



Lightning protection risk management calculations
To BS EN 62305-2:2012 (Edition 2)
Full case report

Project name: OTH - Albert Memorial
Project ref:
Case name: Albert Memorial
Client:
Prepared by:
Issue date: 31/01/2024



Project details

Project name: OTH - Albert Memorial

Client:

Standard: BS EN 62305-2:2012 (Edition 2)

Project address:

Project ref:

Calculation ref:

Calculation notes:

Project author:

Created: 18/01/2024

Modified: 31/01/2024

Case details

Case name: Albert Memorial

Case title: OTH - Albert Memorial

Case notes: Albert Memorial is the largest monument in Albert Square. It is Grade I listed.
The memorial is a ciborium, containing a marble statue on a plinth inside.
The memorial is topped with a spire and a crocketed gable with canopied pinnacles on colonettes on each side.

Loss of cultural heritage (L3) and economic loss (L4) are relevant for this type of structure.

The risk (R3) for loss of cultural heritage (L3) is determined based on the risk components R_B3 and R_V3 (according to BS EN 62305-2 Table 2).
This risk is then compared with the tolerable risk (R_T3) of 1×10^{-4} (according to BS EN 62305-2 Table NF.1).

The risk (R4) for loss of economic value (L4) is determined based on the risk components R_B, R_C, R_M, R_V, R_W and R_Z.

Suitable protection measures will be selected to reduce the risk to or below the tolerable risk.

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

<i>R</i> ₃	0E00	Risk of loss of cultural heritage in the structure This risk has not been determined
<i>R</i> ₄	0E00	Risk of loss of economic value in the structure

Protection system design parameters

Structural LPS Requirement for a structural lightning protection system (LPS) and where necessary the chosen Lightning protection level (LPL)

None



*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.

0 kA

Line 1

External lighting circuit

Service entrance SPD Requirement to protect Line 1 at its entrance to the structure with an equipotential bonding SPD (rated to *I*_{SPD} above) in accordance with BS EN 62305-2:2012 (Edition 2)

NOTE: Where SPDs are required but an LPS is not (*I*_{SPD} = 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)

None

Coordinated SPD set Requirement to protect all internal systems connected to Line 1 with a coordinated set of SPDs in accordance with BS EN 62305-2:2012 (Edition 2)

None

Zone 1

Inside the memorial

Fire protection system None or risk of explosion

Zone 2

Outside the memorial

Fire protection system None or risk of explosion

Environmental factors

<i>N</i> _G	0.8	Lightning ground flash density (Flashes/km ² /year)
<i>C</i> _D	0.25	Location factor
<i>C</i> _E	0.01	Environmental factor

Primary structure

Structure ID: 1 - Primary Structure

*L*_b 6 m Length of structure (metres)



W_b	6 m	Width of structure (metres)
H_e	17.28 m	Height to eaves of structure
H_r	23.5 m	Height to ridge of structure

Line factors

Line 1 - External lighting circuit

K_{S3}	1	Factor relevant to the characteristics of internal wiring
P_{EB}	1	Probability of failure of internal systems or a service when SPDs are provided for equipotential bonding (in accordance with BS EN 62305-3)
P_{SPD}	1	Probability of failure of internal systems or a service when coordinated SPDs are provided
U_w	1 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)	100 m	Length of line section (metres)
L_H (Section 1)	0 m	Height of line section (metres)
C_T (Section 1)	1	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

C_{I3}	£2,000,000.00	Total value of cultural heritage (building & contents) of the structure
C_{I4}	£1,050,000.00	Total value of the structure for animals, building, content and internal systems including their activities
i	0.10%	Interest rate
a	0.10%	Amortization rate
m	0.10%	Maintenance rate

Zone 1 - Inside the memorial

Zone Location		Inside the structure LPZ 1...n
r_p	1E00	Factor reducing the loss due to provisions against fire in zone
r_f	0E00	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_{z4}	1E00	Factor increasing the loss of economic value due to presence of special hazard in zone
L_{F3}	1E-01	Loss to structure due to physical damage in zone
L_{T4}	0E00	Loss due to injury due to touch and step voltages in zone



L_{F4}	5E-01	Loss to structure due to physical damage in zone
L_{O4}	1E-03	Loss to structure due to failure of internal systems in zone
C_{z3}	£1,000,000.00	Value of cultural heritage in zone
C_{a4}	£0.00	Cost of animals in zone
C_{b4}	£1,000,000.00	Cost of building in zone
C_{c4}	£0.00	Cost of contents in zone
C_{s4}	£0.00	Cost of internal systems in zone

Zone 2 - Outside the memorial

Zone Location		Outside the structure LPZ 0A...0B
r_p	1E00	Factor reducing the loss due to provisions against fire in zone
r_f	1E-03	Factor reducing the loss due to the risk of fire in zone
r_t	1E-02	Factor reducing the loss due to the type of floor/surface in zone
h_{z4}	1E00	Factor increasing the loss of economic value due to presence of special hazard in zone
L_{F3}	1E-01	Loss to structure due to physical damage in zone
L_{T4}	0E00	Loss due to injury due to touch and step voltages in zone
L_{F4}	5E-01	Loss to structure due to physical damage in zone
L_{O4}	1E-02	Loss to structure due to failure of internal systems in zone
C_{z3}	£1,000,000.00	Value of cultural heritage in zone
C_{a4}	£0.00	Cost of animals in zone
C_{b4}	£0.00	Cost of building in zone
C_{c4}	£0.00	Cost of contents in zone
C_{s4}	£50,000.00	Cost of internal systems in zone

Assessment of Ax - Collection areas

Primary Structure

A_D	15,614.50 m ²	Collection area of structure (square metres)
A_M	797,398.16 m ²	Collection area of surrounding ground (square metres)
A_L	4,000.00 m ²	Collection area of flashes striking line (square metres)
A_I	400,000.00 m ²	Collection area of flashes near line (square metres)

Line 1 - External lighting circuit (Section 1)

A_L	4,000.00 m ²	Collection area of flashes striking line (square metres)
A_I	400,000.00 m ²	Collection area of flashes near line (square metres)

Assessment of Nx - Annual number of dangerous events

Primary Structure

N_D	3.1229E-03	Average number of flashes to main structure
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N_M	6.3792E-01	Average number of flashes to surrounding ground
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Line 1 - External lighting circuit (Section 1)

N_L	1.6E-05	Average number of flashes to line
N_i	1.6E-03	Average number of flashes near line

Line 1 - External lighting circuit

N_L	1.6E-05	Average number of flashes to line
N_i	1.6E-03	Average number of flashes near line

Assessment of P_x - Probability of damage for a structure

P_B	1E00	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 - Inside the memorial

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	1E00	Probability that a lightning flash near to the structure will cause failure of internal systems

Zone 1 - Inside the memorial (External lighting circuit)

P_{MS}	1E00	Probability of failure of internal systems (with protection measures) associated with line
P_M	1E00	Probability that a lightning flash near to the structure will cause failure of internal systems
P_U	1E00	Probability that injuries of living beings will be caused by a flash to line

Zone 2 - Outside the memorial

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	1E00	Probability that a lightning flash near to the structure will cause failure of internal systems

Zone 2 - Outside the memorial (External lighting circuit)

P_{MS}	1E00	Probability of failure of internal systems (with protection measures) associated with line
P_M	1E00	Probability that a lightning flash near to the structure will cause failure of internal systems
P_U	1E00	Probability that injuries of living beings will be caused by a flash to line

**Line 1 - External lighting circuit**

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}	1E00	Factor relating to the impulse withstand voltage of a system associated with line
P_{LD}	1E00	Probability of failure of internal systems (flashes to a connected service) associated with line
P_{LI}	1E00	Probability of failure of internal systems (flashes near a connected service) associated with line
P_V	1E00	Probability that physical damage will be caused by a flash to line
P_W	1E00	Probability that failure of internal systems will be caused by a flash to line
P_Z	1E00	Probability that failure to internal systems will be caused by a flash near to line

Assessment of L_x - Amount of loss for a structure**Zone 1 - Inside the memorial**

L_{B3}	0E00	Loss in a structure related to physical damage (flashes to structure) in zone
L_{V3}	0E00	Loss in a structure due to physical damage (flashes to service) in zone
L_{A4}	0E00	Loss related to injury to living beings in zone
L_{B4}	0E00	Loss in a structure related to physical damage (flashes to structure) in zone
L_{C4}	0E00	Loss related to failure of internal systems (flashes to structure) in zone
L_{M4}	0E00	Loss related to failure of internal systems (flashes near structure) in zone
L_{U4}	0E00	Loss related to injury of living beings (flashes to service) in zone
L_{V4}	0E00	Loss in a structure due to physical damage (flashes to service) in zone
L_{W4}	0E00	Loss related to failure of internal systems (flashes to service) in zone
L_{Z4}	0E00	Loss related to failure of internal systems (flashes near a service) in zone

Zone 2 - Outside the memorial

L_{B3}	5E-05	Loss in a structure related to physical damage (flashes to structure) in zone
L_{V3}	5E-05	Loss in a structure due to physical damage (flashes to service) in zone
L_{A4}	0E00	Loss related to injury to living beings in zone
L_{B4}	2.381E-05	Loss in a structure related to physical damage (flashes to structure) in zone
L_{C4}	4.7619E-04	Loss related to failure of internal systems (flashes to structure) in zone



L_{M4}	4.7619E-04	Loss related to failure of internal systems (flashes near structure) in zone
L_{U4}	0E00	Loss related to injury of living beings (flashes to service) in zone
L_{V4}	2.381E-05	Loss in a structure due to physical damage (flashes to service) in zone
L_{W4}	4.7619E-04	Loss related to failure of internal systems (flashes to service) in zone
L_{Z4}	4.7619E-04	Loss related to failure of internal systems (flashes near a service) in zone

Assessment of Rx - Risk components

Zone 1 - Inside the memorial

R_{B3}	0E00	Risk component of risk R3 due to physical damage to a structure (D2) caused by flashes to a structure (S1) in zone
R_{A4}	0E00	Risk component of risk R4 due to injury to living beings (D1) caused by flashes to a structure (S1) in zone
R_{B4}	0E00	Risk component of risk R4 due to physical damage to a structure (D2) caused by flashes to a structure (S1) in zone
R_{C4}	0E00	Risk component of risk R4 due to failure of internal systems (D3) caused by flashes to a structure (S1) in zone
R_{M4}	0E00	Risk component of risk R4 due to failure of internal systems (D3) caused by flashes near a structure (S2) in zone

Zone 1 - Inside the memorial (Line 1 - External lighting circuit)

R_{V3}	0E00	Risk component of risk R3 due to physical damage to structure (D2) caused by flashes to a connected service (S3)
R_{U4}	0E00	Risk component of risk R4 due to injury to living being (D1) caused by flashes to a connected service (S3) associated with line
R_{V4}	0E00	Risk component of risk R4 due to physical damage to structure (D2) caused by flashes to a connected service (S3) associated with line
R_{W4}	0E00	Risk component of risk R4 due to failure of internal systems (D3) caused by flashes to a connected service (S3) associated with line
R_{Z4}	0E00	Risk component of risk R4 due to failure of internal systems (D3) caused by flashes near a service (S4) associated with line

Zone 2 - Outside the memorial

R_{B3}	0E00	Risk component of risk R3 due to physical damage to a structure (D2) caused by flashes to a structure (S1) in zone
R_{A4}	0E00	Risk component of risk R4 due to injury to living beings (D1) caused by flashes to a structure (S1) in zone
R_{B4}	0E00	Risk component of risk R4 due to physical damage to a structure (D2) caused by flashes to a structure (S1) in zone
R_{C4}	0E00	Risk component of risk R4 due to failure of internal systems (D3) caused by flashes to a structure (S1) in zone
R_{M4}	0E00	Risk component of risk R4 due to failure of internal systems (D3) caused by flashes near a structure (S2) in zone


Zone 2 - Outside the memorial (Line 1 - External lighting circuit)

R_{V3}	0E00	Risk component of risk R3 due to physical damage to structure (D2) caused by flashes to a connected service (S3)
R_{U4}	0E00	Risk component of risk R4 due to injury to living being (D1) caused by flashes to a connected service (S3) associated with line
R_{V4}	0E00	Risk component of risk R4 due to physical damage to structure (D2) caused by flashes to a connected service (S3) associated with line
R_{W4}	0E00	Risk component of risk R4 due to failure of internal systems (D3) caused by flashes to a connected service (S3) associated with line
R_{Z4}	0E00	Risk component of risk R4 due to failure of internal systems (D3) caused by flashes near a service (S4) associated with line

Primary risk totals

R_{3_T}	0E00	Risk of loss of cultural heritage in the structure
R_{4_T}	0E00	Risk of loss of economic value in the structure

Primary risk totals with respect to source of damage

R_{3_D}	0E00	Risk of loss of cultural heritage in the structure due to flashes to the structure (S1)
R_{4_D}	0E00	Risk of loss of economic value in the structure due to flashes to the structure (S1)
R_{3_I}	0E00	Risk of loss of cultural heritage in the structure due to flashes influencing, but not striking the structure (S2, S3, & S4)
R_{4_I}	0E00	Risk of loss of economic value 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_{3_S}	0E00	Risk of loss of cultural heritage in the structure due to injury to living beings (D1)
R_{4_S}	0E00	Risk of loss of economic value in the structure due to injury to living beings (D1)
R_{3_F}	0E00	Risk of loss of cultural heritage in the structure due to physical damage (D2)
R_{4_F}	0E00	Risk of loss of economic value in the structure due to physical damage (D2)
R_{3_O}	0E00	Risk of loss of cultural heritage in the structure due to failure of internal systems (D3)
R_{4_O}	0E00	Risk of loss of economic value in the structure due to failure of internal systems (D3)