

Lightning protection risk management calculations

To IS IEC 62305-2:2012 (Edition 2)

Full case report

Project name:	Acme Ozone Tower 1
Project ref:	PDA
Case name:	Solution
Client:	Lodha
Prepared by:	SC
Issue date:	04/06/2021

Project details

Project name:	Acme Ozone Tower 1
Client:	Lodha
Standard:	IS IEC 62305-2:2012 (Edition 2)
Project address:	Mumbai, Maharashtra
Project ref:	PDA
Calculation ref:	IS IEC 62305:2
Calculation notes:	
Project author:	SC
Created:	04/06/2021
Modified:	

Case details

Case name:	Solution
Case title:	Acme Ozone Tower 1
Case notes:	Assumption: Lightning Flash Density - 16/year. Structure Dimensions - 46 x 21 x 122. Incoming power line Shielding - Yes. Type of Flooring - Carpet / Marble Risk of Fire - Ordinary Fire Protection - Automatic Sprinkler

The following primary risks and their relevant tolerable risks have been taken into consideration as part of this risk management calculation

R_1	7.5383E-06	Risk of loss of human life in the structure. The tolerable risk of 1E-05 is not exceeded based on the application of the protection measures listed below.
R_2	3.7126E-04	Risk of loss of service to the public in the structure The tolerable risk of 0.001 is not exceeded based on the application of the protection measures listed below.

Protection system design parameters

Structural LPS	Requirement for a structural lightning protection system (LPS) and where necessary the chosen Lightning protection level (LPL)
	Lightning protection level (LPL) I
Imax	Maximum peak current
	200 kA
ProbImax	Probability that lightning current parameters are smaller than the maximum value defined above

	99%
Imin	Minimum peak current
	3 kA
ProbImin	Probability that lightning current parameters are greater than the minimum value defined above
	99%
r	Radius of rolling sphere
	20 m
I_{SPD}	Maximum peak current of SPDs for each of the 1 lines considered (based on the simple current division concept).
	NOTE: The worst case surge that could be expected on a two-wire telephone or data line is 2.5kA (10/350 µs) per line (Category D test to IEC/EN 61643-21) to earth or 5 kA (10/350 µs) per pair.
	100 kA

Line 1

Power Line Typical

Service entrance SPD	Requirement to protect Line 1 at its entrance to the structure with an equipotential bonding SPD (rated to ISPD above) in accordance with IS IEC 62305 Part 2 :2012 (Edition 2)
	NOTE: Where SPDs are required but an LPS is not (ISPD = 0), protect overhead lines with Type 1 SPDs (mains 12.5kA 10/350µs, data/telecom 2.5kA 10/350µs), protect underground lines with overvoltage or Type 2 SPDs (tested with an 8/20 µs waveform)
	Lightning protection level (LPL) I
Coordinated SPD set	Requirement to protect all internal systems connected to Line 1 with a coordinated set of SPDs in accordance with IS IEC 62305 Part 2 :2012 (Edition 2)
	None

Zone 1

Internal

Fire protection system	Automatic extinguishing or alarm installations

Environmental factors

N_G	1.6	Lightning ground flash density (Flashes/km²/year)

C_D	0.5	Location factor
C_E	0	Environmental factor
Rho	500	Soil resistivity (Ohm metres)

Primary structure

Structure ID: 1 - Primary Structure

L_b	46 m	Length of structure (metres)
W_b	21 m	Width of structure (metres)
H_b	122 m	Height of structure (metres)

Line factors

Line 1 - Power Line Typical

K_{S3}	1	Factor relevant to the characteristics of internal wiring
P_{SPD}	0.01	Probability of failure of internal systems or a service when coordinated SPDs are provided
U_W	6 kV	Rated impulse withstand voltage of a system (kV)
C_{LD}	1	Factor depending on shielding, grounding and isolation conditions of the line for flashes to a line
C_{LI}	1	Factor depending on shielding, grounding and isolation conditions of the line for flashes near a line
Type	1	
Connected structure:		
L_L (Section 1)	500 m	Length of line section (metres)
L_H (Section 1)	0 m	Height of line section (metres)
C_T (Section 1)	0.2	Factor taking into account the presence of an HV/LV transformer on a line section
C_I (Section 1)	0.5	Factor relating to the routing of a line section

Zone factors

n_{t2}	0	Total number of users served by the structure

Zone 1 - Internal

Zone Location		Inside the structure LPZ 1...n
r_p	2E-01	Factor reducing the loss due to provisions against fire in zone
r_f	1E-02	Factor reducing the loss due to the risk of fire in zone
r_t	1E-03	Factor reducing the loss due to the type of floor/surface in zone
h_{z1}	5E00	Factor increasing the loss of human life due to presence of special hazard in zone
L_{T1}	1E-04	Loss due to injury due to touch and step voltages in zone
L_{F1}	1E-01	Loss to structure due to physical damage in zone
L_{O1}	0E00	Loss to structure due to failure of internal systems in zone
L_{F2}	1E-01	Loss to structure due to physical damage in zone
L_{O2}	1E-03	Loss to structure due to failure of internal systems in zone

n_{z2}	0	Number of users served by zone

Assessment of Ax - Collection areas

Primary Structure

A_D	4,70,845.19 m²	Collection area of structure (square metres)
A_M	2,30,815.54 m²	Collection area of surrounding ground (square metres)
A_L	2,996.33 m²	Collection area of flashes striking line (square metres)
A_I	2,79,508.50 m²	Collection area of flashes near line (square metres)

Line 1 - Power Line Typical (Section 1)

A_L	2,996.33 m²	Collection area of flashes striking line (square metres)
A_I	2,79,508.50 m²	Collection area of flashes near line (square metres)

Assessment of Nx - Annual number of dangerous events

Primary Structure

N_D	3.7668E-01	Average number of flashes to main structure
N_M	-7.3713E-03	Average number of flashes to surrounding ground

Line 1 - Power Line Typical (Section 1)

N_L	4.7941E-04	Average number of flashes to line
N_I	0E00	Average number of flashes near line

Line 1 - Power Line Typical

N_L	4.7941E-04	Average number of flashes to line
N_I	0E00	Average number of flashes near line

Assessment of Px - Probability of damage for a structure

P_B	2E-02	Probability that a flash to a structure will cause physical damages
P_C	1E00	Probability that a lightning flash near to the structure will cause failure of internal systems
K_{S1}	1E00	Factor relating to screening effectiveness of the structure

Zone 1 - Internal

P_{TA}	1E00	Probability that lightning will cause injuries to living beings
P_A	1E00	Probability that lightning will cause injuries to living beings present in zone
K_{S2}	1E00	Factor relating to screening effectiveness of shields internal to the structure
P_M	9.4E-01	Probability that a lightning flash near to the structure will cause failure of internal systems

Zone 1 - Internal (Power Line Typical)

P_{MS}	9.4E-01	Probability of failure of internal systems (with protection measures) associated with line
P_M	9.4E-01	Probability that a lightning flash near to the structure will cause failure of internal systems
P_U	1E-02	Probability that injuries of living beings will be caused by a flash to line

Line 1 - Power Line Typical

P_C	1E00	Probability that a lightning flash near to the structure will cause failure of internal systems
K_{S3}	1E00	Factor relevant to the characteristics of internal wiring
K_{S4}	2.5E-01	Factor relating to the impulse withstand voltage of a system associated with line
P_{LD}	2E-02	Probability of failure of internal systems (flashes to a connected service) associated with line
P_{LI}	2E-03	Probability of failure of internal systems (flashes near a connected service) associated with line
P_V	1E-02	Probability that physical damage will be caused by a flash to line
P_W	2E-02	Probability that failure of internal systems will be caused by a flash to line
P_Z	2E-03	Probability that failure to internal systems will be caused by a flash near to line

Assessment of Lx - Amount of loss for a structure

Zone 1 - Internal

L_{A1}	1E-07	Loss related to injury to living beings in zone
L_{B1}	1E-03	Loss in a structure related to physical damage (flashes to structure) in zone
L_{C1}	0E00	Loss related to failure of internal systems (flashes to structure) in zone
L_{M1}	0E00	Loss related to failure of internal systems (flashes near structure) in zone
L_{U1}	1E-07	Loss related to injury of living beings (flashes to service) in zone
L_{V1}	1E-03	Loss in a structure due to physical damage (flashes to service) in zone
L_{W1}	0E00	Loss related to failure of internal systems (flashes to service) in zone
L_{Z1}	0E00	Loss related to failure of internal systems (flashes near a service) in zone
L_{B2}	2E-04	Loss in a structure related to physical damage (flashes to structure) in zone
L_{C2}	1E-03	Loss related to failure of internal systems (flashes to structure) in zone
L_{M2}	1E-03	Loss related to failure of internal systems (flashes near structure) in zone
L_{V2}	2E-04	Loss in a structure due to physical damage (flashes to service) in zone
L_{W2}	1E-03	Loss related to failure of internal systems (flashes to service) in zone
L_{Z2}	1E-03	Loss related to failure of internal systems (flashes near a service) in zone

Assessment of Rx - Risk components

Zone 1 - Internal

R_{A1}	0E00	Risk component of risk R1 due to injury to living beings (D1) caused by flashes to a structure (S1) in zone

R_{B1}	7.5335E-06	Risk component of risk R1 due to physical damage to a structure (D2) caused by flashes to a structure (S1) in zone
R_{C1}	0E00	Risk component of risk R1 due to failure of internal systems (D3) caused by flashes to a structure (S1) in zone
R_{M1}	0E00	Risk component of risk R1 due to failure of internal systems (D3) caused by flashes near a structure (S2) in zone
R_{B2}	1.5067E-06	Risk component of risk R2 due to physical damage to a structure (D2) caused by flashes to a structure (S1) in zone
R_{C2}	3.7668E-04	Risk component of risk R2 due to failure of internal systems (D3) caused by flashes to a structure (S1) in zone
R_{M2}	-6.929E-06	Risk component of risk R2 due to failure of internal systems (D3) caused by flashes near a structure (S2) in zone

Zone 1 - Internal (Line 1 - Power Line Typical)

R_{U1}	4.7941E-13	Risk component of risk R1 due to injury to living being (D1) caused by flashes to a connected service (S3) associated with line
R_{V1}	4.7941E-09	Risk component of risk R1 due to physical damage to structure (D2) caused by flashes to a connected service (S3) associated with line
R_{W1}	0E00	Risk component of risk R1 due to failure of internal systems (D3) caused by flashes to a connected service (S3) associated with line
R_{Z1}	0E00	Risk component of risk R1 due to failure of internal systems (D3) caused by flashes near a service (S4) associated with line
R_{V2}	9.5883E-10	Risk component of risk R2 due to physical damage to structure (D2) caused by flashes to a connected service (S3) associated with line
R_{W2}	9.5883E-09	Risk component of risk R2 due to failure of internal systems (D3) caused by flashes to a connected service (S3) associated with line
R_{Z2}	0E00	Risk component of risk R2 due to failure of internal systems (D3) caused by flashes near a service (S4) associated with line

Primary risk totals

R_{1_T}	7.5383E-06	Risk of loss of human life in the structure.
R_{2_T}	3.7126E-04	Risk of loss of service to the public in the structure

Primary risk totals with respect to source of damage

R_{1_D}	7.5335E-06	Risk of loss of human life in the structure due to flashes to the structure (S1)
R_{2_D}	3.7818E-04	Risk of loss of service to the public in the structure due to flashes to the structure (S1)
R_{1_I}	4.7946E-09	Risk of loss of human life in the structure due to flashes influencing, but not striking the structure (S2, S3, & S4)
R_{2_I}	-6.9185E-06	Risk of loss of service to the public in the structure due to flashes influencing, but not striking the structure (S2, S3, & S4)

Primary risk totals with respect to type of damage

R_{1_S}	4.7941E-13	Risk of loss of human life in the structure due to injury to living beings (D1)

R_{2_S}	0E00	Risk of loss of service to the public in the structure due to injury to living beings (D1)
R_{1_F}	7.5383E-06	Risk of loss of human life in the structure due to physical damage (D2)
R_{2_F}	1.5077E-06	Risk of loss of service to the public in the structure due to physical damage (D2)
R_{1_O}	0E00	Risk of loss of human life in the structure due to failure of internal systems (D3)
R_{2_O}	3.6976E-04	Risk of loss of service to the public in the structure due to failure of internal systems (D3)