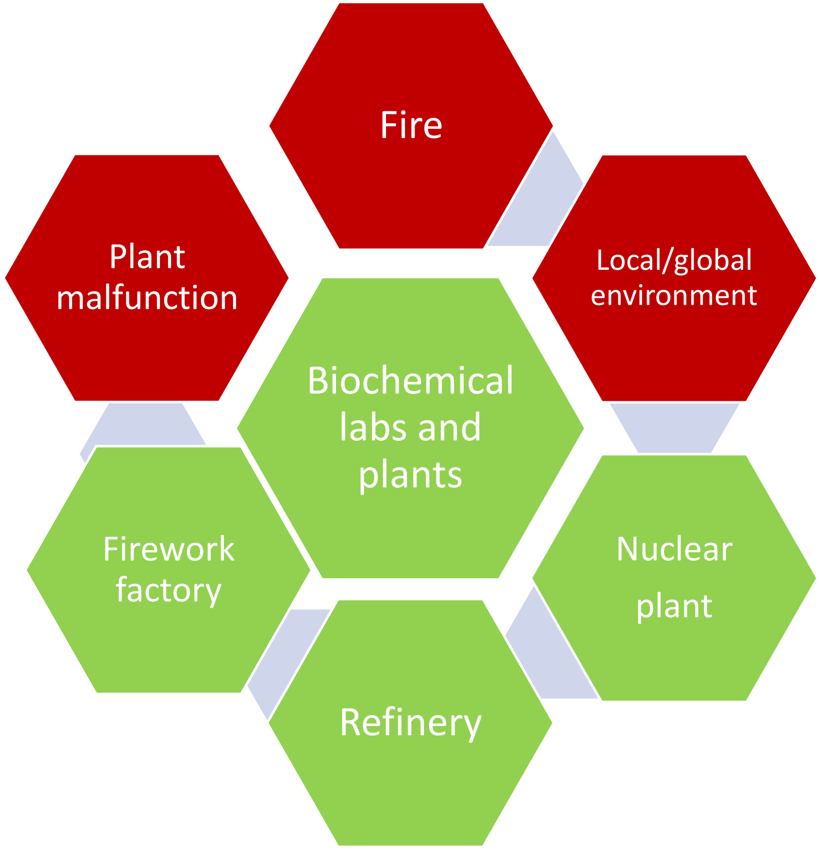

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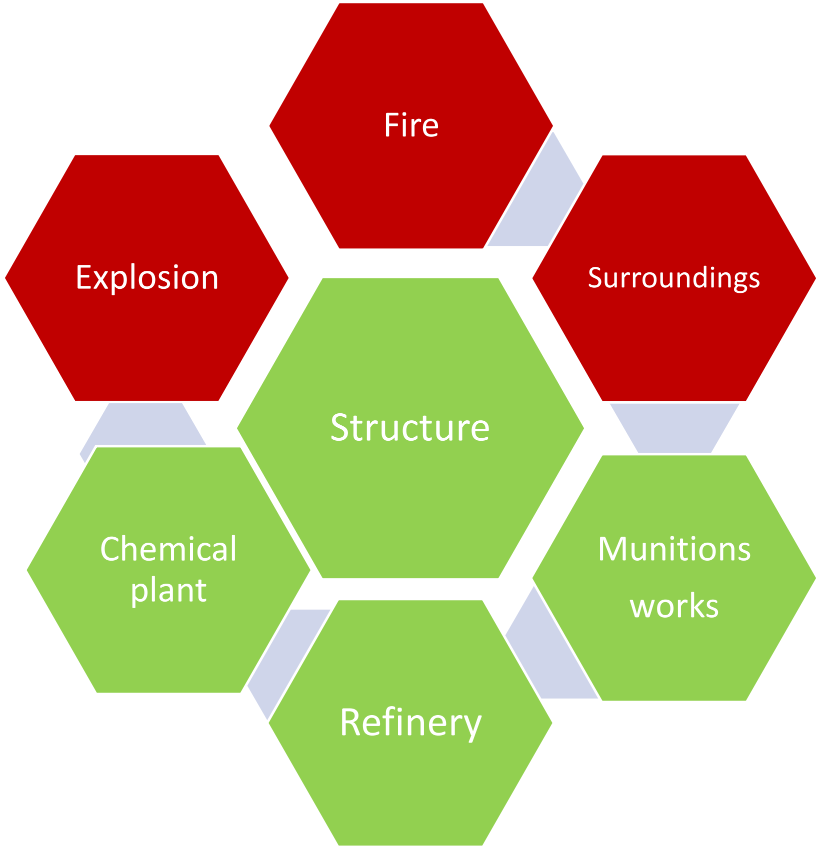
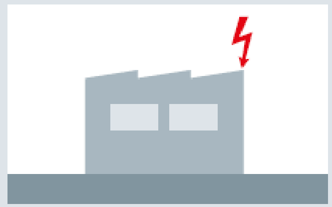
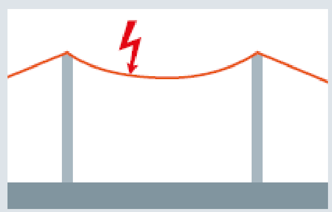
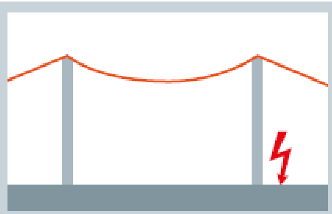
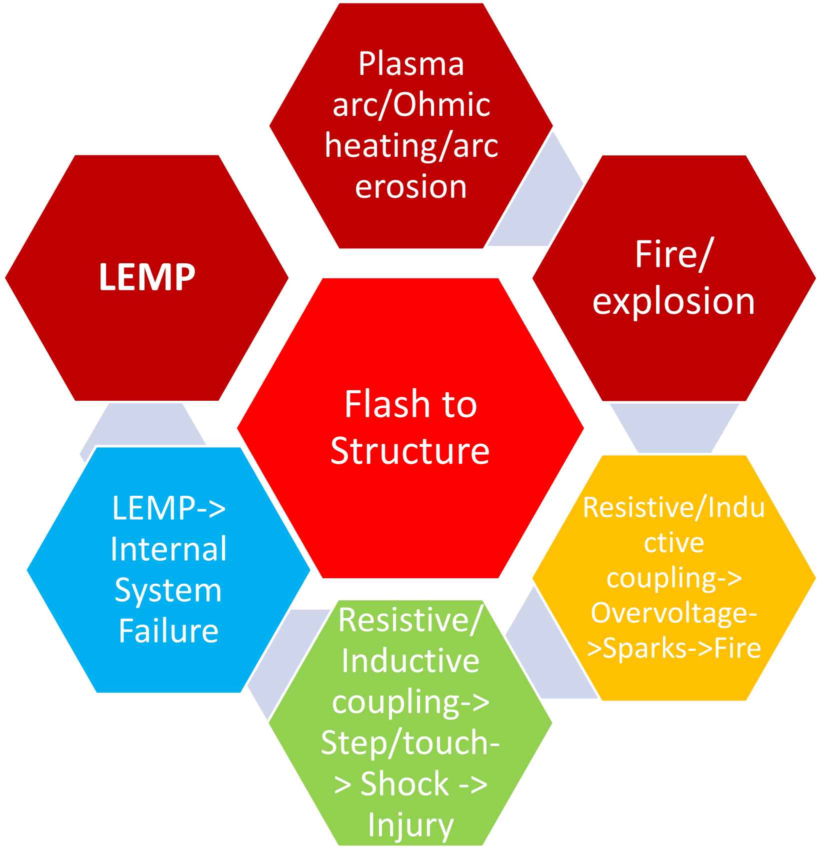


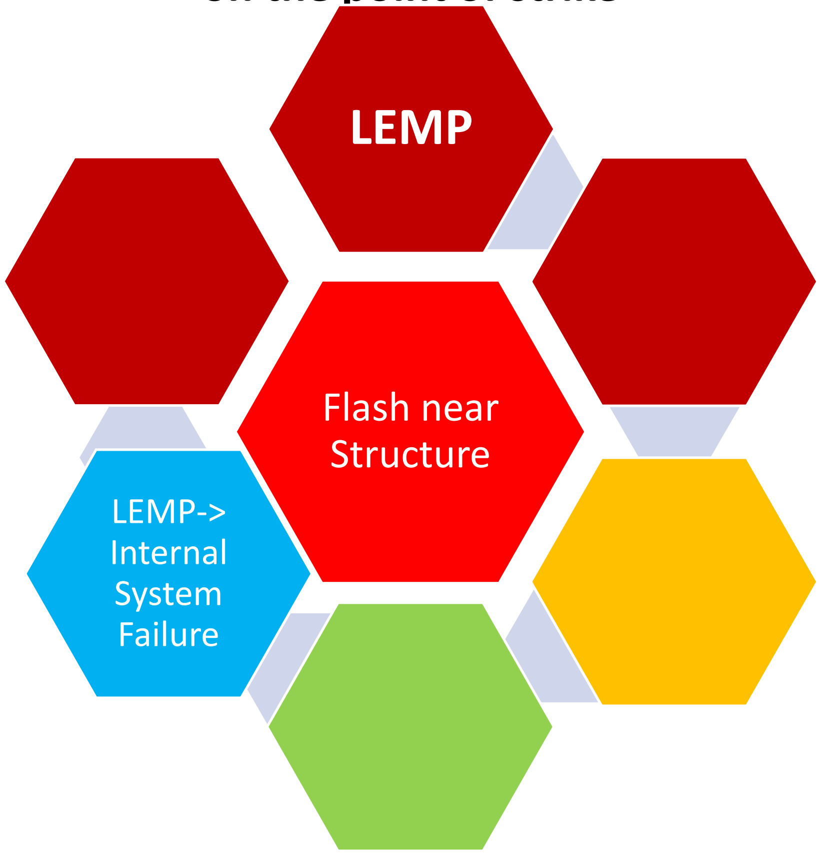
Sources of damage, types of damage and types of loss depending on the point of strike

Point of strike	Example	Type of damage	Type of loss
Structure S1		D1 D2 D3	L1, L4[b] L1, L2, L3, L4 L1[a], L2, L4
Near structure S2		D3	L1[a], L2, L4
Incoming line S3		D1 D2 D3	L1, L4[b] L1, L2, L3, L4 L1[a], L2, L4
Near incoming line S4		D3	L1[a], L2, L4

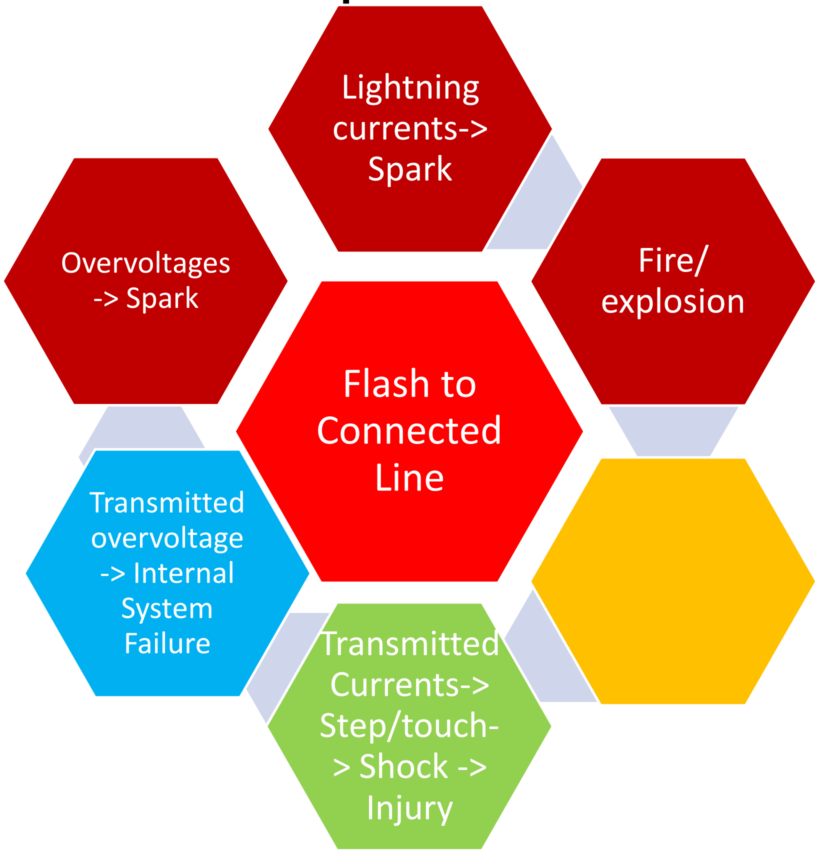
Sources of damage, types of damage and types of loss depending on the point of strike



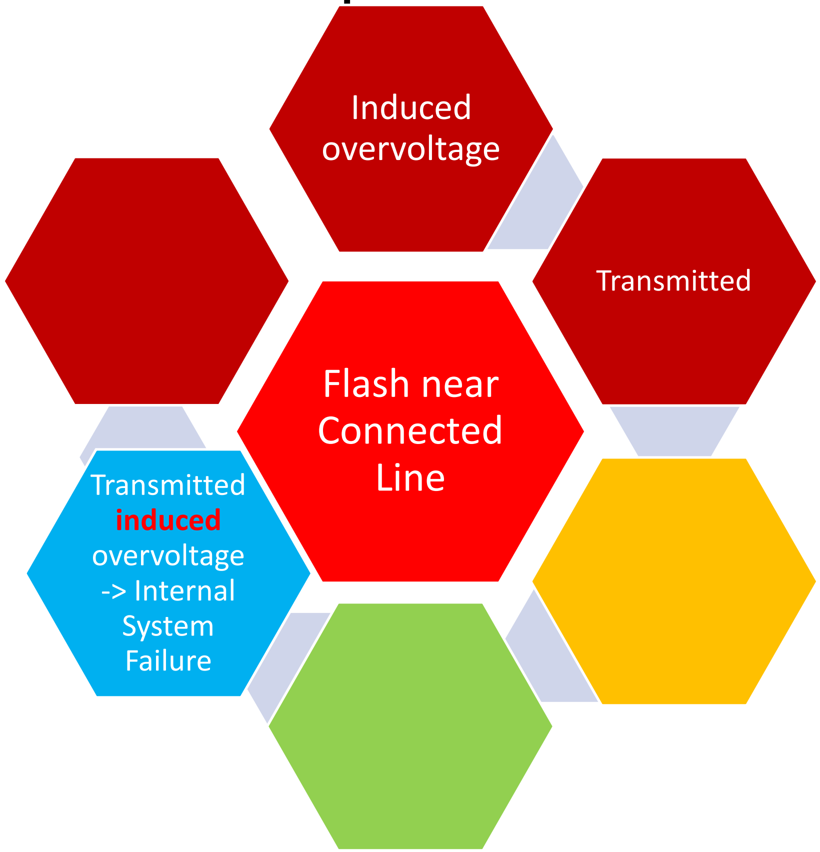
Sources of damage, types of damage and types of loss depending on the point of strike



Sources of damage, types of damage and types of loss depending on the point of strike



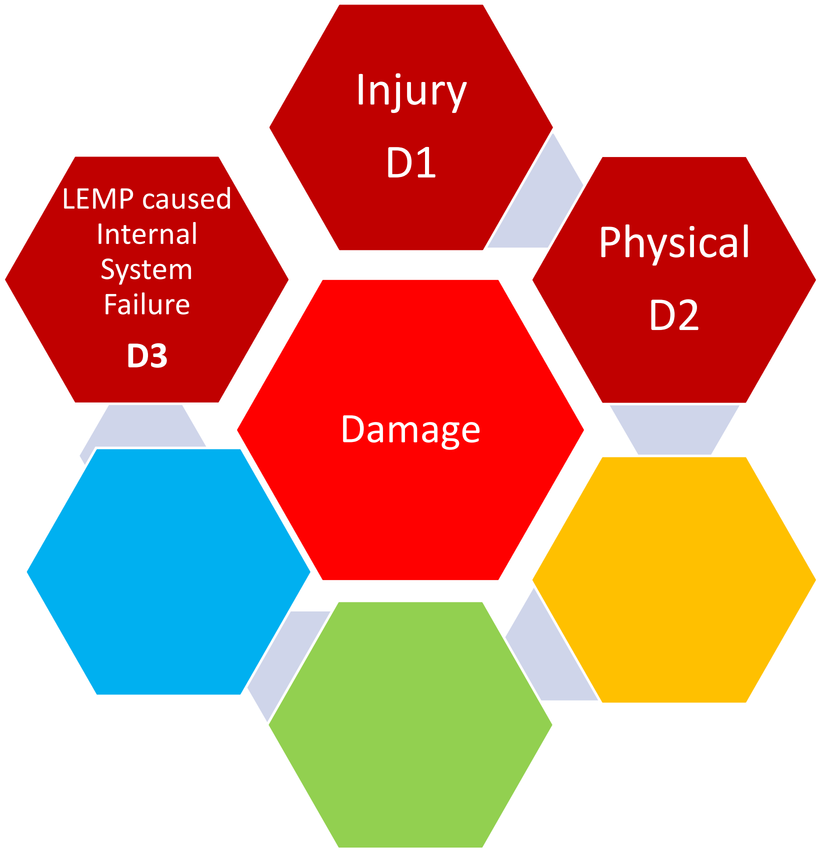
Sources of damage, types of damage and types of loss depending on the point of strike



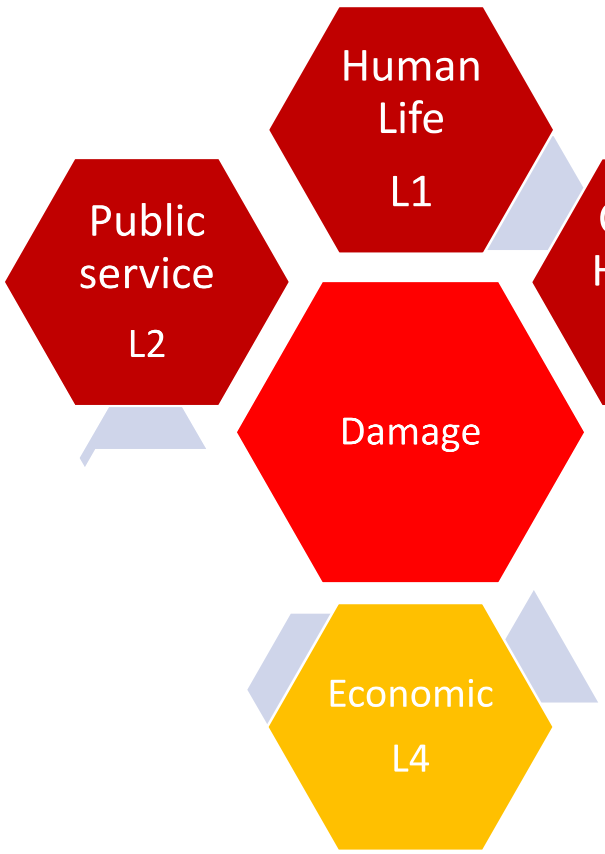
Note:

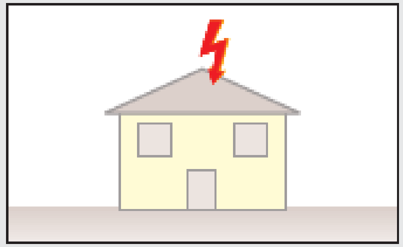
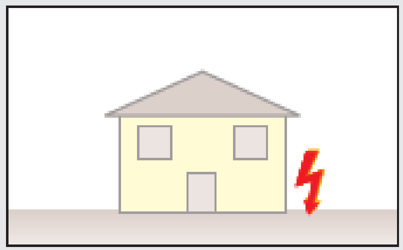
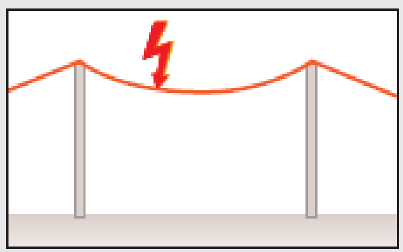
- Only sparks carrying lightning current (total or partial) are regarded as able to trigger fire
- Lightning flashes, direct to or near the incoming **pipelines**, do not cause damages to the structure, provided that they are bonded to the equipotential bar of the structure

Types of damage

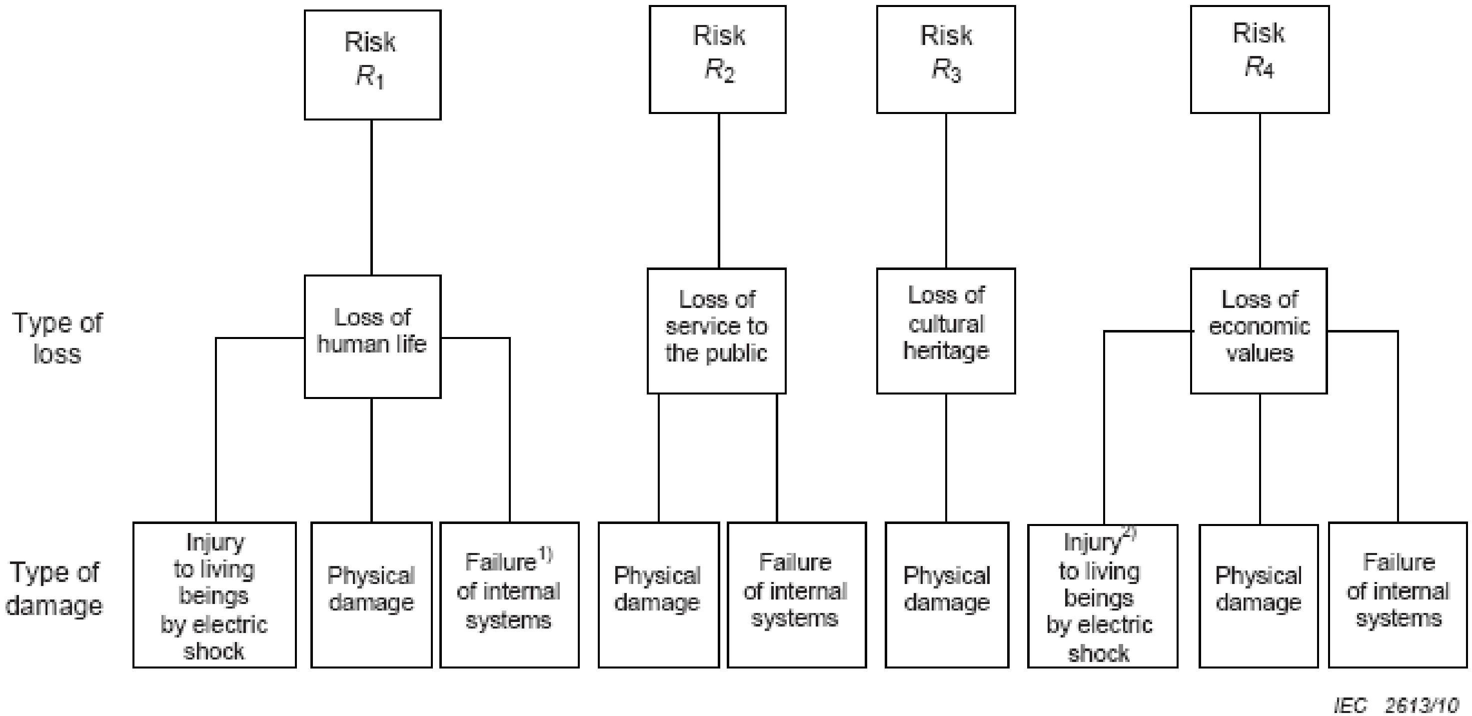


Types of Loss



			Building or structure	
Point of Strike	**Example**	**Source of damage**	**Type of damage**	**Type of loss**
Building or structure		S1	D1 D2 D3	L1, L4[b] L1, L2, L3, L4 L1[a], L2, L4
Earth next to the structure		S2	D3	L1[a], L2, L4
Entering supply line		S3	D1 D2 D3	L1, L4[b] L1, L2, L3, L4 L1[a], L2, L4
Earth next to the entering supply line		S4	D3	L1[a], L2, L4

Types of loss and corresponding risks resulting from different types of damage



[a] Only for hospitals or other structures where failure of internal systems immediately endanger human life.

[b] Only for properties where animals may be lost.

Fundamentals of risk analysis

- Risk is expressed as

$$\mathbf{R_x = N_x \,.\, P_x \,.\, L_x}$$

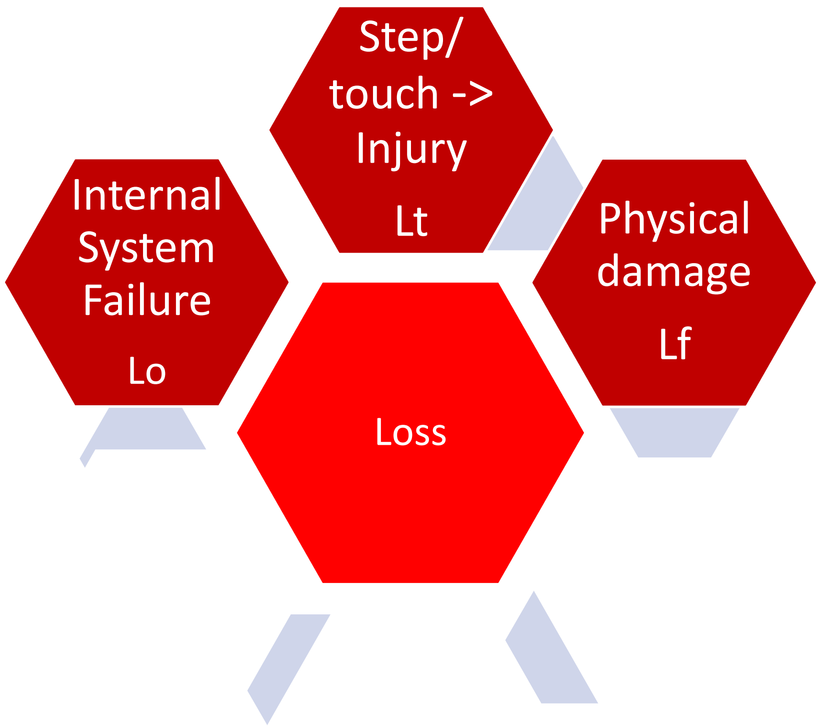
where

N_x is the number of dangerous events, i.e. the frequency of lightning strikes causing damage in the area under consideration (How many dangerous events occur each year?);

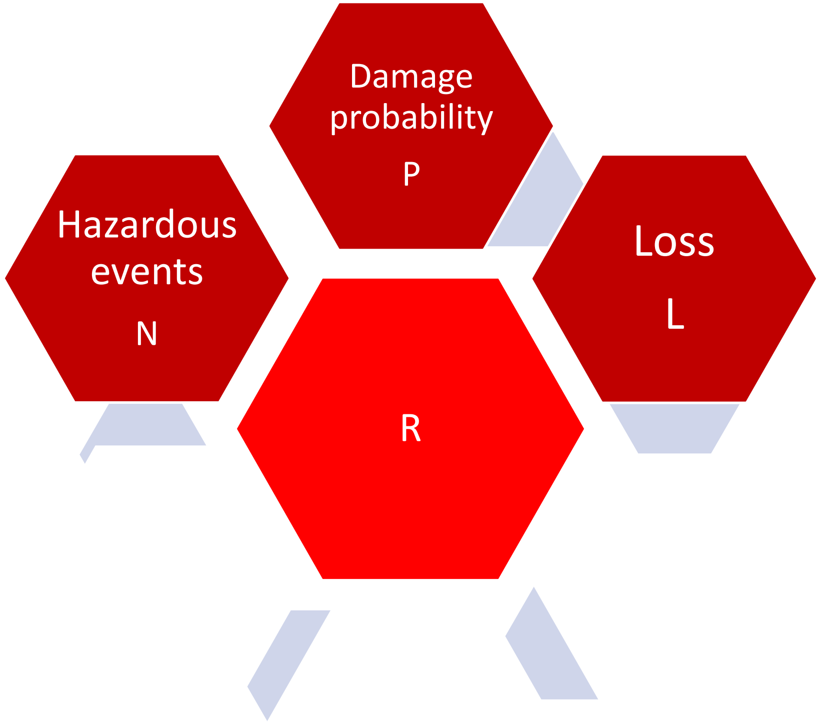
P_x is the probability of damage (What is the probability that a dangerous event causes certain damage?);

L_x is the loss factor, i.e. the quantitative evaluation of damage (What are the effects, amount of loss, extent and consequences of a certain damage?).

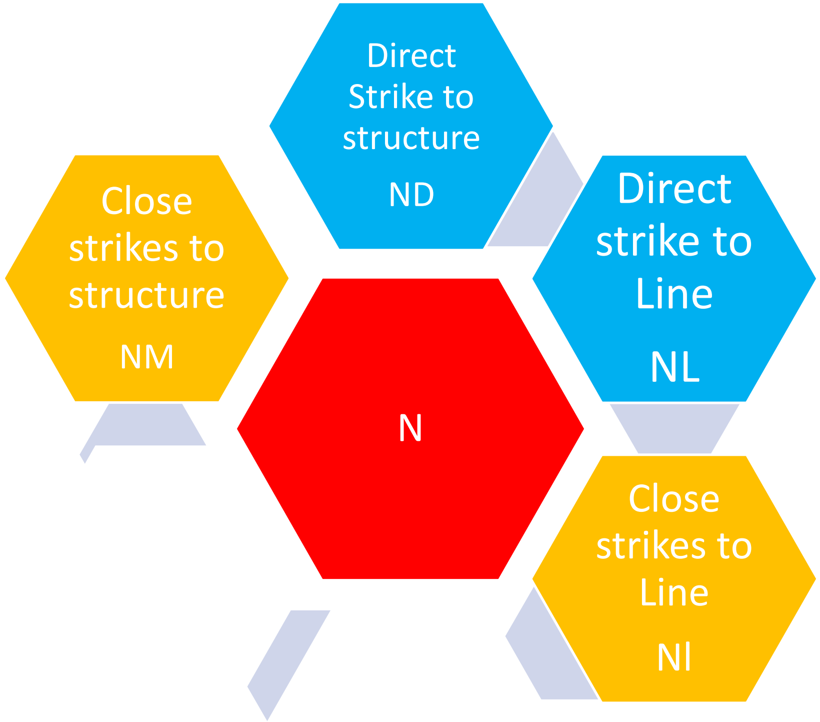
Types of Loss



Types of Loss



Types of Loss



Number of Hazardous Events

$$N_D = N_g \cdot A_d \cdot C_d \cdot 10^{-6}$$

$$N_M = N_g \cdot A_m \cdot 10^{-6}$$

$$N_L = N_g \cdot A_l \cdot C_e \cdot C_t \cdot 10^{-6}$$

$$N_l = N_g \cdot A_i \cdot C_t \cdot C_e \cdot 10^{-6}$$

Number of Hazardous Events

$$N_D = N_g \cdot A_d \cdot C_d \cdot 10^{-6}$$

A_d is the equivalent interception area of the isolated building or structure (**Figure 3.2.3.2**), C_d a site factor so that the influence of the surroundings (built-up, terrain, trees, etc.) can be taken into account (**Table 3.2.3.1**).

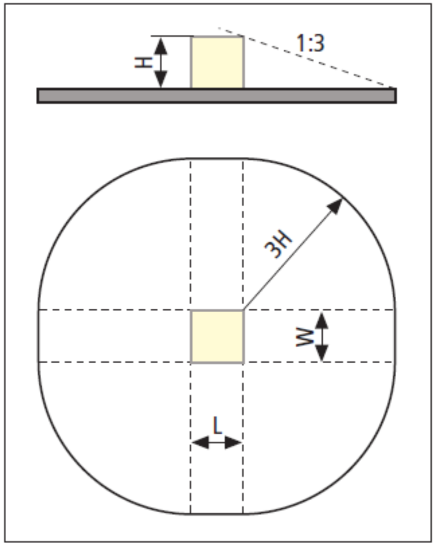


Fig. 3.2.3.2 Equivalent interception area A_d for direct lightning strikes into a stand-alone structure

Relative site of the building or structure	C_d
Object is surrounded by higher objects or trees	0.25
Object is surrounded by objects or trees of the same or lower height	0.5
Free-standing object: no further objects near by (within a distance of 3H)	1
Free-standing object on top of a moutain or a rounded hilltop	2

Table 3.2.3.1 Site factor C_d

Number of Hazardous Events

$$N_M = N_g \cdot A_m \cdot 10^{-6}$$

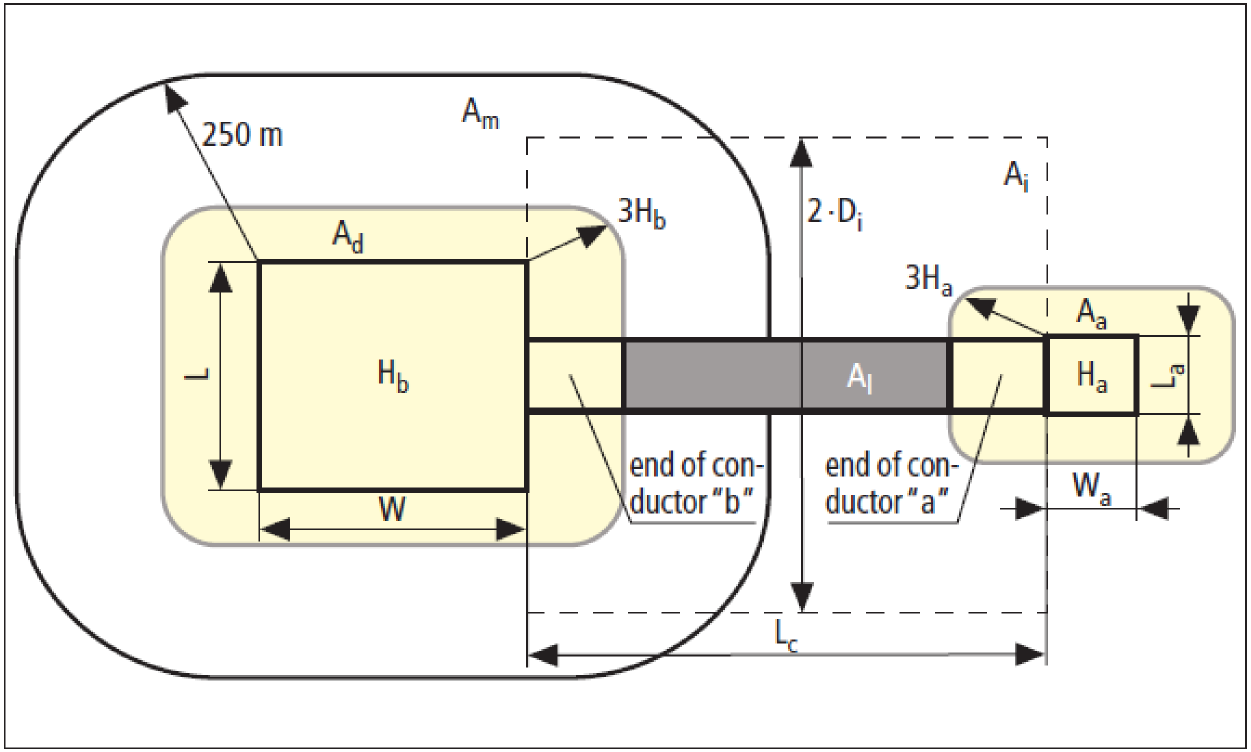


Fig. 3.2.3.3 Equivalent interception areas A_d, A_l, A_a for direct lightning strikes into structures/supply lines and A_m, A_i for indirect lightning strikes near the structures/supply lines

Number of Hazardous Events

$$N_L = N_g \cdot A_l \cdot C_e \cdot C_t \cdot 10^{-6}$$

The area A_l (**Figure 3.2.3.3**) is a function of the type of line (overhead line, cable), the length L_C of the line; in the case of cables, it is a function of the earth resistivity ρ; and for overhead lines it is a function of height H_C of the line above ground level (**Table 3.2.3.2**). If the length of the line is not known, or if it is very time-consuming to ascertain it, then, as a worst-case scenario, a value of L_C = 1000 m can be set.

H_C Height (m) of the line above ground level;

ρ Earth resistivity (Ωm) in, or on, which the line is laid, up to a maximum value of ρ = 500 Ωm;

L_C Length (m) of the line, measured from the building or structure to the first distribution junction, or to the first location where surge protective devices are installed, up to a maximum length of 1000 m;

H Height (m) of the building or structure;

H_b Height (m) of the building or structure;

H_a Height (m) of the neighbouring building or structure connected via the line.

Number of Hazardous Events

$$N_L = N_g \cdot A_l \cdot C_e \cdot C_t \cdot 10^{-6}$$

	Overhead line	Underground cable
A_l	$\left[L_C - 3 \cdot (H_a + H_b)\right] \cdot 6 \cdot H_C$	$\left[L_C - 3 \cdot (H_a + H_b)\right] \cdot \sqrt{\rho}$
A_i	$1000 \cdot L_C$	$25 \cdot L_C \cdot \sqrt{\rho}$

Table 3.2.3.2 Equivalent interception areas A_l and A_i in m^2

Environment	C_e
Urban with high buildings or structures (higher than 20 m)	0
Urban (buildings or structures of heights between 10 m and 20 m)	0.1
Suburban (buildings or structures not higher than 10 m)	0.5
Rural	1

Table 3.2.3.3 Environment factor C_e

Number of Hazardous Events

$$N_l = N_g \cdot A_i \cdot C_t \cdot C_e \cdot 10^{-6}$$

Probabilities of damage

P_A Electric shock suffered by living beings as a result of a direct lightning strike to the building or structure;

P_B Fire, explosion, mechanical and chemical reactions as a result of a direct lightning strike to the building or structure;

P_C Failure of electrical / electronic systems as a result of a direct lightning strike to the building or structure; $P_C = P_{SPD}$

P_M Failure of electrical / electronic systems as a result of a lightning strike to the ground next to the building or structure;

P_U Electric shock suffered by living beings as a result of a direct lightning strike to the utility lines entering the building or structure;

P_V Fire, explosion, mechanical and chemical reactions as a result of a direct lightning strike to a utility line entering the building or structure;

P_W Failure of electrical / electronic systems as a result of a direct lightning strike to a utility line entering the building or structure;

P_Z Failure of electrical / electronic systems as a result of a lightning strike to the ground next to a utility line entering the building or structure.

Probabilities of damage

Characteristics of building or structure	Class of lightning protection system (LPS)	P_B
Building or structure is not protected by LPS	–	1
Building or structure is protected by LPS	IV	0.2
	III	0.1
	II	0.05
	I	0.02
Building or structure with air-termination system according to class of LPS and a metal facade or a concrete reinforcement as natural down conductor system		0.01
Building or structure with metal roof or with air-termination system, preferably including natural components, which protect all roof superstructues entirely against direct lightning strikes, and a metal facade or concrete reinforcement a natural down conductor system.		0.001

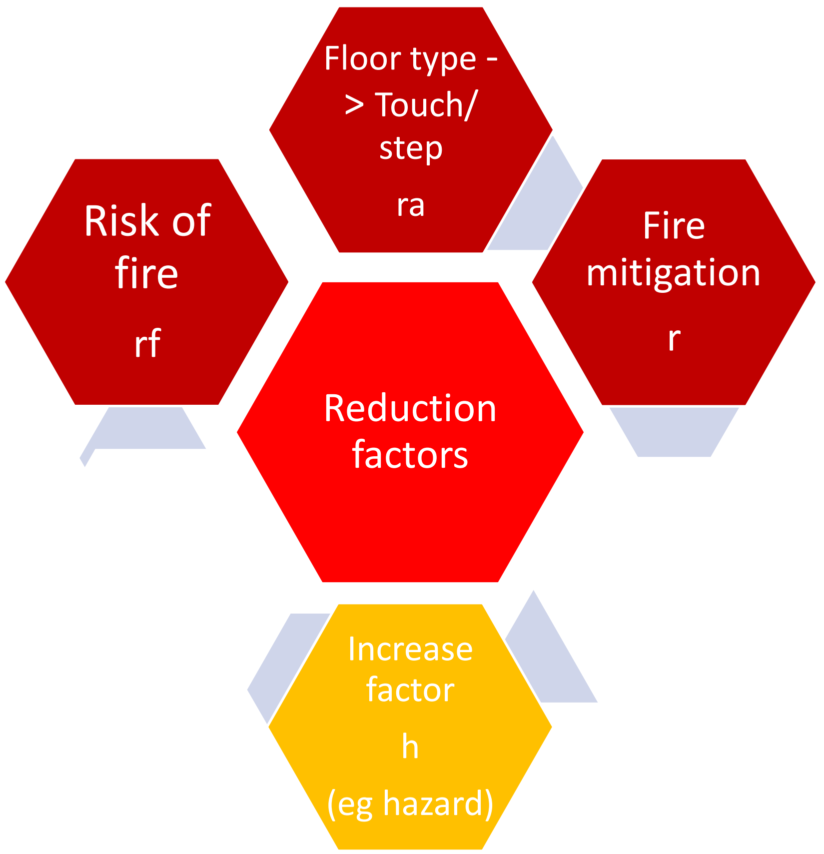
Table 3.2.4.1 Damage factor P_B to describe the protective measures against physical damage

Probabilities of damage

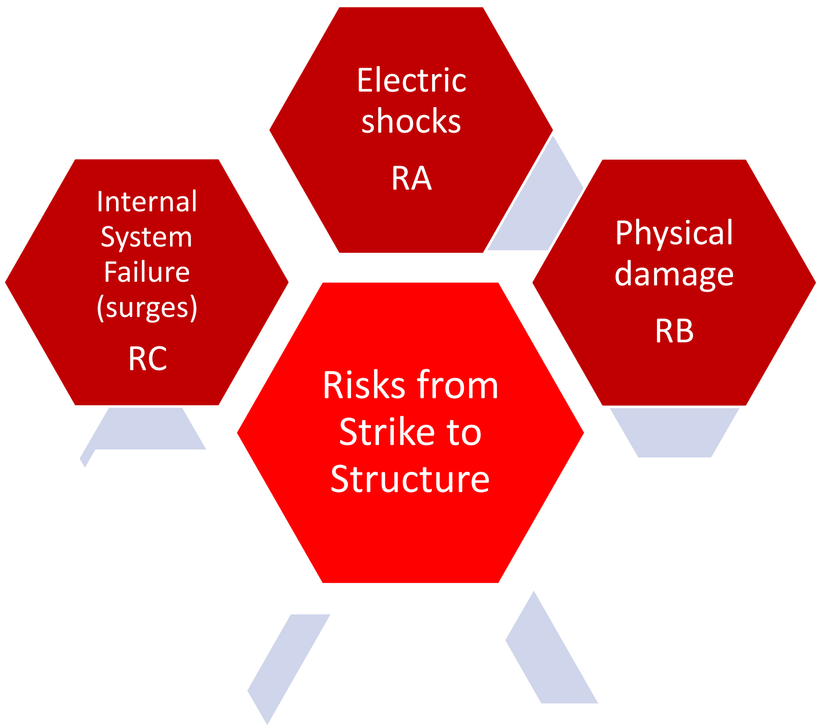
Lightning protection level (LPL)	Damage factor P_{SPD}
No coordinated surge protection	1
III – IV	0.03
II	0.02
I	0.01
Surge protective devices (SPD) having a protective characteristic better than for LPL I (higher lightning current carrying capability, lower protection level, etc.)	0.005 – 0.001

Table 3.2.4.2 Damage factor P_{SPD} to describe the protective measures surge protective devices as a function of the lightning protection level

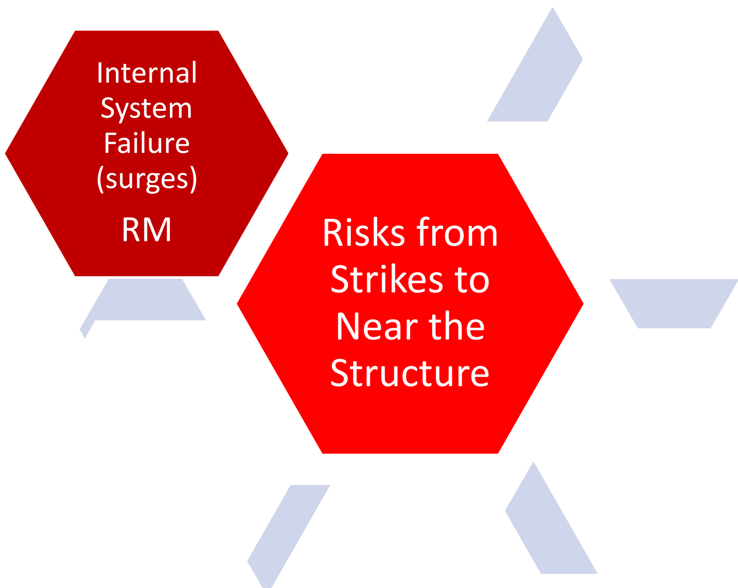
Types of Loss



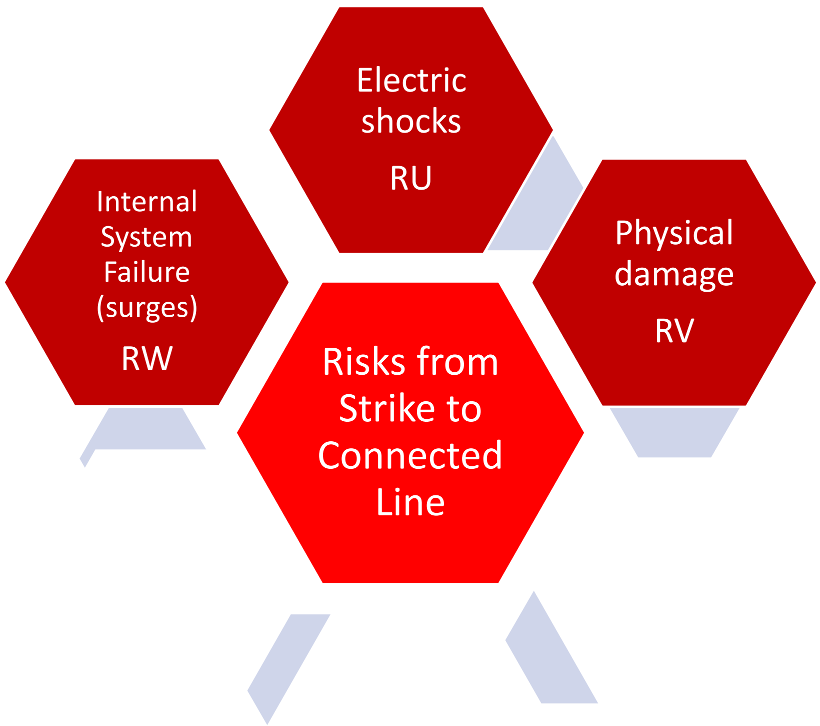
Types of damage



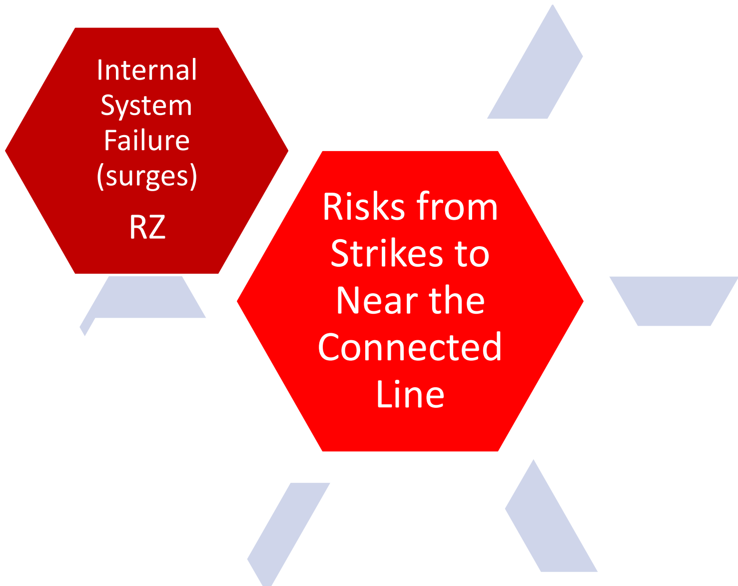
Types of damage



Types of damage



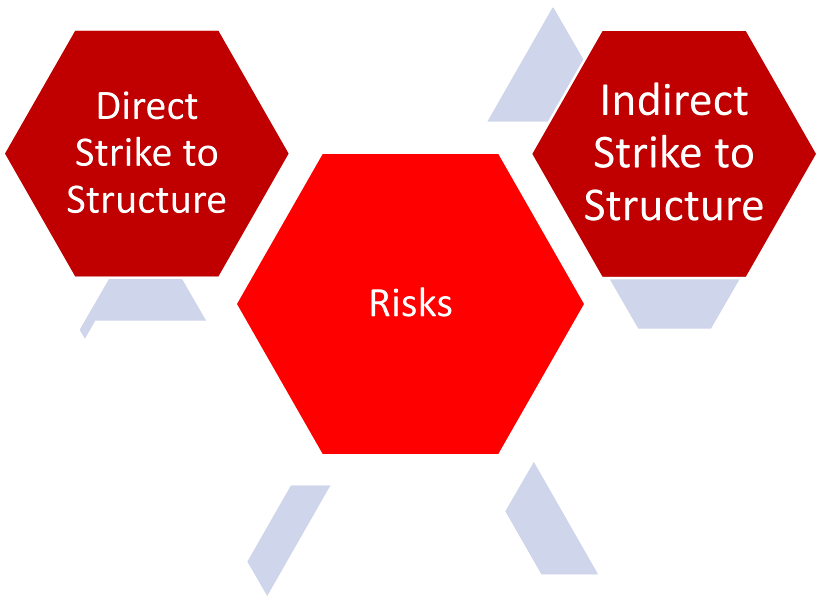
Types of damage



Risks

Source of damage / Type of damage	Lightning strike (with regard to the structure)				
	Direct	Indirect			
	S1 Direct lightning strike into the structure	**S2** Lightning strike into the earth next to the structure	**S3** Direct lightning strike into the entering supply line	**S4** Lightning strike into the earth next to the entering supply line	
D1 Electric shock to living beings	$R_A = N_D \cdot P_A \cdot r_a \cdot L_t$		$R_U = (N_L + N_{DA}) \cdot P_U \cdot r_a \cdot L_t$		$R_s = R_A + R_U$
D2 Fire, explosions, mechanical and chemical effects	$R_B = N_D \cdot P_B \cdot r \cdot h \cdot r_f \cdot L_f$		$R_V = (N_L + N_{DA}) \cdot P_V \cdot r \cdot h \cdot r_f \cdot L_f$		$R_f = R_B + R_V$
D3 Interferences on electrical and electronic systems	$R_C = N_D \cdot P_C \cdot L_o$	$R_M = N_M \cdot P_M \cdot L_o$	$R_W = (N_L + N_{DA}) \cdot P_W \cdot L_o$	$R_Z = (N_I - N_L) \cdot P_Z \cdot L_o$	$R_o = R_C + R_M + R_W + R_Z$
	$R_d = R_A + R_B + R_C$	$R_i = R_M + R_U + R_V + R_W + R_Z$			

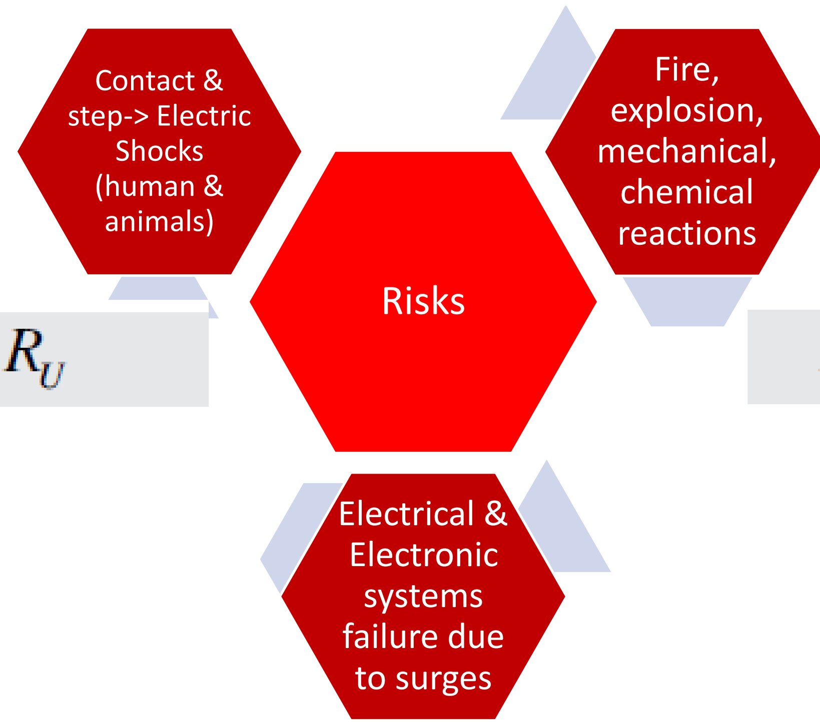
Risks from the view of Strikes



$$R_d = R_A + R_B + R_C$$

$$R_i = R_M + R_U + R_V + R_W + R_Z$$

Risks from the view of Cause of damage



$$R_s = R_A + R_U$$

$$R_f = R_B + R_V$$

$$R_o = R_C + R_M + R_W + R_Z$$

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2. Risk Management - Need and economic justification for LPS

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Need for Lightning Protection

- The need in order to reduce the loss of social values L1, L2 and L3
- In order to evaluate whether or not LP of a structure is needed, a **risk assessment** in accordance with the procedures contained in **IEC 62305-2** is made.
- The following risks shall be taken into account
  - R_1: risk of loss or permanent injury of human life
  - R_2: risk of loss of services to the public
  - R_3: risk of loss of cultural heritage
- **Protection** against lightning is needed if the risk **R** (R_1 to R_3) is higher than the **tolerable level R_T**

$$\mathbf{R > R_T}$$

- In this case, protection measures shall be adopted in order **to reduce the risk R to tolerable level R_T**

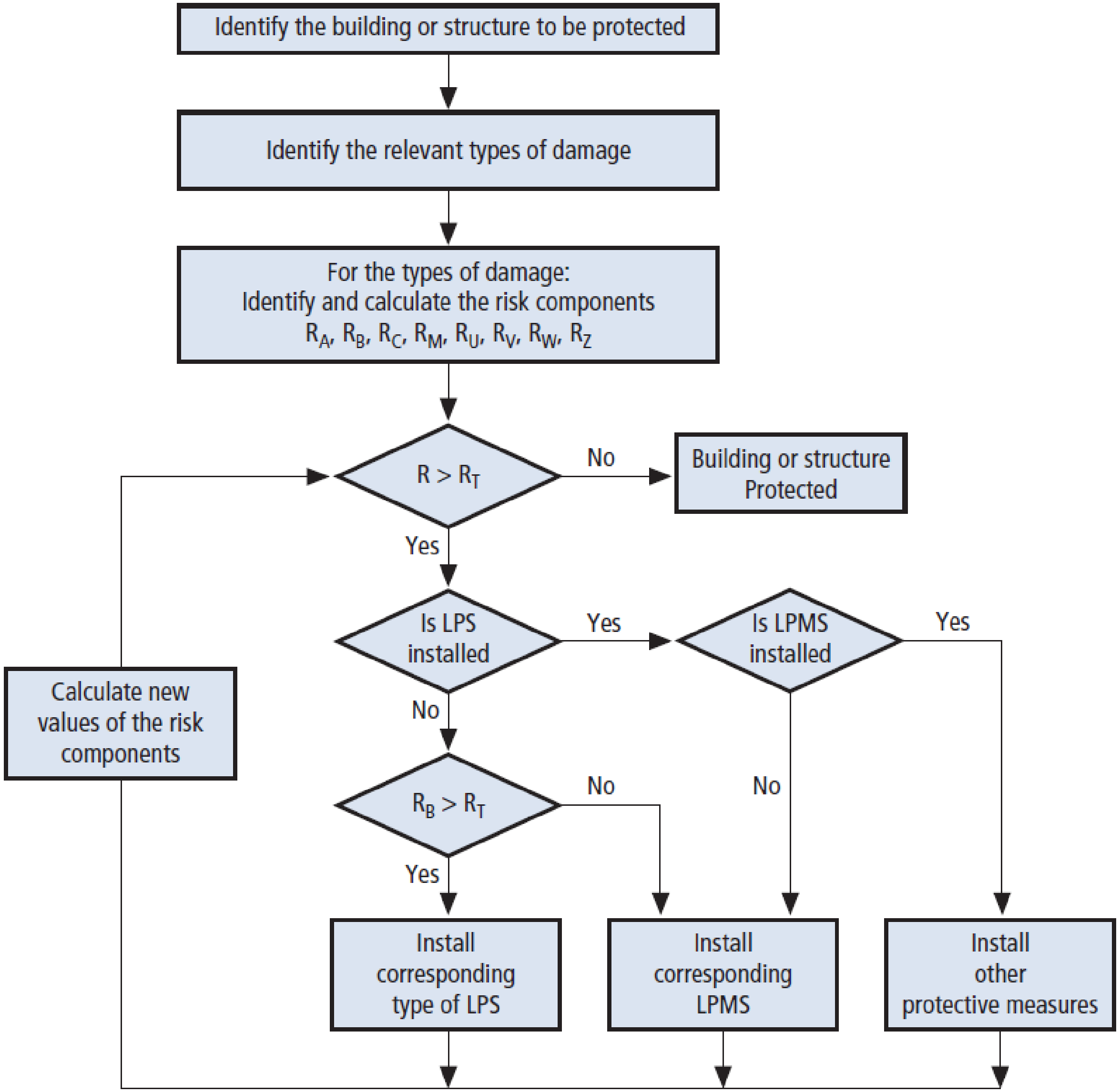
$$\mathbf{R \leq R_T}$$

- If more than one type of loss could appear, the condition **$R \leq R_T$ shall be satisfied for each type of loss (L1, L2 and L3)**

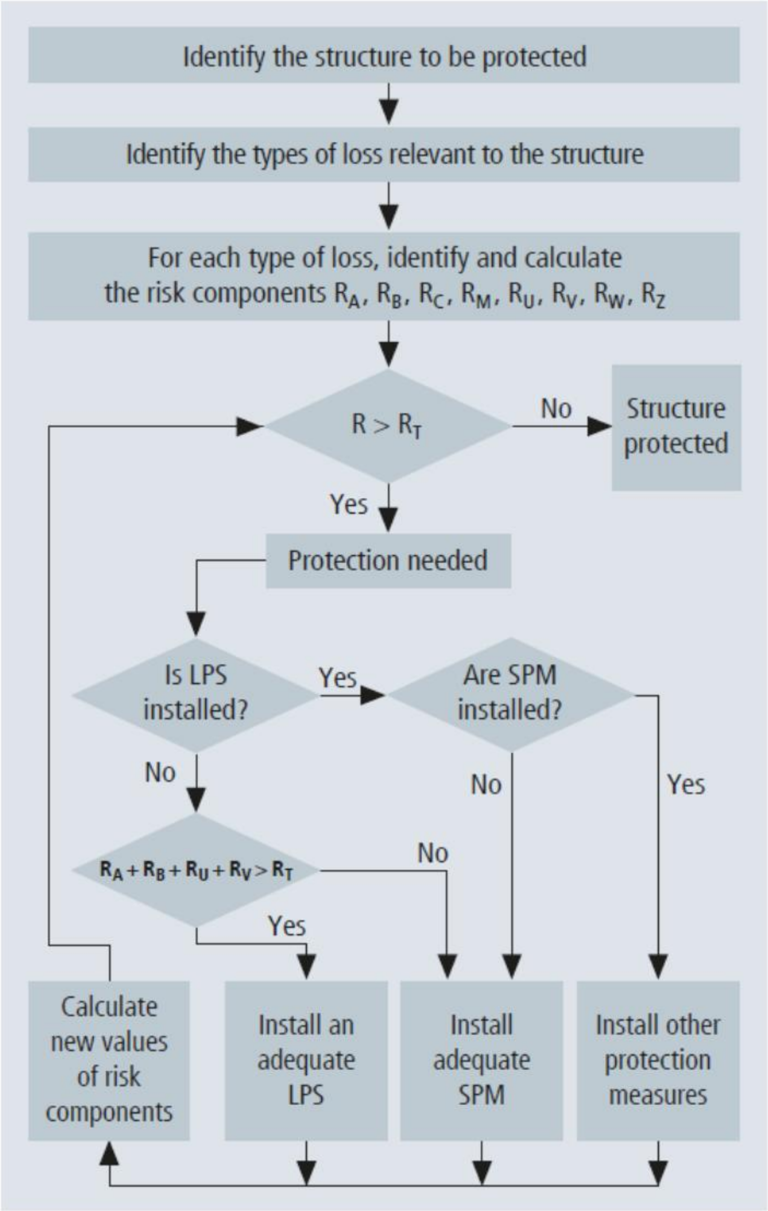
Typical values for the tolerable risk RT

Types of loss		R_T
L1	Loss of human life (injury to, or death of, persons)	10^{-5}/year
L2	Loss of services for the public	10^{-3}/year
L3	Loss of irreplaceable cultural asset	10^{-3}/year

Protection Measures Selection



LPMS: LEMP Protection Measures System



Flow diagram for determining the need of protection and for selecting measures in case of types of loss L1 to L3

Risk components:

R_A human life (S_1)
R_B fire (S_1)
R_C overvoltage (S_1)

R_M overvoltage (S_2)

R_U human life (S_3)
R_V fire (S_3)
R_W overvoltage (S_3)

R_Z overvoltage (S_4)

Economic Justification of Lightning Protection

- The type of loss L4, economic losses, is relevant for many buildings or structures.
- Here it is no longer possible to work with a tolerable risk of damage RT.
- One rather has to compare, whether the protective measures are justifiable from an economical point of view.
- Not an absolute parameter, such as a specified tolerable risk of damage RT, is standard of comparison, but a relative one:
  - Different states of protection of the building or structure are compared and the optimal solution, i.e. the cost of damage as a result of lightning strikes remaining as low as possible, will be realised.
  - So several variants can and shall be examined.

  - But for L1-L3 (public interest), $R < RT$, is always the first criterion.

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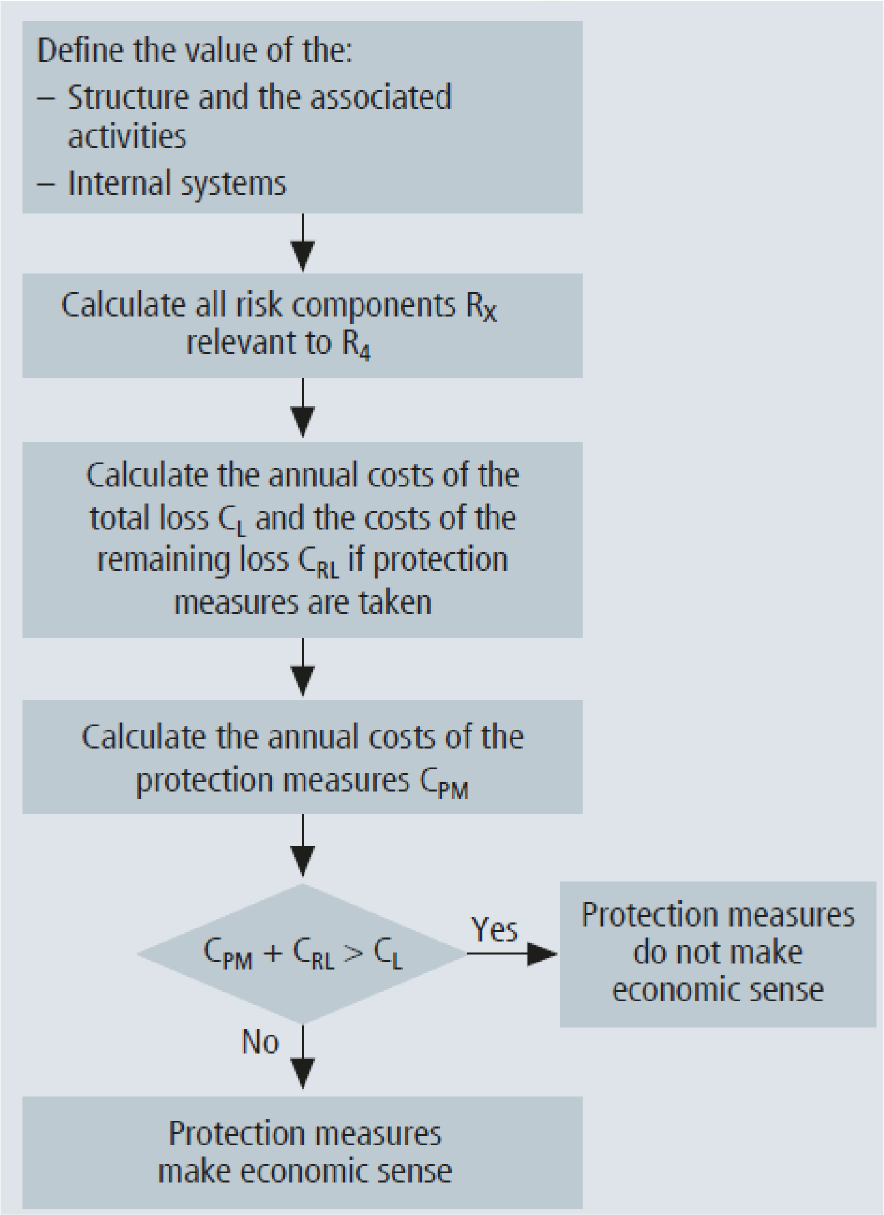
Economic Justification of Lightning Protection

- Besides the need for LP for the structure to be protected, it may be useful to evaluate the economic benefits of providing protection measures in order to reduce the economic loss L4.

- **R4 allows for the evaluation of the cost of the economic loss with and without the adopted protection measures.**

- **LP is cost effective** if the **sum of the cost** of **residual loss** in the **presence** of protection measures**, CRL,** and the **cost of protection measures, CPM,** is **lower** than the **cost of total loss** without protection measures**, CL**

$$CRL + CPM < CL$$



Flow diagram for selecting protection measures in case of loss of economic value

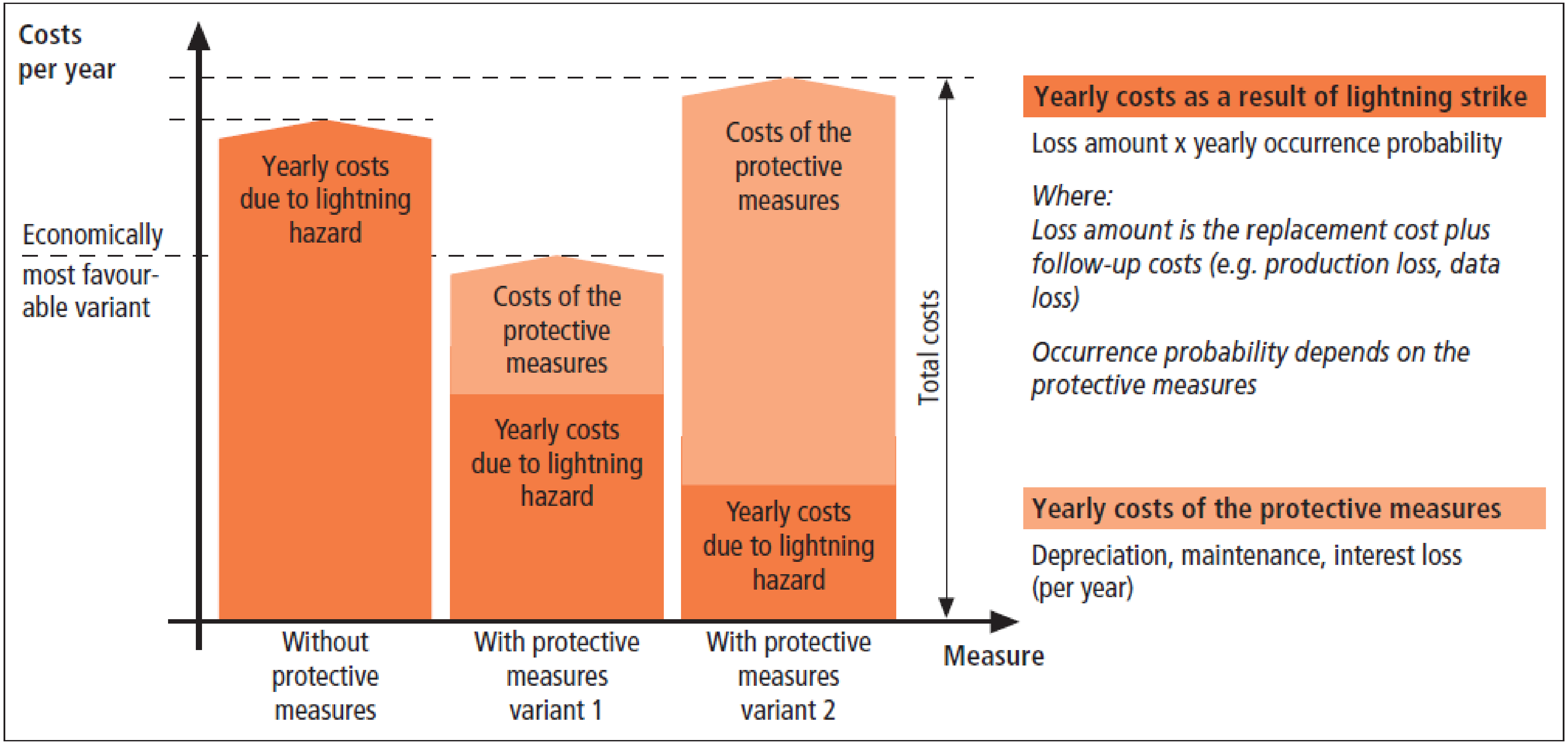


Fig. 3.2.10.1 Basic procedure in case of a purely economic consideration and calculation of the yearly costs

3. Risk Assessment

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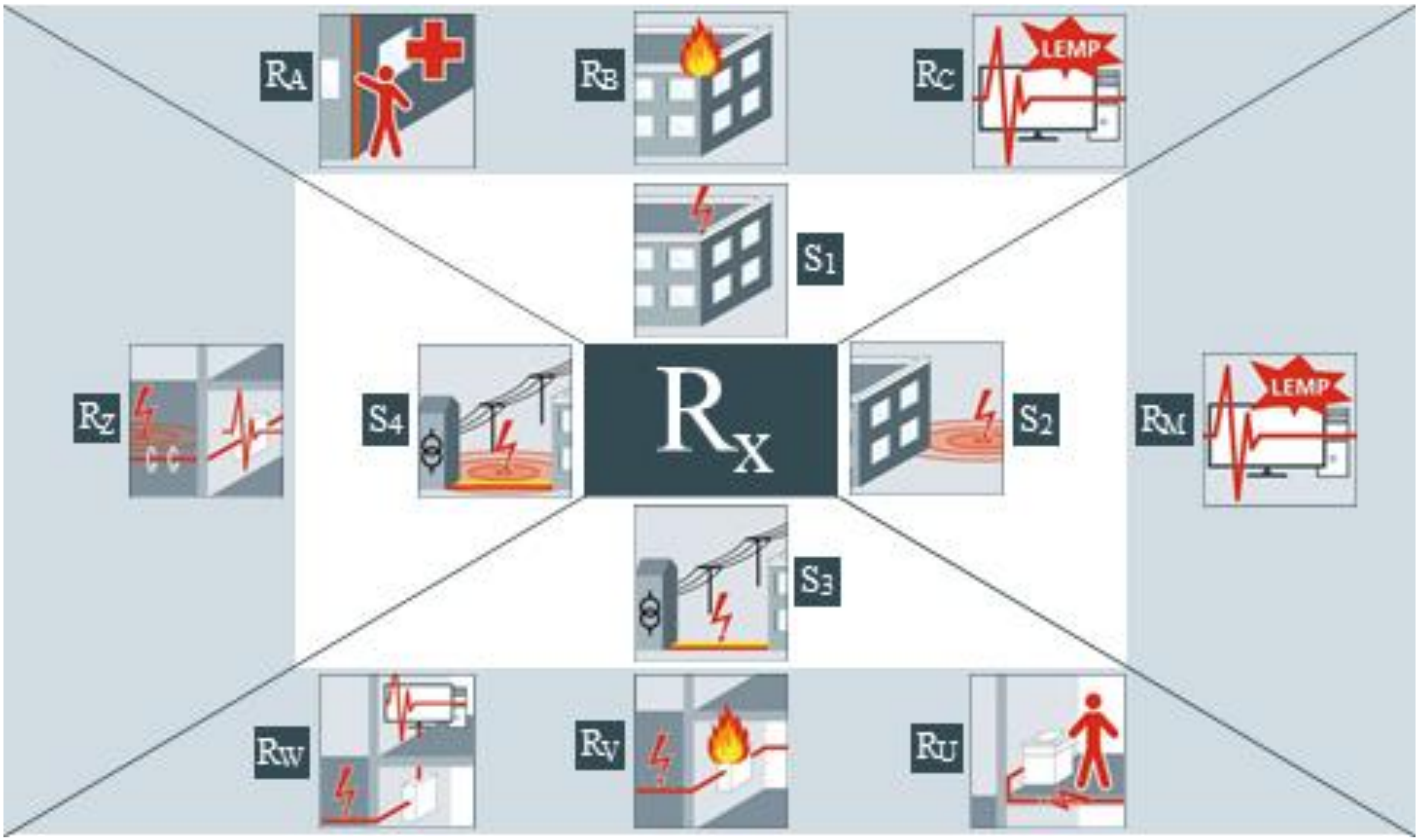
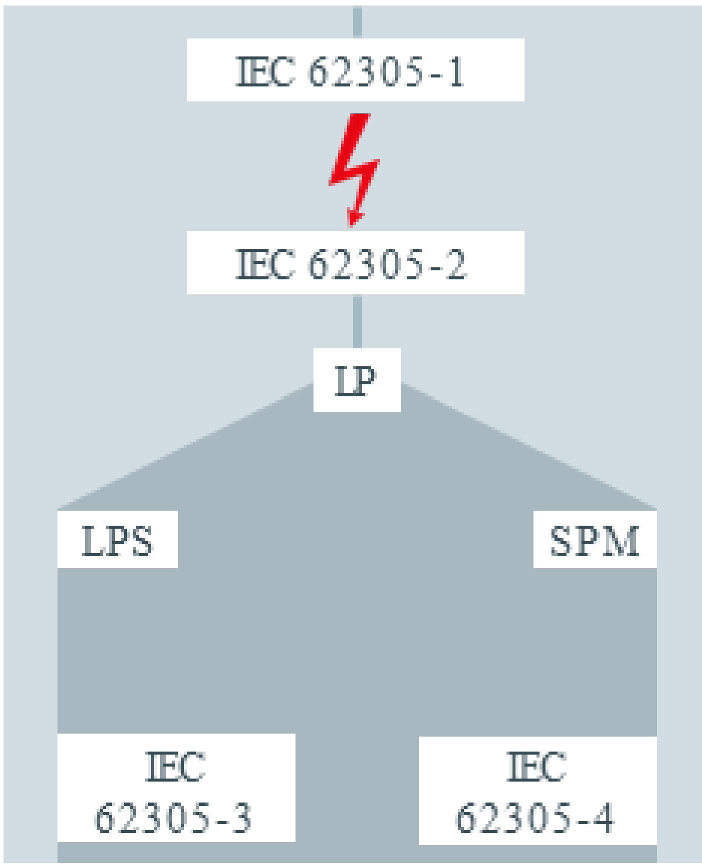
Overview of risk components R_X



Complete Lightning Protection System (LPS)



Lightning threat

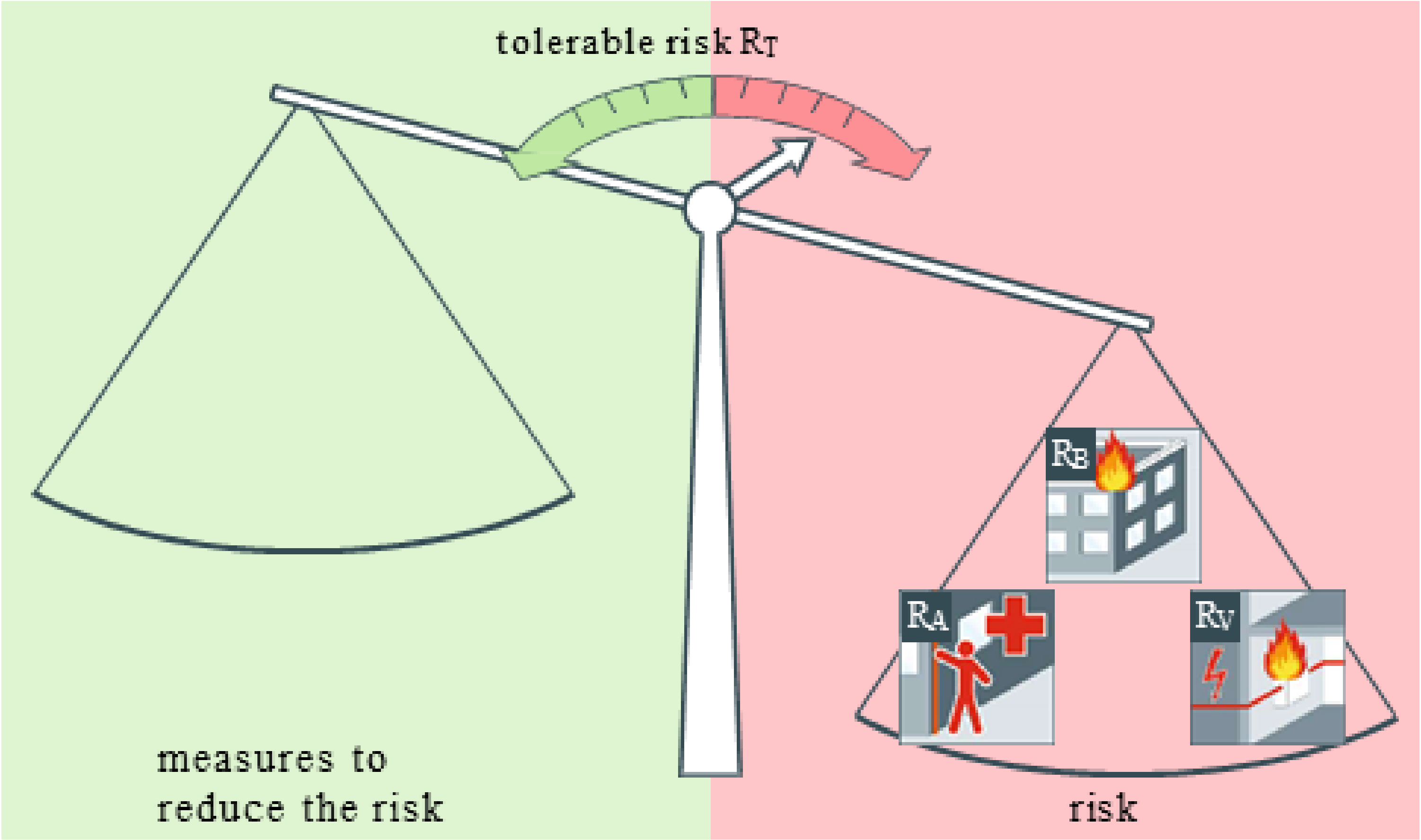
Lightning Risk Analysis

LP: Lightning Protection Level I, II, III & IV

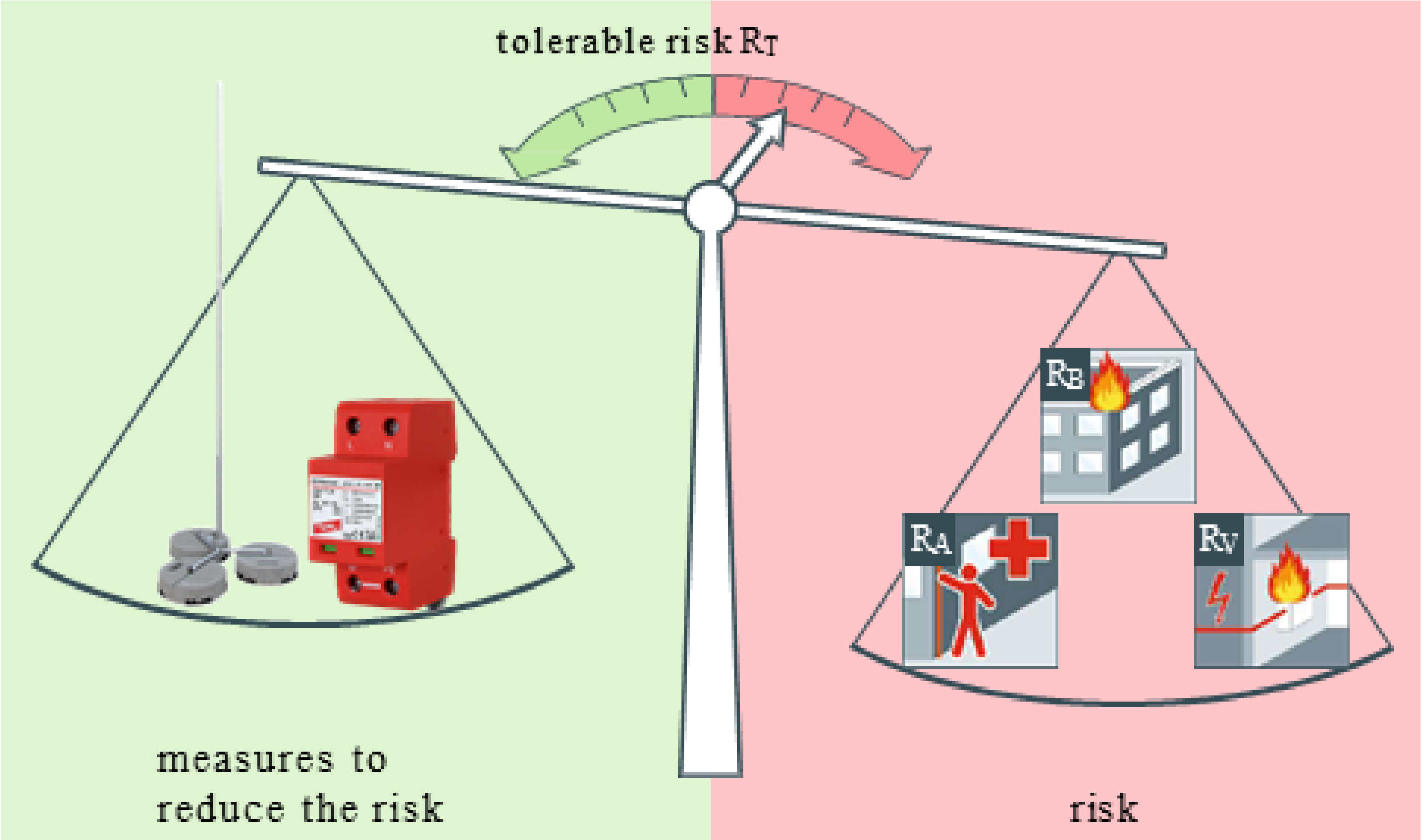
LPS: Lightning Protection System
SPM: Surge Protection Measures

Protection measures

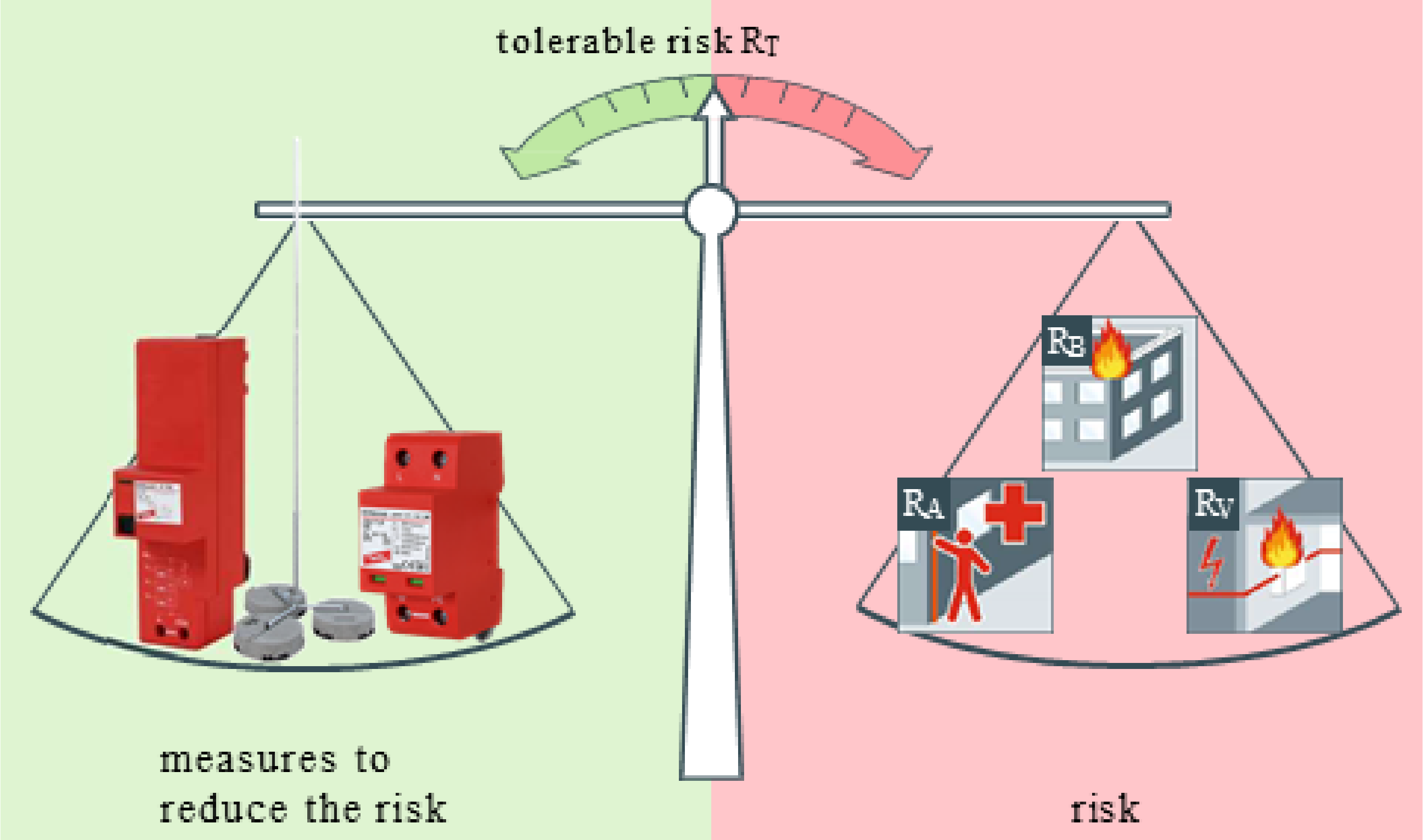
Protection goal: Reduction of the risk below the value of the tolerable risk R_T



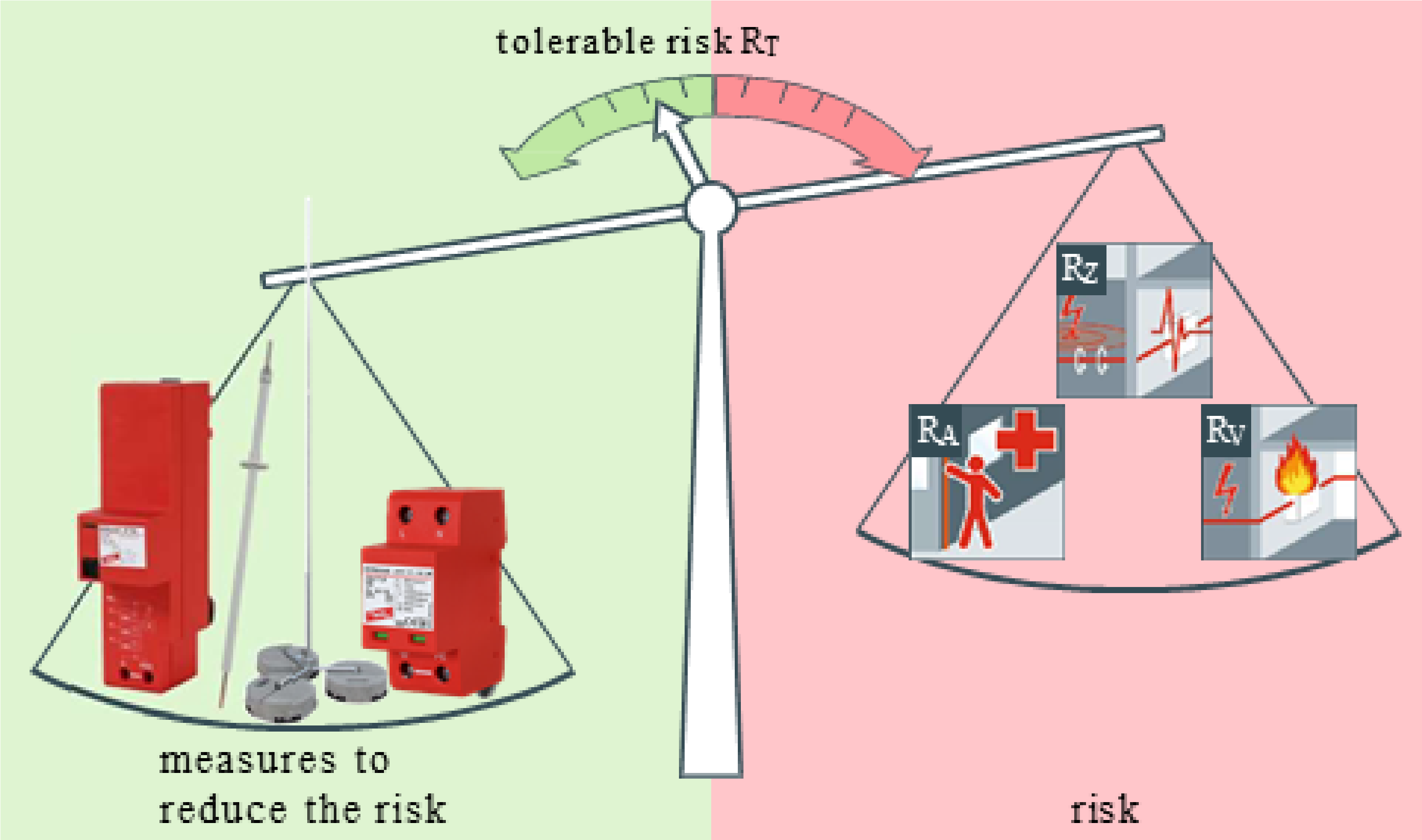
Protection goal: Reduction of the risk below the value of the tolerable risk R_T



Protection goal: Reduction of the risk below the value of the tolerable risk R_T



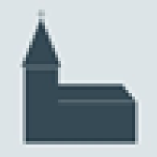
Protection goal: Reduction of the risk below the value of the tolerable risk R_T



Risk composition

Risks

The interaction of the before mentioned factors leads to the following risks of damage which have to be assessed for a building:

			R_T (1/year)
	R_1:	Risk of loss of human life (including permanent injury)	10^{-5}
	R_2:	Risk of loss of service to the public	10^{-3}
	R_3:	Risk of loss of cultural heritage	10^{-4}
	R_4:	Risk of loss of economic value	

Risk R_2
Service

Serivce – Service to the public Risk R_2	
Primary service	**Secondary service**
Gas	Banking
Water	Transportation service
Electricity	Trade
Telecommunication	Civil service
TV	Administration
	Industry
	Health sector
	Food industry
	Digital radio systems of security authorities (BOS)

Service does not only refer to basic needs, but also to the economic dependency on a material good.

Risk composition

Human life

Service

Cultural heritage

Economic value

R_1 | R_2 | R_3 | R_4

Each risk consists of several risk components

$$R_1 = R_A + R_B + R_C + R_M + R_U + R_V + R_W + R_Z$$

$$R_2 = R_B + R_C + R_M + R_V + R_W + R_Z$$

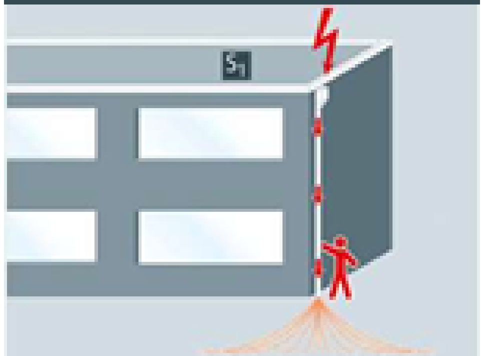
$$R_3 = R_B + R_V$$

$$R_4 = R_A + R_B + R_C + R_M + R_U + R_V + R_W + R_Z$$

Overview of the risk components R_X

Risk components R_A, R_B, R_C
Source of damage S_1

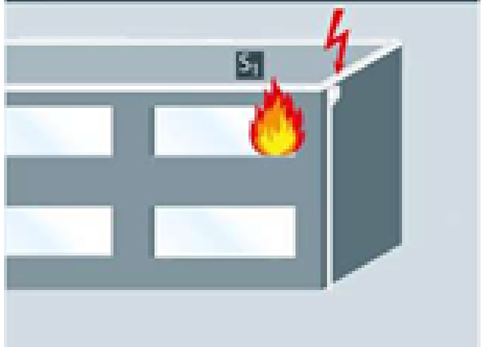
R_A = human life



Injury of human beings caused by touch and step voltage inside and outside the structure.

Possible types of damage:
L_1: human life
L_4: economic loss
(only in case of agricultural buildings)

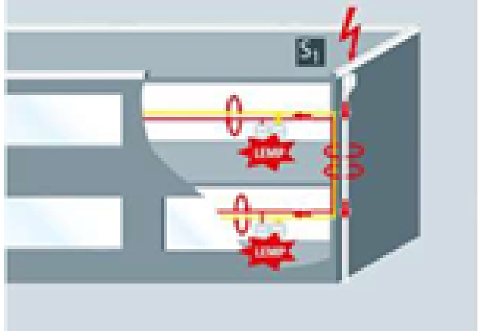
R_B = fire



Physical damage caused by dangerous sparking inside the structure resulting in fire and explosion.

Possible types of damage:
L_1: human life
L_2: service
L_3: cultural heritage
L_4: economic loss

R_C = overvoltage (LEMP)

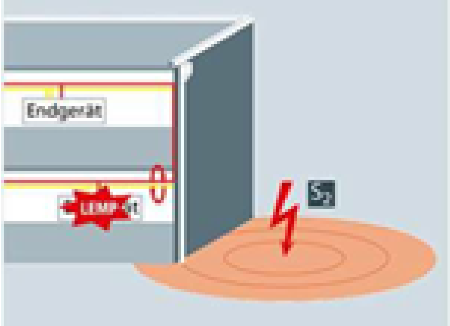


Failure of internal systems as a result of LEMP. Electro-magnetic effects of lightning currents.

Possible types of damage:
L_1: human life (systems in hazardous areas, hospitals)
L_2: service
L_4: economic loss

Risk component R_M
Source of damage S_2

R_M = overvoltage (LEMP)



Failure of internal systems as a result of LEMP. Electro-magnetic effects of lightning currents.

Possible types of damage:

L_1: human life (systems in hazardous areas, hospitals)

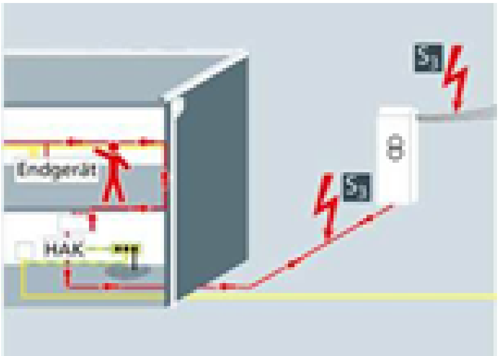
L_2: service

L_4: economic loss

©

Risk components R_U, R_V, R_W
Source of damage S_3

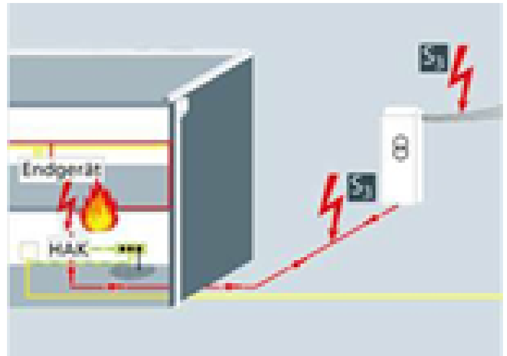
R_U = human life



Injury of human beings inside the structure caused by touch voltage resulting from injected lightning currents.

Possible types of damage:
L_1: human life
L_4: economic loss
(only in case of agricultural buildings)

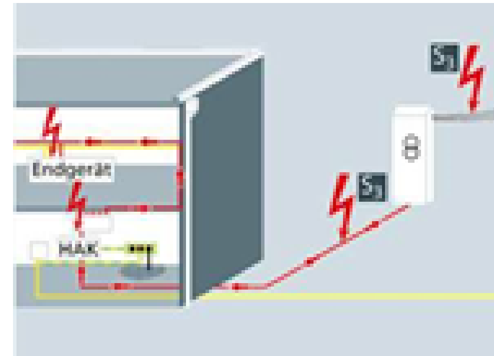
R_V = fire



Physical damage resulting from lightning currents injected into the structure via supply lines.

Possible types of damage:
L_1: human life
L_2: service
L_3: cultural heritage
L_4: economic loss

R_W = overvoltage

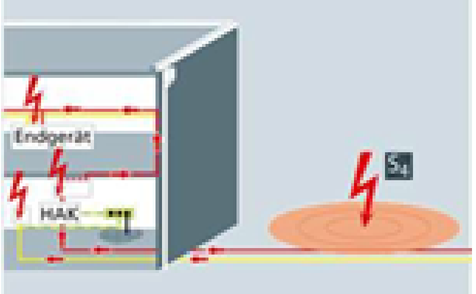


Failure of internal systems as a result of surges induced on the supply lines.

Possible types of damage:
L_1: human life (systems in hazardous areas, hospitals)
L_2: service
L_4: economic loss

Risk component R_Z – Overvoltage
Source of damage S_4

R_Z= overvoltage



Failure of internal systems as a result of surges induced on the supply lines which are injected into the structure.

Possible types ofdamage:

L_1: human life (systems in hazardous areas, hospitals)

L_2: service

L_4: economic loss

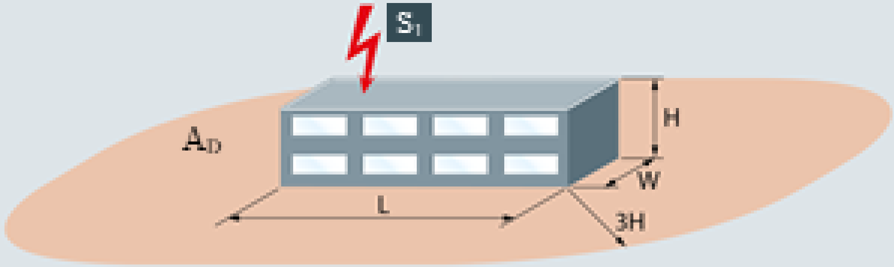
Risks, types of damage, causes of damage and risk components

Risk	Type of damage	Causes of damage	Risk components
R_1	Injury/death of persons (L1)	Electric shock (1)	R_A; R_U
		Fire, etc.	R_B; R_V
		Overvoltage (2)	R_C; R_M; R_W; R_Z
R_2	Loss of service to the public (L2)	Fire, etc.	R_B; R_V
		Overvoltage (3)	R_C; R_M; R_W; R_Z
R_3	Loss of cultural heritage (L3)	Fire, etc.	R_B; R_V
R_4	Loss of economic value (L4)	Electric shock (4)	R_A; R_U
		Fire, etc.	R_B; R_V
		Overvoltage	R_C; R_M; R_W; R_Z

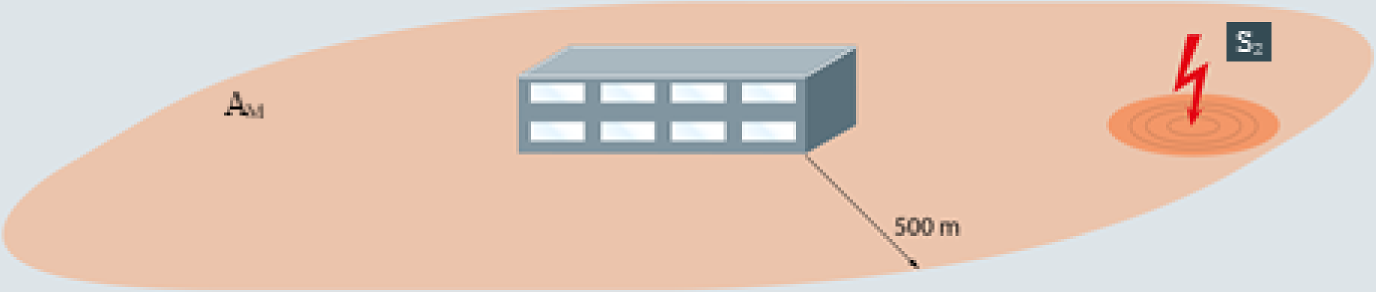
(2) If overvoltages directly threaten human lives (e.g. hospitals),
(3) If overvoltages directly threaten services (e. g. systems in sensitive electronic equipment),
(4) If touch and step voltages threaten animals (e.g. agricultural buildings).

Collection area for lightning strikes

Collection area A_D for lightning strikes to an isolated structure

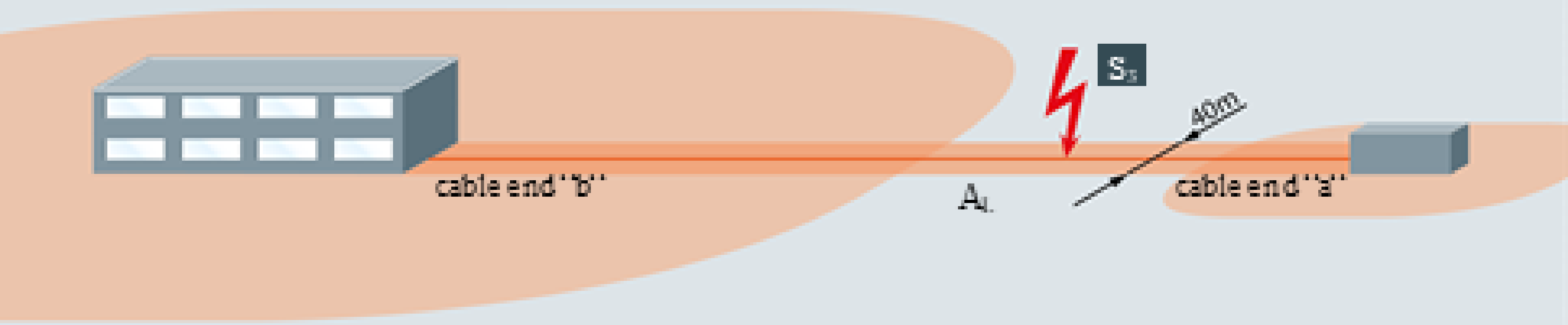


Collection area A_M for lightning strikes next to a structure



Collection area for lightning strikes

Collection area A_L for lightning strikes to a line

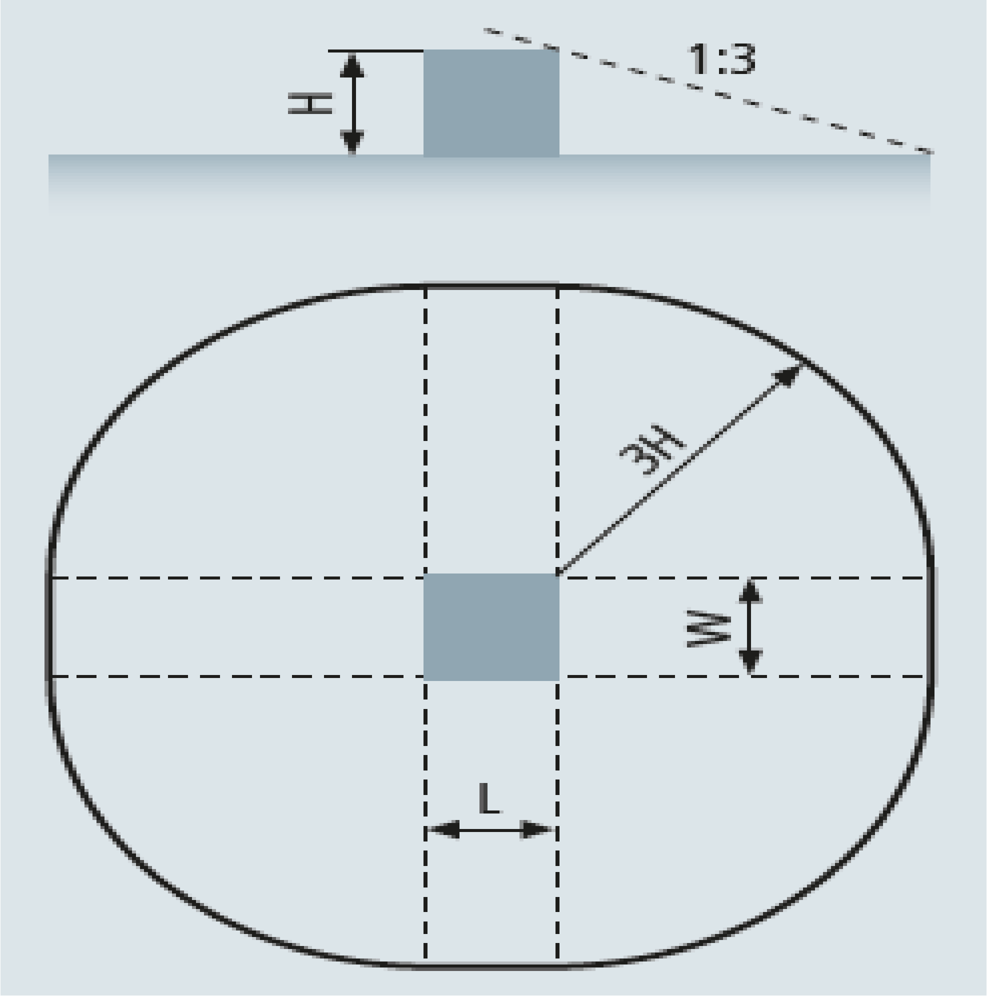


Collection area A_I for lightning strikes next to a line

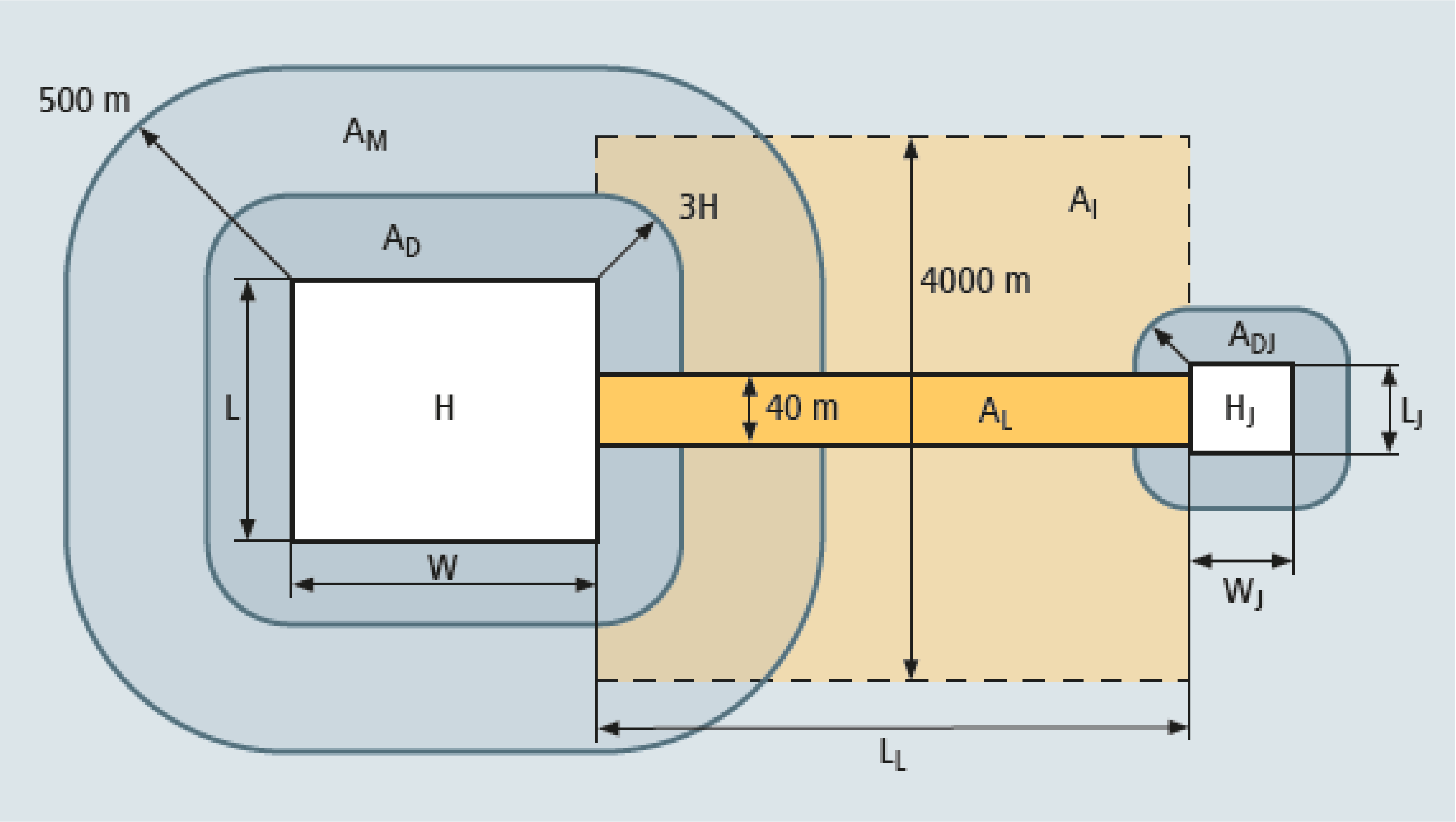
Collection area for lightning strikes

Collection area $A_{I/J}$ for lightning strikes to a connected structure

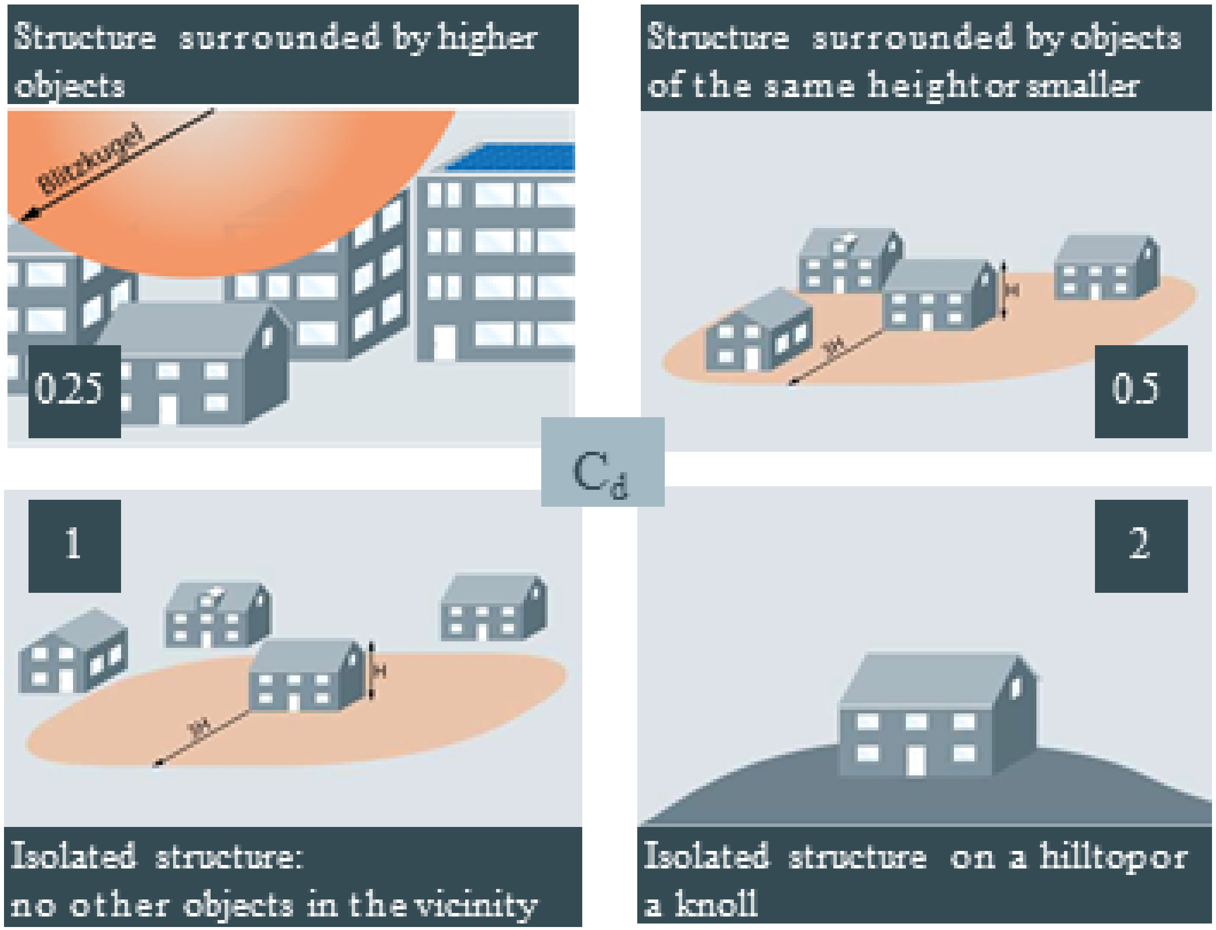
Equivalent collection area A_D for direct lightning strikes to an isolated structure



Equivalent collection area A_M, A_L , A_I for indirect lightning strikes to the structure

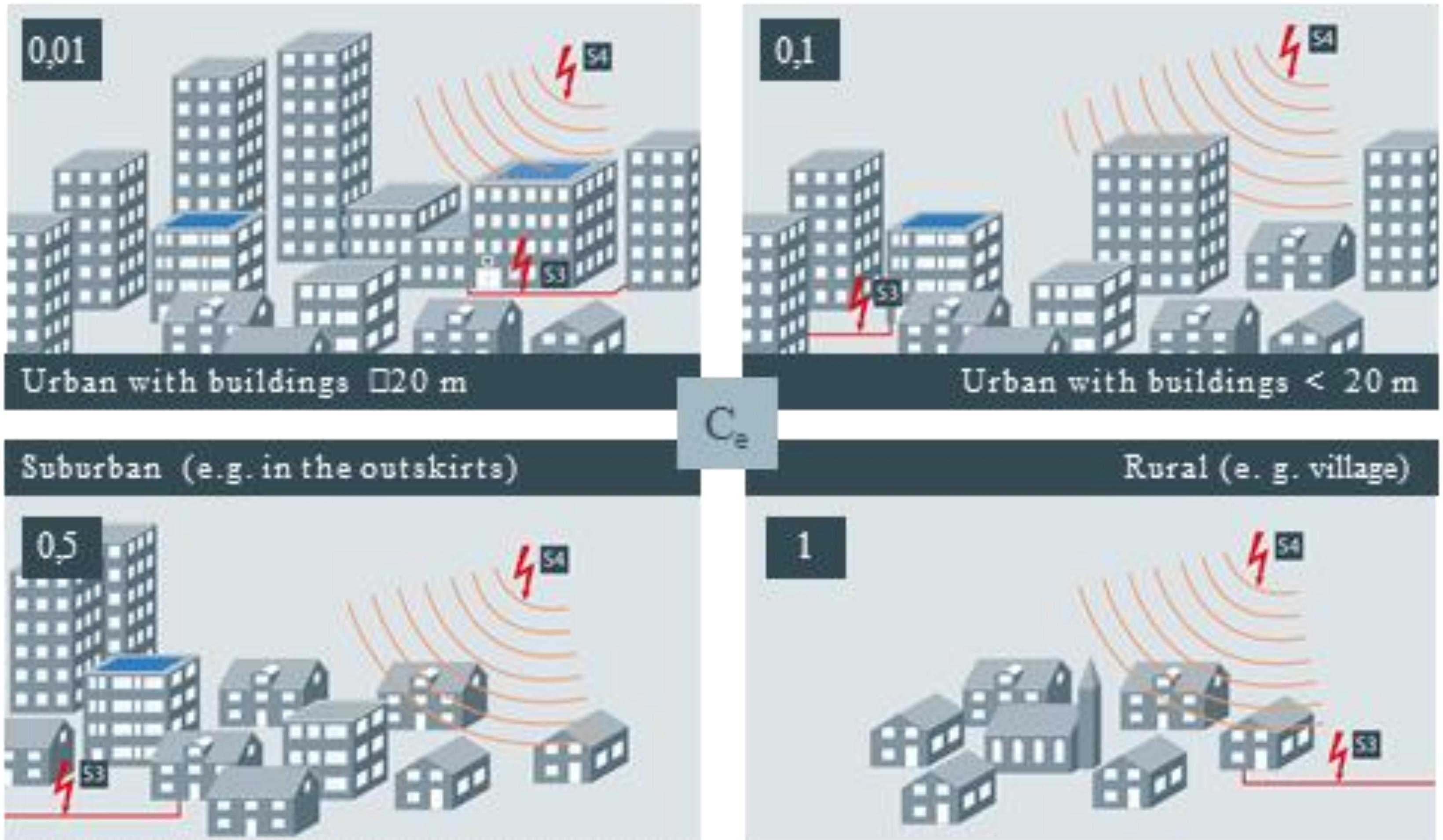


Location factor C_d for the structure



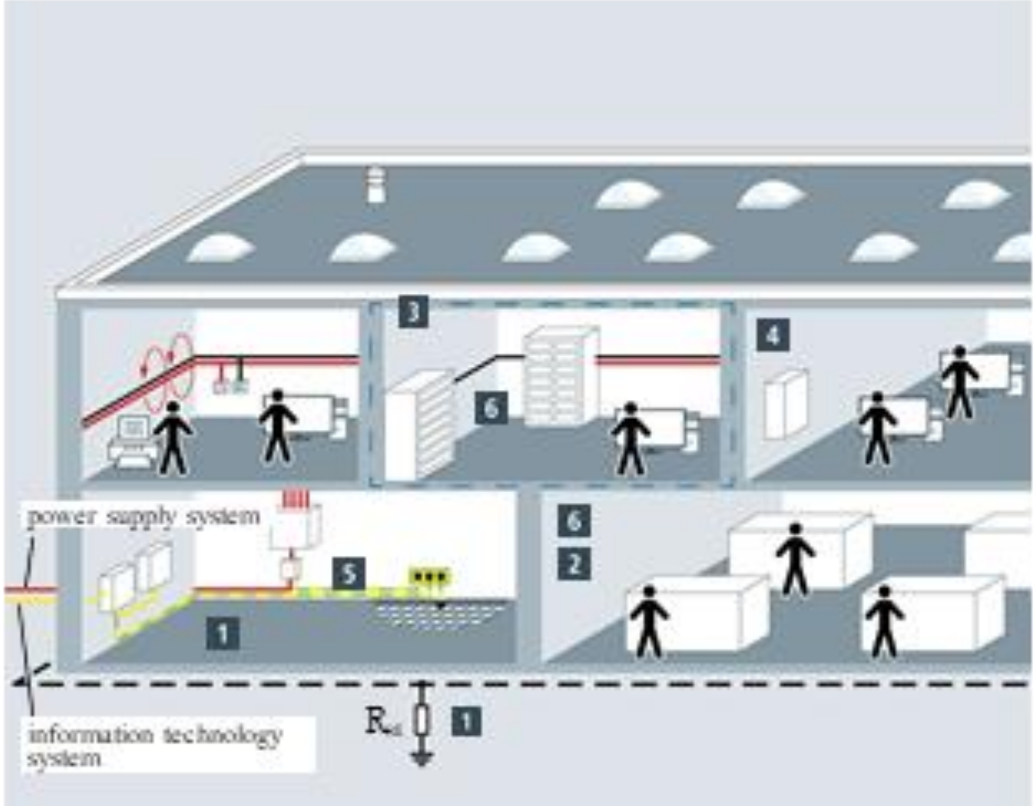
Note:
A more precise evaluation of the surrounding objects' influence can be obtained considering the relative height of the structure with respect to the surrounding objects or the ground within a distance of 3 x from the structure and assuming $C_d = 1$.

Location factor C_E for lines



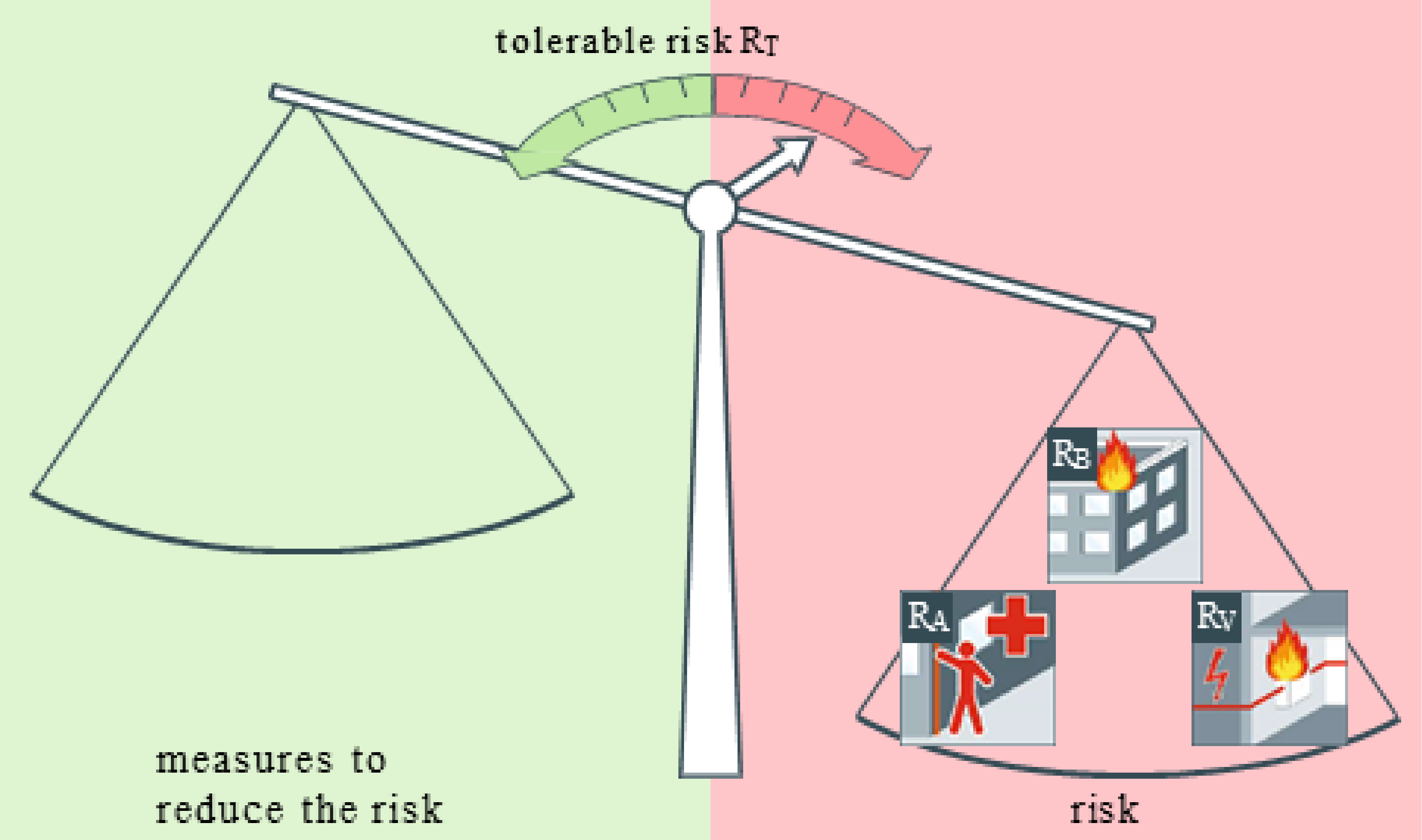
Administration and production building
Division into zones Z_S (areas)

Zones Z_S are mainly defined by:

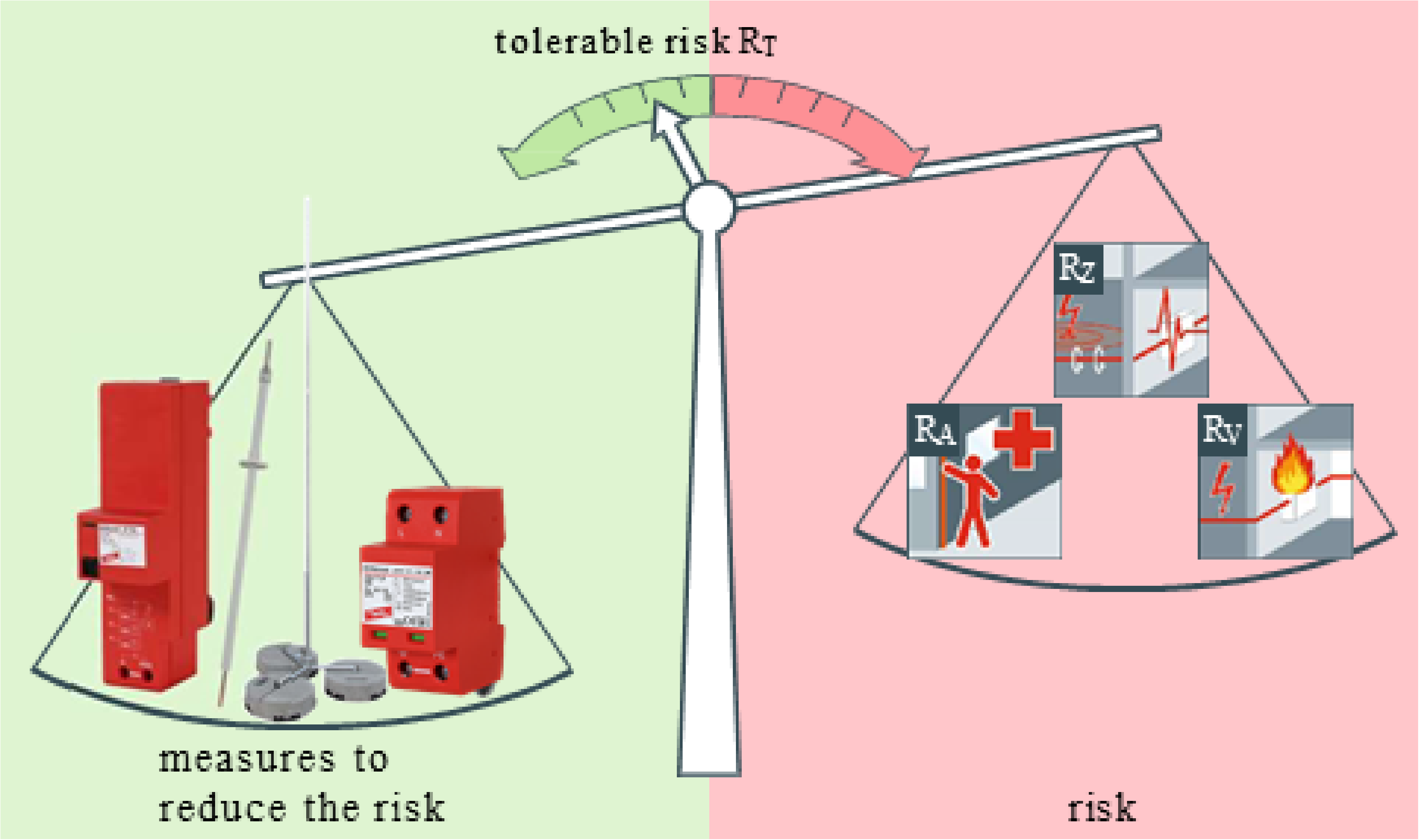


1. Type of soil or floor (risk components R_A and R_U)
2. Fireproof compartments (risk components R_B and R_V)
3. Spatial shields (risk components R_C and R_M)
4. Layout of internal systems (risk components R_C and R_M)
5. Existing protection measures or protection measures to be provided (all risk components)
6. Loss values L_X

Protection goal: Reduction of the risk below the value of the tolerable risk R_T



Protection goal: Reduction of the risk below the value of the tolerable risk R_T



Reduced Risk > tolerable Risk

$$R > R_T$$

What should I do,
if I could not reduce the Risk to a tolerable level?

Lightning and surge protection measures and their influences on the individual risk components

Properties of the structure or internal systems – Protection measures	R_A	R_B	R_C	R_M	R_U	R_V	R_W	R_Z
Physical restrictions, insulation, warning notice, potential control on the ground	•				•			
Lightning protection system (LPS)	•	•	•	• [a]	• [b]	• [b]		
Surge protective device for lightning equipotential bonding	•	•			•	•		
Isolating interfaces			• [c]	• [c]	•	•	•	•
Coordinated SPD system			•	•			•	•
Spatial shielding			•	•				
Shielding of external lines					•	•	•	•
Shielding of internal lines			•	•				
Routing precautions			•	•				
Equipotential bonding network			•					

[a] Only for grid-like external LPS
[b] Due to equipotential bonding
[c] Only if they belong to equipment to be protected

4. Exercises

Exercise

Carry out a risk assessment exercise on the following hospital

Risk Assessment type: R1

Hospital and Detailed Parameters
GFD = 0.7 strikes/yr/km2

L_b	Length:	50.00 m
W_b	Width:	150.00 m
H_b	Height:	10.00 m
H_{pb}	Highest point (if applicable):	10.00 m

The environment surrounding the structure is an important factor for determining the number of possible direct / indirect lightning strikes. This is defined as follows for the structure Hospital without measures:
Relative location C_{db}: 1.00

Hospital and Detailed Parameters

Division of the structure into lightning protection zones/zones

- LPZ 0B - Structure protected against direct lightning strikes
  - zone 1 outside building
- LPZ 1 - Inner zone of the protected structure
  - zone 2 rooms block
  - zone 3 operating blook
  - zone 4 intensive care unity

Hospital and Detailed Parameters

Supply lines

- Internal power system and relevant incoming power line characteristics
- Internal telecom system and relevant incoming line characteristics

5.1 Internal power system and relevant incoming power line characteristics

Line type:	Aerial
Ground resistance:	200.00
Relative location:	Object is surrounded by objects or trees of the same height or smaller
Environment:	Suburban (buildings smaller than 10 m)
Transformer:	Supply with double-winding transformer - conductor with HV/LV isolation transformer

The conductor length outside the structure up to the next node is 500.00 m.

Hospital and Detailed Parameters

Supply lines

The dielectric strength of the electrical equipment which is connected with the Internal power system and relevant incoming power line characteristics was defined per zone:

	Internal power system and relevant incoming power line characteristics - Uw
zone 1 outside building	2.5 kV < Uw <= 4.0 kV
zone 2 rooms block	2.5 kV < Uw <= 4.0 kV
zone 3 operating blook	2.5 kV < Uw <= 4.0 kV
zone 4 intensive care unity	2.5 kV < Uw <= 4.0 kV

Hospital and Detailed Parameters

Supply lines

The conductors in the building of the Internal power system and relevant incoming power line characteristics are installed per zone:

	Internal power system and relevant incoming power line characteristics - pint
zone 1 outside building	Unshielded cables - precautions taken to prevent large installtion loops
zone 2 rooms block	Unshielded cables - precautions taken to prevent large installtion loops
zone 3 operating blook	Unshielded cables - precautions taken to prevent large installtion loops
zone 4 intensive care unity	Unshielded cables - precautions taken to prevent large installtion loops

Supply lines

5.2 Internal telecom system and relevant incoming line characteristics

Line type:	Buried
Ground resistance:	200.00
Relative location:	Object is surrounded by objects or trees of the same height or smaller
Environment:	Suburban (buildings smaller than 10 m)
Transformer:	Supply line only - line without transformer

The conductor length outside the structure up to the next node is 300.00 m.

Hospital and Detailed Parameters

Supply lines

	Internal telecom system and relevant incoming line characteristics - Uw
zone 1 outside building	1.5 kV < Uw <= 2.5 kV
zone 2 rooms block	1.5 kV < Uw <= 2.5 kV
zone 3 operating blook	1.5 kV < Uw <= 2.5 kV
zone 4 intensive care unity	1.5 kV < Uw <= 2.5 kV

The conductors in the building of the Internal telecom system and relevant incoming line characteristics are installed per zone:

	Internal telecom system and relevant incoming line characteristics - pint
zone 1 outside building	Unshielded cables - precautions taken to prevent installation loops
zone 2 rooms block	Unshielded cables - precautions taken to prevent installation loops
zone 3 operating blook	Unshielded cables - precautions taken to prevent installation loops
zone 4 intensive care unity	Unshielded cables - precautions taken to prevent installation loops

Hospital and Detailed Parameters

6. Properties of the structure

6.1 Risk of fire

The risk of fire is one of the most important criteria for determining whether an LPS (lightning protection system) must be installed. The risk of fire is classified according to the specific fire load. The fire load should be determined by a fire safety expert or defined after consultation with the proprietor of the building and his / her insurance company. A distinction is made according to the following criteria:

- None
- Low (specific fire load in the building less than 400 MJ/m²)
- Ordinary (specific fire load in the building between 400 MJ/m² and 800 MJ/m²)
- High (specific fire load in the building greater than 800 MJ/m²)
- Explosion: zone 2 / 22
- Explosion: zone 1 / 21
- Explosion: zone 0 / 20

The risk of fire in a structure is an important factor for determining the required protection measures. The risk of fire for the structure Hospital with measures, first solution was defined as follows:

Hospital and Detailed Parameters

	Z1	Z2	Z3	Z4
None	☑	☐	☐	☐
Low (sports stadium, railway station, telephone exhange)	☐	☐	☑	☑
Ordinary (office, school, theatre, hotel, museum, shop)	☐	☑	☐	☐
High (paper mill, industrial warehouse with flammable stock)	☐	☐	☐	☐
Explosion (petrochemical plant, ammunition store, gas compound)	☐	☐	☐	☐

Hospital and Detailed Parameters

6.2 Measures to reduce the consequences of a fire

The following measures were selected to reduce the consequences of a fire:

	Z1	Z2	Z3	Z4
No measures	☑	☑	☑	☑
Fire extinguishers, manual fire alarm system, hydrants, fire-proof compartments, protected escape routes	☐	☐	☐	☐
Automatic fire extinguishing system/fire alarm system	☐	☐	☐	☐

Hospital and Detailed Parameters

6.3 Special hazards in the building for persons

Due to the number of persons, the possible risk of panic for the structure Hospital with measures, first solution was defined as follows:

	Z1	Z2	Z3	Z4
No specific threat	☑	☐	☐	☐
Low danger of panic (up to approx. 100 persons)	☐	☐	☐	☐
Average danger of panic (from approx 100 to approx. 1000 persons)	☐	☑	☑	☑
Evacuation problems (persons in need of help)	☐	☐	☐	☐
High danger of panic (from approx. 1000 persons)	☐	☐	☐	☐
Threat for surrounding area or environment	☐	☐	☐	☐
Contamination of surrounding area or environment	☐	☐	☐	☐

Hospital and Detailed Parameters

Spatial shielding attenuates the magnetic field within a structure caused by lightning strikes to or near the object and reduces internal surges.
This can be achieved by an intermeshed equipotential bonding network in which all conductive parts of the structure and the internal systems are integrated. Consequently, the external / internal spatial shield is only a part of a shielded building structure. It must be observed that metal coverings and claddings are connected to one another and conductively to the equipotential bonding of the building. In this context, the relevant normative requirements must be observed.

Covering of the structure Hospital with measures, first solution:

- No shielding

Suggested Protection Measures – Solution 1

The risk was reduced to an acceptable level by selecting the following protection measures.

This selection of protection measures is part of the risk management for the object Hospital with measures, first solution and is only valid in connection with this object.

Measures Hospital with measures, first solution:

Area		Measures	Factor
	pB:	Lightning protection system (LPS) Class of LPS II	5.000E-02
		Internal power system and relevant incoming power line characteristics:	
	pEB:	Lightning equipotential bonding Improved equipotential bonding for LPL II	2.000E-03
		Internal telecom system and relevant incoming line characteristics:	
	pEB:	Lightning equipotential bonding Improved equipotential bonding for LPL II	2.000E-03

Suggested Protection Measures – Solution 1

LPZ 1:

zone 2 rooms block

rp:	Fire precautions Automatic fire extinguishing system/fire alarm system	2.000E-01
	<u>Internal power system and relevant incoming power line characteristics:</u>	
pSPD:	Coordinated SPD system Improved SPD protection according to LPL II	2.000E-03
	<u>Internal telecom system and relevant incoming line characteristics:</u>	
pSPD:	Coordinated SPD system Improved SPD protection according to LPL II	2.000E-03

zone 3 operating blook

KS2:	Internal spatial shielding Mesh-like shield	6.000E-02
KS2W:	Mesh size	0.5

Suggested Protection Measures – Solution 1

		Internal power system and relevant incoming power line characteristics:	
	pSPD:	Coordinated SPD system Improved SPD protection according to LPL II	2.000E-03
		Internal telecom system and relevant incoming line characteristics:	
	pSPD:	Coordinated SPD system Improved SPD protection according to LPL II	2.000E-03
zone 4 intensive care unity			
	KS2:	Internal spatial shielding Mesh-like shield	6.000E-02
	KS2W:	Mesh size	0.5
		Internal power system and relevant incoming power line characteristics:	
	pSPD:	Coordinated SPD system Improved SPD protection according to LPL II	2.000E-03
		Internal telecom system and relevant incoming line characteristics:	
	pSPD:	Coordinated SPD system Improved SPD protection according to LPL II	2.000E-03

Suggested Protection Measures – Solution 2

Change from Class II to I