



SANS 10313:2010 and IEC 62305 Parts 2 and 3

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The South African code of practice as amended in 2010 gives a brief description of the requirements for the protection of structures and persons against lightning. The document itself does not cover all aspects of the protection structures and persons against lightning. The cover page of the code of practice therefore clearly states that it can only be used in conjunction with the IEC/ SANS 62305 series. This explanation will give a brief description on the requirements as per IEC/ SANS 62035 part 2 (Risk Assessments) and concentrate on the basic requirements of IEC/ SANS 62305 part 3 (Physical Damage and Life Hazard [1]).

Each part of the IEC code is a substantial document and the objective of the article is to give readers a clear and practical insight into these requirements. It covers the process of assessing the risk of damage caused by lightning and gives a brief description of the basic requirements of protecting structures and living beings against the hazards of lightning.

IEC / SANS 62305: Part 2 [1] Risk assessments

Risk assessments shall be conducted for all structures under consideration. The 'risk', defined as the probable average annual loss in a structure and its services due to lightning flashes, depends on:

- The annual number of flashes to the structure and its services (N)
- The probability of damage by one of the lightning flashes (P)
- The mean amount of consequential loss (L)

Therefore, $R = N \times P \times L$

The risk must be determined for all sources of damage and the consequential risk of loss:

- S1 – Direct lightning strike to the structure
- RA – Human Life
- RB – Fire/ Explosion
- RC – Overvoltage (LEMP)

Sources of damage

- S2 – Lightning strike near the structure
- RM – Overvoltage (LEMP)
- S3 – Lightning strike to a service connected to the structure
- RU – Human
- RV – Fire/ explosion
- RW – Overvoltage

- S4 – Lightning strike near to a service connected to the structure
- RZ – Overvoltage

The risk of damage must be calculated for all of the R' values. It is therefore preferable to perform risk assessments with the assistance of computer software. Protection against lightning is needed if the calculated risk is higher than the tolerable risk (RT).

$R > RT$

Every risk must be calculated.

Type of loss	RT (y ⁻¹)
Loss of human life	10 ⁻⁵
Loss of services to the public	10 ⁻³
Loss of cultural heritage	10 ⁻³

Table 1: Tolerable risk.

10⁻⁵ = 1 in 100 000 chance of a fatal injury over the course of one year (maximum tolerable risk – loss of human life).

IEC 62305 Part 3:

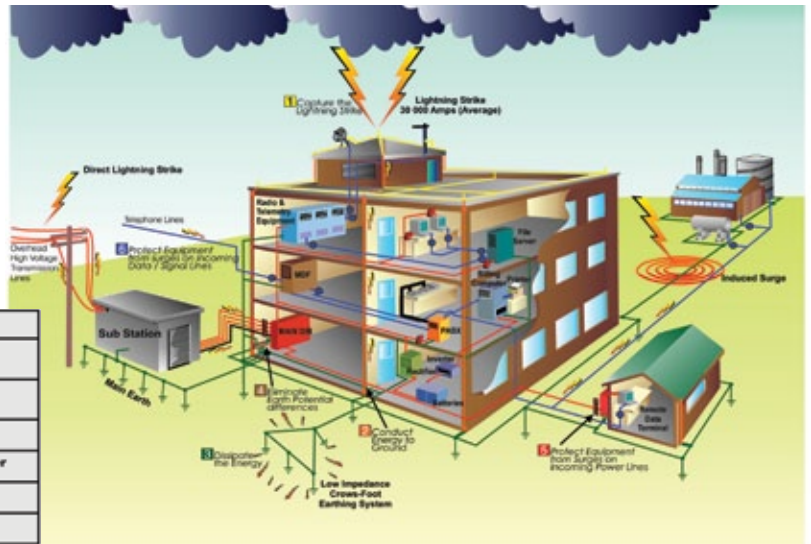
Protection against physical damage and life hazard

The main and most effective measure for protection of structures against physical damage is considered to be the lightning protection system.

A lightning protection system (LPS) usually consists of an external and an internal (LPS). A complete system must incorporate both external and internal LPS.

An External LPS is intended to:

- Intercept a lightning flash to the structure (air termination system)
- Conduct lightning current safely towards earth (down conductor system)



KEY	
1	Capture lightning strike to a preferred point using a purpose designed air termination system
2	Conduct the energy to the ground safely via a purpose designed down conductor system
3	Dissipate energy into the ground via a low impedance earthing system
4	Eliminate earth potential differences by positive bonding of various earths together
5	Protect equipment from surges on all incoming power lines
6	Protect equipment from surges on all incoming Telecom & data lines

- Disperse lightning current into the earth (earth termination system)

An Internal LPS:

- Prevents dangerous sparking within the structure using either equipotential bonding or a separation distance between the external LPS and other electrically conducting elements internal to the structure.

Class of LPS

The class of required LPS shall be selected on the basis of a risk assessment [1].

Four classes of LPS (I – IV) are defined and correspond to the lightning protection level as shown in Table 2.

Class of LPS	Lightning Protection Level	LPS Efficiency
I	I	0,98
II	II	0,95
III	III	0,90
IV	IV	0,80

Table 2: Four levels of protection.

Protection measures are effective provided that they comply with the requirements of IEC 62305 Part 3 [1] and are able to withstand the stress expected in the place of its installation.

Air termination systems

The probability of structure penetration by lightning is considerably decreased by the presence of a properly designed air termination system.

Air termination systems can comprise any of the following elements:

- Rods and finials (including free-standing masts)
- Centenary wires
- Meshed conductors

Individual air termination rods should be connected together at roof level to ensure current division.

Positioning

Air terminals installed to a structure shall be located at corners, exposed points and edges in accordance with one or all of the following methods:

lowing methods:

- Protection angle method
- Rolling sphere method
- Mesh method

Class of LPS	Protection Method		
	Rolling Sphere Radius r M	Mesh size w m	Protection angle a°
I	20	5 x 5	
II	30	10 x 10	See Figure 1
III	45	15 x 15	
IV	60	20 x 20	

Table 3: Positioning.

Construction

Air terminals should be installed as follows:

- If the roof is made of non-combustible material, air terminals may be installed on the surface of the roof.
- If the roof is made of readily-combustible material, due care needs to be taken with regard to the distance between the air termination conductors and the material. Typically, for thatch roofs, a distance of 1,0 m is adequate.

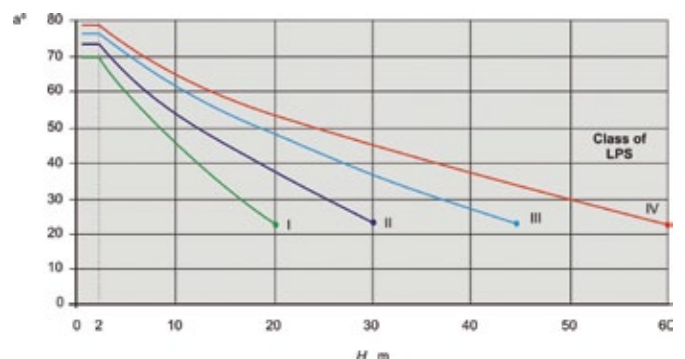


Figure 1: Maximum value for the protective angle – air terminals.

The maximum heights for the Protective Angle method are:

- Level 1 = 20 m
- Level 2 = 30 m
- Level 3 = 45 m
- Level 4 = 60 m

Natural air terminals

Metal components of a roof structure may be considered as natural air terminals and therefore part of the LPS – provided they are in accordance with the following table:

Class of LPS	Material	Thickness ^a <i>t</i> mm	Thickness ^b <i>t</i> mm
I - IV	Lead	-	2,0
	Steel (stainless, galvanised)	4	0,5
	Titanium	4	0,5
	Copper	5	0,5
	Aluminium	7	0,65
	Zinc	-	0,7
^a <i>t</i> = Prevents puncture, hot spot or ignition			
^b <i>t</i> = Only for metal sheets if it is not important to prevent puncture, hot spot or ignition problems			

Table 4: Minimum thickness of metal sheets or pipes in air termination systems.

Down conductor systems

In the event of a direct lightning strike to the LPS, the down conductor system is designed to safely guide the lightning current towards the earth termination system.

In order to reduce the probability of damage due to lightning current flowing in the LPS, the down conductors shall be arranged in such a way from the point of strike to earth:

- So that several parallel current paths to earth exist.
- So that the length of current path is kept to a minimum.
- So that equipotential bonding to conducting parts of the structure is performed.

The separation distance between the down conductors and other electrically conductive elements within the structure shall be taken into account and calculated.

Down conductor materials

- The number of spacing of the down conductors should be as previously described.
- Copper, aluminium and galvanised steel are generally used as down conductor materials, the minimum dimension shown in Table 5.
- When the distance from a down conductor to a combustible material cannot be assured, the cross section of the conductor shall not be less than 100 mm².

Protection level	Material	Down conductor mm ²
	Copper	50
1 to 4	Aluminium	50
	Steel	50

Table 5: Minimum dimensions for down conductor materials.

Natural down conductors

The following parts of a structure can be considered as a natural down conductor:

- Structural steelwork
- Concrete steel reinforcing (care must be taken to ensure electrical continuity across the interconnected concrete steel reinforcing)
- Rainwater downpipes (provided that the cross section exceeds 50 mm², the thickness exceeds 0,5 mm and that the sections are welded together)
- Steel facades (provided that the thickness exceeds 0,5 mm and that there is electrical continuity in a vertical direction)

Down conductors – test joints

- At the connection to the earth termination system, a test joint should be fitted on each down conductor.
- An exception can be made when using natural down conductors with foundation earth electrodes.
- The joint shall be capable of being opened with the aid of a tool. In normal use the joint shall remain closed.

Earth termination systems

The shape and dimension of the lightning protection earthing system are important when dealing with safe dispersion of the lightning current into the ground. In order to minimise any dangerous overvoltages, a low resistance earthing system is recommended – if possible lower than 10 Ohms. A single integrated earthing system is preferable, which is suitable for all purposes (ie lightning protection, power systems, telecommunications systems and data systems). Alternatively, all earthing systems shall be equipotentially bonded.

Types of earthing arrangements

Type 'A'

This type comprises horizontal or vertical earth electrodes installed outside the structure, each connected to a down conductor. In type 'A' arrangements, the total number of earth electrodes shall not be less than two.

- o The minimum length of vertical electrodes = 0,5 minimum length shown on the graph.
- o Protection levels III and IV are independent of soil resistivity.
- o The minimum lengths can be disregarded if the overall resistance of the earth termination system is less than 10 Ohms.

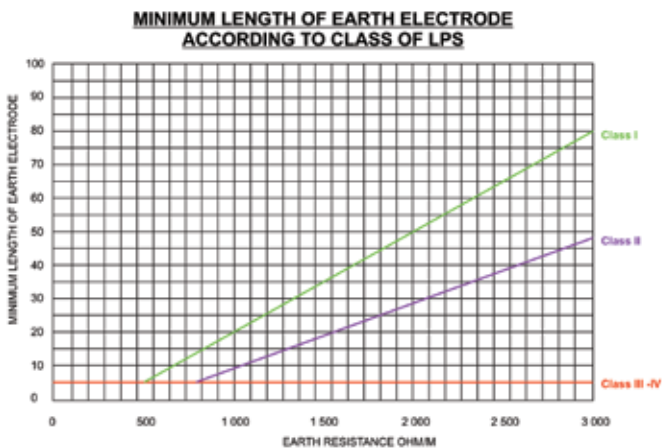


Figure 2: Minimum length of earth electrode according to class of LPS.

Type 'B'

- o Type 'B' arrangements consist of a ring conductor external to the structure being protected. The conductor shall be in contact with the soil for at least 80% of its length.
- o A foundation earthing system can also be regarded as type 'B'; type 'B' earthing systems can also be meshed.
- o The minimum resistance of a type 'B' earthing system can be disregarded provided that the minimum length requirements according to the protection level are met.
- o Additional vertical earth electrodes should be installed when a single integrated earthing system is utilised and the overall resistance of the earthing system does not meet the minimum requirements of the safety earthing system (ie 1 Ohm or less).

Earthing materials

- Natural earth electrodes
Interconnected reinforcing steel in concrete foundations or concrete piles and other underground metal structures should be used as a natural earthing electrode.
- Earthing materials:

Protection level	Material	Earthing conductor mm ²
1 to 4	Copper	50
	Aluminium	N/A
	Steel	80

Table 6: Minimum dimensions for earthing materials.

Equipotential bonding

Equipotentialisation is performed to prevent dangerous sparking

within a structure due to lightning current flowing in the external LPS or any conductive parts of a structure.

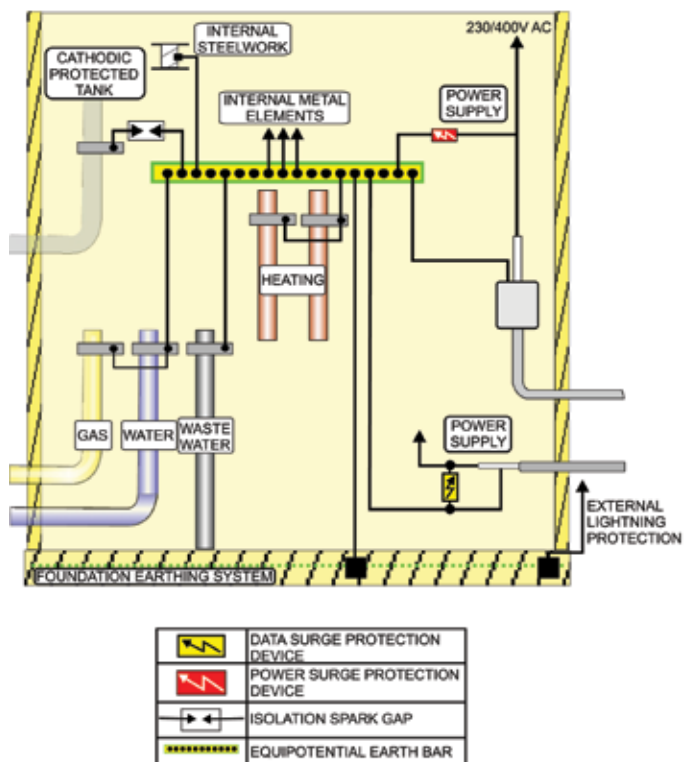
The equipotential bonding of the following elements to the external LPS is essential:

- Metal installations
- Internal systems
- External conductive parts and lines connected to the structure

The interconnection of the LPS to these systems can be done by means of the following:

- Bonding conductors, where electrical continuity is not provided by natural bonding
- Surge Protection Devices (SPDs) where direct connections with bonding conductors is not feasible

The value of the carrying out of correct equipotential bonding cannot be understated in value of protecting electronic equipment.



Separation distances

An adequate separation distance should be maintained between the external LPS and all conductive parts of the structure. The separation distance can be calculated as follows:

$$S = k_i \cdot \frac{kd}{km}$$

Where

k_i - depends on the LPS level

k_c - depends on the lightning current flowing on the down conductors

k_m - depends on the electrical insulation level

l - is the length in metres along the air termination or the down conductor, from the point where the separation distance is to be considered, to the nearest equipotential bonding point

Values of coefficient k_i

Class of LPS	k_i
I	0,08
II	0,06
III and IV	0,04

Values of coefficient k_c

No of down conductors	k_c
1	1
2	1... 0,5
4 and more	1... 1/n

Values of coefficient k_m

Material	k_m
Air	0,08
Concrete, bricks	0,06

Table 7: Values of coefficient k_i .

Conclusion

As a result of the substantial changes made in the lightning protection codes of practice in 2010, and the author's belief that many contractors are not implementing the required changes, the author's company has embarked on an education programme to inform consulting engineers of these new requirements. This article, as part of this programme, gives an outline of the basic requirements of the SANS and IEC codes of practice. The information supplied is a brief summary of the basic principles as described in the codes of practice and does not in any way constitute all of the requirements as stipulated in the various codes of practice.

References

- [1] IEC 62305: 2010. Part 2. Risk Management. Part 3. Physical damage and life hazard.
- [2] SANS 10313:2010. Edition 3.1. Protection against lightning – Physical damage to structures and life hazard.



Trevor Manas is the managing director of Pontins, a company established in 1972. Over the years, Pontins has become widely recognised as a leader in the earthing and lightning protection fields in South Africa and Africa. Enquiries: Tel. 011 792 1300 or email info@pontins.co.za.

About the author