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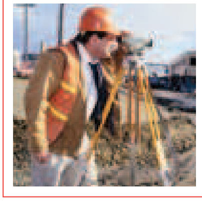
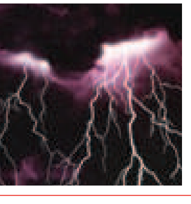
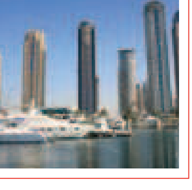






Consultants Handbook

Welcome to our Wallis Designers Lightning Protection Handbook.

This handbook offers a guide for any designers of the structural Lightning protection system to comply with the requirements of BS EN 62305 range of standards, the guide offers a simplified version of the suite of documents which make up the standard.

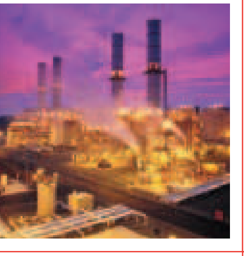
This guide is the Wallis interpretation of the BS EN 62305 : 2011 standard which is relatively new and replaced the BS 6651 document.

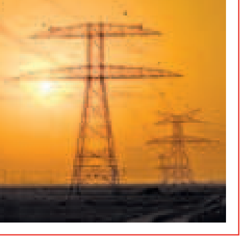
This Wallis handbook should be used in conjunction with the risk assessment software and consideration should also be given to the selection of materials and the requirements for Surge protection within the structure in accordance with BS EN 50164 standards.

The risk assessment is a cumbersome process made simpler by using the Wallis software but the risk assessment parameters are briefly described in the final section of this guide.

The Lightning protection standard is constantly being worked on by committees made up of experts from all over the world and as changes are made to parameters or materials specifications this guide will be changed to reflect those changes.

If you require any clarification on points raised in this guide or advice on the design of the Lightning Protection System please call Wallis on **+44 (0)115 927 1721**





CONTENTS

The Design of the Structural Lightning Protection to comply with BS EN 62305

The LPS (lightning protection system) is required to:

- Intercept the lightning strike (the air termination network)
- Conduct the Lightning strike safely to ground (down conductors)
- Disperse the strike safely in the earth (earthing)
- Whilst the structural protection is there to conduct a strike safely to earth this is normally combined with internal protection to prevent sparking within the structure ensuring all metallic services are at equipotential (bonding)

The designer of the LPS should ensure that:

- The safest path to earth is the LPS
- The risk of sparking whilst the strike is conducted safely to earth is minimised (separation distance's')
- The risk of voltage differential whilst the strike is being dissipated in the ground safely is minimised (step & touch potentials)

The designer of the LPS has to gather all the relevant information to ensure the design is as safe as possible within any economic restraints:

- A designer may find it impractical to fully install the desired LPS
- A designer may not be able to justify the cost of providing the desired LPS
- A designer may consider using the metal roof or reinforcing bars within a building as the safest and most economic design
- A designer may consider extra bonding and surge protection devices are required to protect the internal space, especially if the space houses sensitive electronic equipment
- A designer may consider a building of such a high risk that additional measures are taken to ensure safety, possibly a flour factory or a building with a combustible roof, in these cases the LPS system may have to stand off the building

Criteria for The Protection Of Structures

The level of protection/Lightning Protection Level (LPL) applied to the structure is identified by the risk assessment.

Lightning Protection System (LPS) level

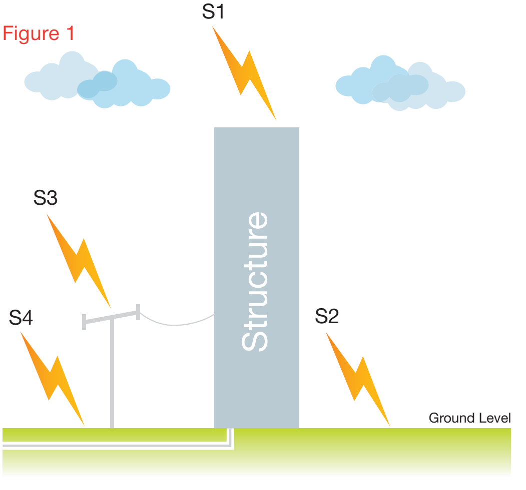
LPL I requires a Class I LPS
LPL II requires a Class II LPS
LPL III Requires a Class III LPS
LPL IV requires a Class IV LPS

Design of The LPS, General Considerations

To help the designer, the threat of Lightning to a structure or building can be defined in lightning protection zones requiring protection and the type of lightning strike likely to enter the building shown in Figure 2.

S1 – Strike directly to the structure
S2 – Strike on the ground near the structure
S3 – Strike to a service connected to the structure
S4 – Strike on the ground near a service connected to the structure

Figure 1



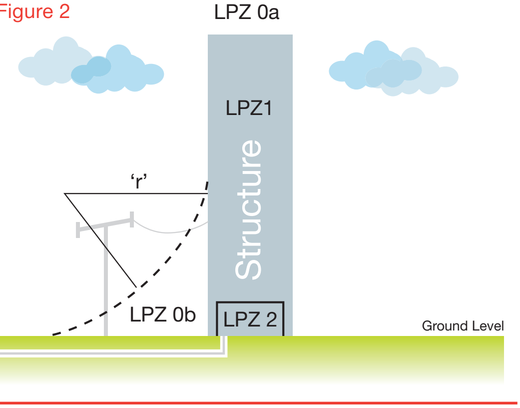
LPZ1 – The protected zone inside the building, the zone where current is limited by current sharing and SPD's at the boundary (less the separation distance).

LPZ 0a – At risk from the full lightning strike and the full lightning electromagnetic field.

LPZ 0b – Not at risk from a direct lightning strike considering the protected area through the rolling sphere but at risk from the full lightning electromagnetic impulse. (LEMP)

LPZ 2 – Protected zone with further dampened magnetic field.

Figure 2



The LPS designer should ensure everything to be protected falls inside the LPZ 0b range in figure 2.

- The bonding measures employed need consideration at the design stage
- The earthing design should consider fully the step and touch potential risks
- The requirements for Surge Protection Devices (SPDs) on incoming mains and conductive services should be considered in accordance with the risk assessment carried out for the structure LPS requirements
- Where combustible wooden type materials are present a distance of 0.15 m should be maintained between the LPS conductors and the roof, for any other combustible surfaces a distance not less than 0.10 m is required
- Some structures will have reinforced sections with expansion joints, if the designer of the LPS considers electronic equipment within the building is at risk then bonding conductors should be provided across the joints to provide low-impedance potential equalization. The separation distance between the bonds should not be more than half the distance between the down conductors
- Natural components within/part of the structure such as the rebars can be made use of provided they will always remain an integral part of the structure conforming to the requirements below

Using the natural conductors as part of the LPS

The building's natural components, metal roof, rebar, steelwork etc can be considered as part of the LPS provided they meet the minimum criteria shown in Table 1.

Table 1

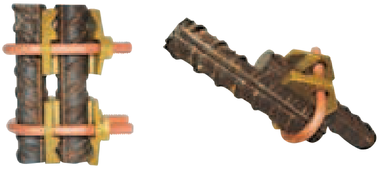
Material for LPS level I to IV	Prevents puncture, hot spots or ignition. minimum thickness (mm) (ta) requirement	Only for metal sheets where preventing puncture, hot spots or ignition is not important. minimum thickness (mm) requirement (tb)
Lead	-	2.00
Stainless Steel	4	0.50
Titanium	4	0.50
Copper	5	0.50
Aluminium	7	0.65
Zinc	-	0.70

The reinforcing bars within the concrete structure can be used as a natural component of the LPS provided they are electrically continuous by either welding or clamping the joints.

The re-bars are considered as electrically continuous provided that the major part of interconnections of vertical and horizontal bars are welded or otherwise securely connected by clamps conforming to BS EN 50164 standards.

The connecting rebar must overlap and be clamped or welded to a minimum of 20 times the diameter of the rebar as shown in figure 3. (Welding to be done on either side of the rebars.)

Figure 3

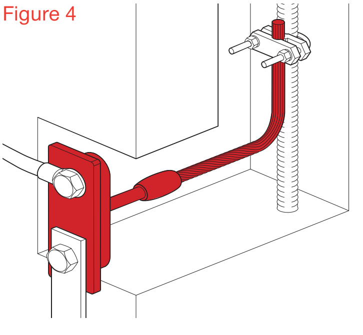


Example of a rebar joined by clamps

To test the continuity of the reinforcing bars the resistance between the re-bar connection to the air termination network and the rebar connection to the earthing network should be measured, the resistance should not exceed 0.2Ω, otherwise proprietary down conductors will be required.

In order to provide a connection to the rebar from outside the concrete a cast-in earth plate can be used as shown in figure 4, the earth point sits in the wall (or within an enclosure) providing a connection to the re-bar with a welded copper tail attached to the earth point and to the re-bar with propriety clamps.

Figure 4



It's advisable to specify the locations of these cast-in bonding points early to ensure that sufficient locations are provided to satisfy lightning protection equipotential bonding.

Using the re-bar as part of the roof termination network to intercept a lightning strike is not advisable because of resulting damage to the waterproof roof layer and façade with the added hazard of chunks of concrete falling from the building roof.

The designer of the structural LPS has 4 main criteria to consider

- The roof termination system
- The down conductor configuration
- The Earth termination network including equipotentialization and the risk of step and touch potential, (equipotentialization on its own is not effective in reducing the risk against touch voltages)
- Bonding (creating a euipotential zone across all zones, 0a, 0b, Z1, Z2)

Methods of Designing the Air Termination Network

1 - The rolling sphere

2 - The protective angle design

3 - The mesh design

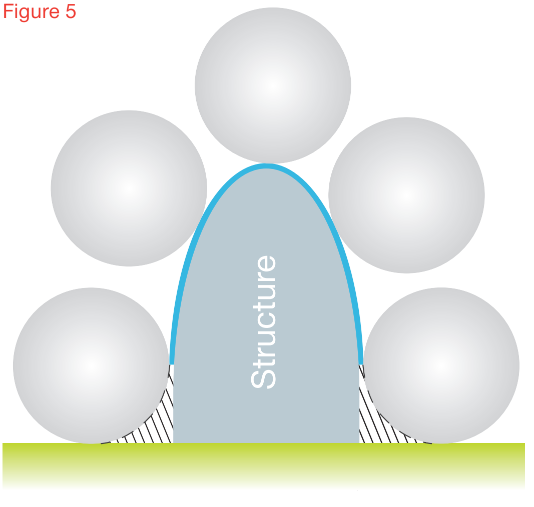
The Rolling Sphere Method

This method simply rolls a sphere around the building to be protected, wherever the sphere touches the building dictates where the protection measure is to be applied, where the sphere does not touch the building, this is accepted as a protected area, this method can be used to design the LPS on complex structures or where the LPS has to be isolated.

The rolling sphere method is especially relevant on complex structures with many different levels, this method easily identifies the protected space and where protection measures should be applied to the structure.

Examples of the air termination system using the rolling sphere technique

Figure 5



The diameter of the sphere depends on the class of LPS selected/determined.

Class of LPS	Sphere radius
I	20
II	30
III	45
IV	60

Figure 6

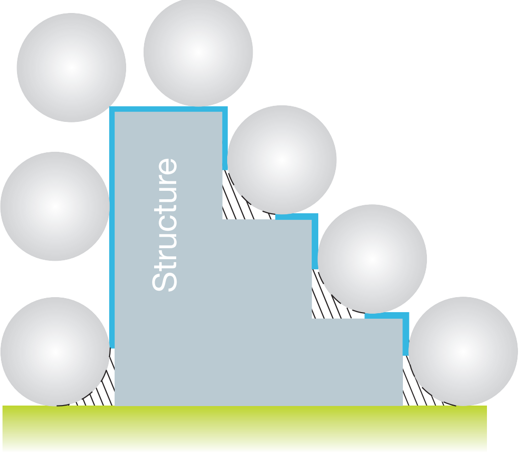


Figure 7

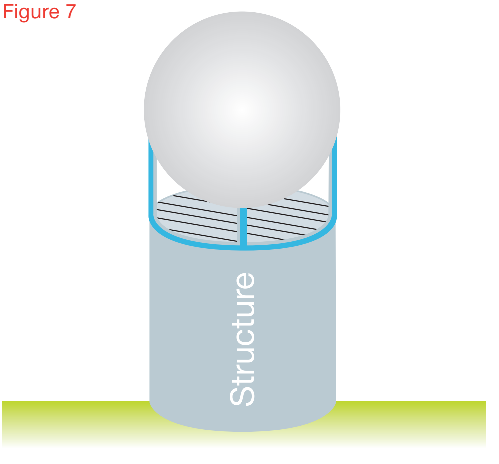
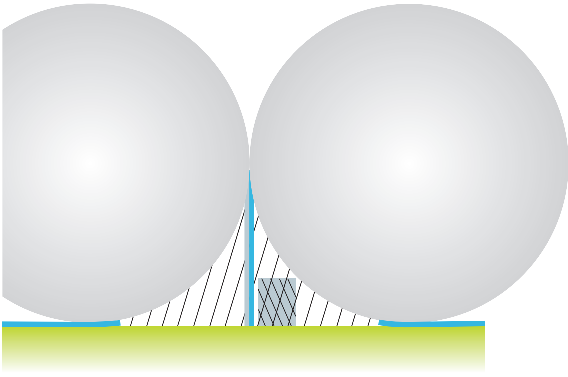
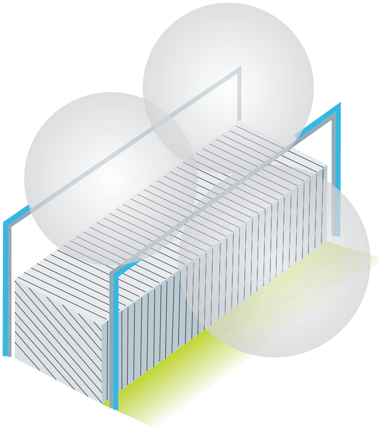


Figure 8





Using various configurations with tape, rods, masts and catenary wire different LPS designs are possible.

The Protective angle design

The Protective angle method in figure 10 is only used on simple structures or for small sections of larger structures.

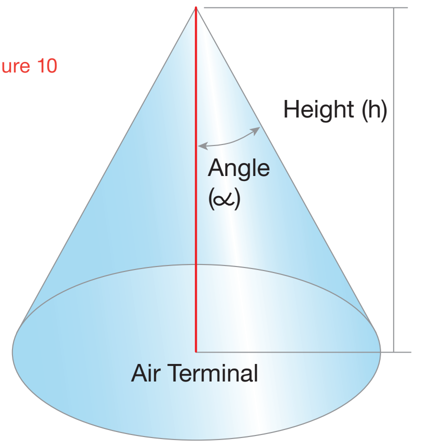
The Protective angle design method cannot be used where the part of the structure/service to be protected is higher than the radius of the rolling sphere corresponding to the class of LPS.

The level of LPS dictates the angle of protection depending on the reference height, see figure 9.

This method of design is an alternative method based on the rolling sphere and is not offered to give a wider range of protection than the rolling sphere.

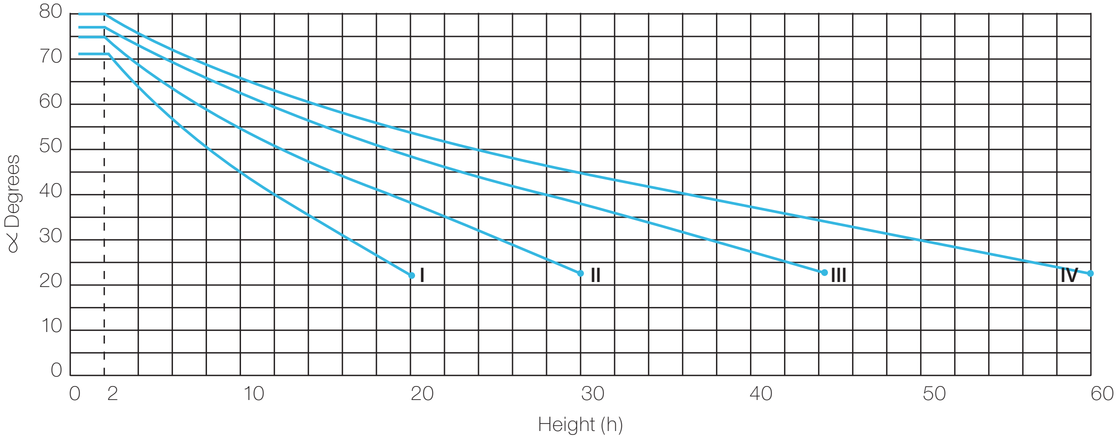
In figure 9 the height limits for designers are clear and correspond to the radius of the rolling sphere.

Figure 10



Cone of Protection

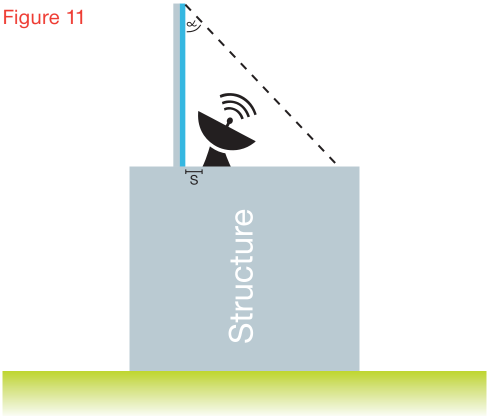
Figure 9



Height = The height of the air termination from the base to the tip of the termination only.

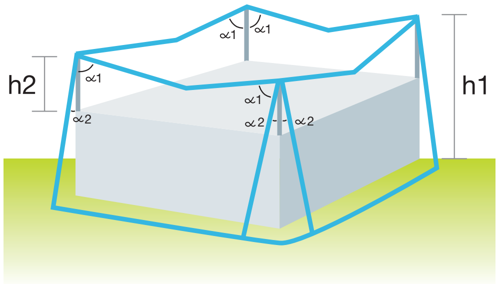
The Protective angle design (continued)

Figure 11



Using the Protective angle design to protect free standing equipment on the roof of a building.

Figure 13



Using the Protective angle method on a simple building. Note the angle at protection changes as reference height changes from h1 to h2 as shown in figure 13.

The Mesh design

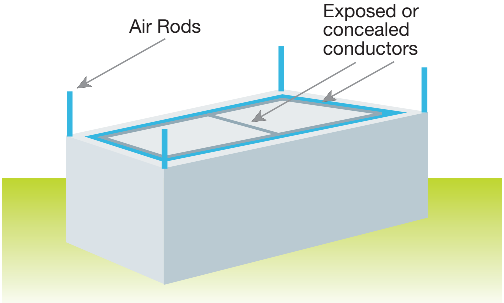
The most commonly used method, is usually employed where the structure is simple, a square or rectangular building or typical house or block of apartments with a sloping roof, the mesh method is for protection in zone 0A

The mesh design protects the whole area if conductors are positioned on the edge of the roof where the slope of the roof exceeds 1:10.

On structures up to 60 m in height, only consider applying an air termination system to the roof and provide protection to points, corners and edges of the structure. No lateral air termination is required regardless of the class of LPS.

On structures higher than 60 m lateral air termination systems should be applied to the top 20% of the structure relevant to its class of LPS (or at least conforming to class IV LPS).

Figure 12



The mesh of conductors are installed on the roof, the conductor must be at the edge of the area to be protected and for metal items such as air conditioning units that protrude above the conductor, the protective angle design should be applied for protection.

The size of mesh required is defined by the level of LPS determined/selected

LPS Class	Mesh Size (M)
I	5 x 5
II	10 x 10
III	15 x 15
IV	20 x 20

The roof termination network can be concealed below the tiles or cladding provided the air rods/strike pads protrude above the tiles or cladding Figure 15.
Air rods to be selected based on the protection angle method. Strike pads should be provided in accordance with mesh spacing.

Designing the Air termination network (continued)

The air termination system will usually consist of Air rods, flat tape conductors in a mesh or in some designs a catenary wire (in case of isolated LPS), there are three methods for the designer to determine the air termination system in the LPS, each is acceptable to BS EN 62305.

The design comes from one of three options already detailed, the rolling sphere, protective angle or mesh alternatives, each method has different criteria for the roof network.

Wherever possible the air termination network should be located:

- At the corners of the building
- At the most exposed points of the building
- As close to the edge of the building as possible (on the parapet wall is usually as close as you can get)

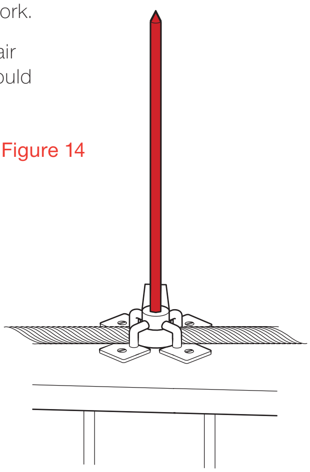


Figure 14

The roof network should follow the most direct route with minimal bends.

Where roof tiles are non-conducting the air-termination conductor may be placed either under, or over the roof tiles (over is always preferable), Where the conductor is sited below the tiles vertical finials or flat strike plates should be used These should be spaced at not more than 10 m for air rods and 5 m for strike plates. (corresponding to class of LPS)

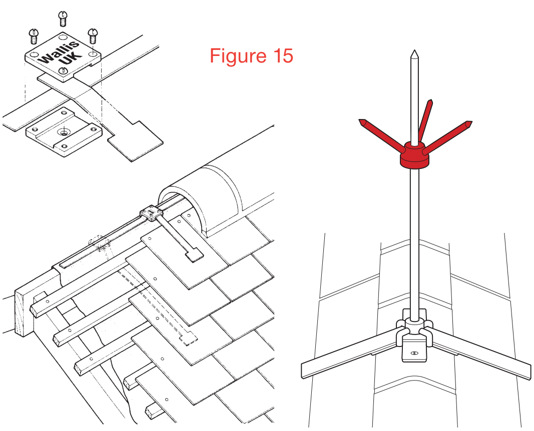


Figure 15

In circumstances where two horizontal LPS air-termination conductors are placed parallel above the horizontal reference plane, the distance that the rolling sphere penetrates below the level of the conductors within the space between the horizontal conductors is:

Where

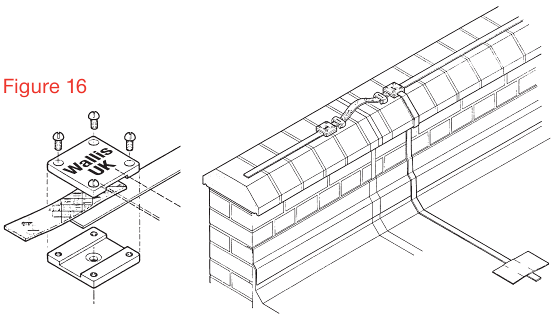
p = penetration distance
r = rolling sphere radius
d = distance between the two parallel air terminal rods or conductors

The penetration distance (p) should be less than the height of the air terminal/conductor above the roof surface/ reference plane, (ht), minus the height of objects to be protected.

[BS EN 62305-3, E.4]

$p = r - (\sqrt{}r2 - (d/2)^2$

Figure 16



Protection for open roof car parks

For car park structures where the roof is an open parking area (as shown in figure 17) for cars, normally surrounded by a parapet wall, it is not advisable to have any kind of roof conductors as they are constantly being driven over and walked upon.

In these circumstances the standard allows the use of Air rods on the parapet wall with a mesh on the roof hidden between the edges of adjoining slabs or bedded in the concrete with strike pads installed visible above the tarmac or concrete.

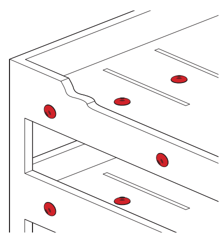


Figure 17

Persons and vehicles on this parking area are above the Lightning protection system and not protected from lightning.

If the top level of the car park has to be protected then air rods, catenary wire and natural masts such as lamp posts can be designed in to provide an enhanced protected area.

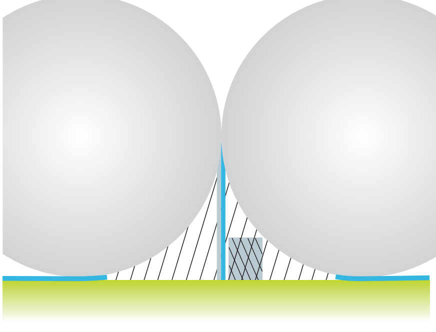
The step and touch potential risk on the top level of the car park can be overcome provided the roof is constructed of reinforced concrete with interconnected reinforcement steel with continuity provided by welding or clamping.

Conductive fixtures on the roof

Conductive roof fixtures such as AC units outside the zone of protection can be ignored if their height is under 300mm or if it's under 1mtr/2 or it's less than 2mtr long.
Non conductive roof fixtures outside the zone can be ignored if less than 500mm in height.

A conducting fixture such as pipes or an air conditioning unit needing protection should be protected by an air termination system figure 18. If this is not possible insulated parts, with lengths corresponding to at least twice the specified separation distance, can be installed on the conductive installations. *[BS EN 62305-3, E.5.2.4.2.4]*

Figure 18



When a non-conductive chimney falls outside the protective zone of the air-termination system, it should be protected by means of air-termination rods or air-termination conductors. The air termination rod on a chimney should be of such height that the complete chimney lies within the protective space of the rod.

[BS EN 62305-3, E. 5.2.4.2.4]

Metal roof fixtures should be bonded to the air termination system when the necessary clearance for conformity to the separation distance cannot be maintained.

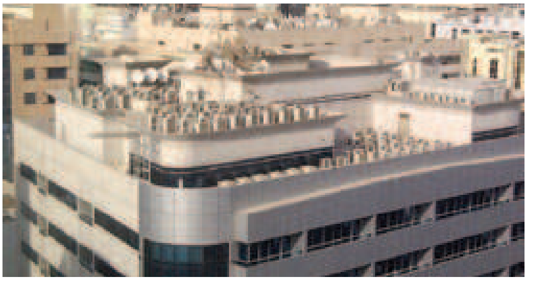
[BS EN 62305¬3, E.5.2.4.2.4]

Conductive electrical appliances and fittings on the roof are some of the most difficult problems facing the designer of the LPS if the requirements of BS EN 62305-3 are to fully met and the system be fully compliant. See figure 19.

To fully comply with BS EN 62305

- Metallic roof fixtures such as air conditioning units must fall within a zone of protection offered in accordance with the angle of protection (or with the rolling sphere method)
- The units must also maintain a separation distance between the fixture and the protective air-termination equipment to prevent dangerous sparking (not required if. metallic fixtures are mechanically and electrically continuous with the structure)

In practice this is very difficult to achieve with the sometimes crowded nature of the average apartment block See Picture, units on roof.



Protecting Fixtures which Cannot Withstand Direct Strike to Its Casing

This is where the casing is not of sufficient cross-section to comply with the thickness requirements of the standard, in these cases an air termination system should be installed to cover these units.

A separation distance should be maintained between the fixture and the air-termination to prevent sparking between the air-termination and fixture in the event of a Lightning strike.

If it's not possible to meet the requirements of BS EN 62305 the air-terminal should still be fitted and the fixture should be bonded to the conductor connecting to the air-termination

Services from the fixture going into the building should be bonded to an equipotential bar and protected by installing a Type 1 Surge Protection Device.

Protecting Fixtures which Can Withstand a Direct Strike to Its Casing

There is an option here to consider using the casing of the fixture itself as part of the air-termination network, the argument against is that electromagnetic effects of a direct Lightning Strike are likely to be greater than if the fixture was protected within the air termination network.

If the casing is used as part of the Air termination network

- Fixture should be bonded to the air-termination network when entering the building and connected to a equipotential bonding bar
- Any armoring or screening should be connected to a equipotential bonding bar and their live cores connected to the same bar using SPDs

It could be argued this is introducing the Lightning strike into the building but the alternative to this approach would be to ensure that all mechanical services are insulated where they enter the building and split cables fitted with SPD's which in the majority of cases is not practical.

Electrical Installation outside the zone of protection

If it's just not possible to have antenna masts, satellite dishes and other electrical equipment within the zone of protection they should as a minimum be bonded into the LPS in at least two positions. [BS EN 62305-3, E. 5.2.4.2.6]

It's unlikely all cables and other provisions will enter the building in the same place so as a all conductive sheaths and conductive mechanical protection should be bonded to the lightning protection air-termination by means of a common earth bar. [BS EN 62305-3, E.5.2.4.2.6]

Lightning protection for Structures Covered by Soil

Structures with a layer of soil on the roof where people are not regularly present should be fitted with a meshed air-termination system sited on top of the soil. Practically, a permanent fixed mesh could be installed. Alternatively, air termination rods sited in accordance with the rolling sphere or protective angle method and connected by a buried mesh may be used see BS EN 62305-3, E.5.2.4.2.8

If people are likely to be present a mesh 5mtr x 5mtr should be installed beneath the soil to protect against step potentials but practically there would need to be visual warnings to the public advising against being in the area in the event of a Lightning storm BS EN 62305¬3, E.5.2.4.2.8

In the case of underground bunkers containing explosives an interconnected isolated LPS should be fitted as well as the mesh. [BS EN 62305-3, E.5.2.4.2.81]

Natural Components as part of the air termination network

Below are all permissible as part of the air termination network in the LPS according to BS EN 62305.

Metal sheets

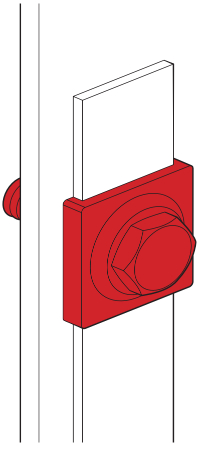
- Provided there is reliable and durable electrical continuity between the various parts and it's not clad with insulation
- The thickness of the metal sheet meets the minimum dimensions shown in table 1
- It's permissible to use this metalwork but unlikely any designer would accept puncturing of the membrane in the event of a direct strike so as a minimum air rods should be fitted to the perimeter.
- Metalwork on the roof, railings, lights, water tanks, coverings provided the metalwork meets the minimum dimensions shown in table 1.
- Even pipes and tanks carrying combustible materials can be considered provided the provided they are constructed of material with thickness not less than the standard allows (for detailed information [BS EN 62305-3, Annex E].

If the metallic parapet is to be used as part of the air-termination network it has to be both electrically and mechanically continuous, the minimum thickness should comply with the dimensions in table 1 and figure 23.

If a metallic roof parapet is not being used in the air-termination network then it should be bonded every 20 metres along the complete length and to each down-conductor (or at down conductor spacing)

Conductive metal objects above the roof surface and passing through the roof structure should be bonded onto the air termination network; examples of this could be a water tank with pipe work passing through the roof into the structure.

Examples of Wallis earth bonds



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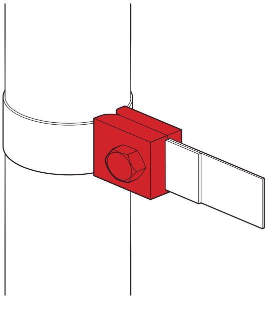

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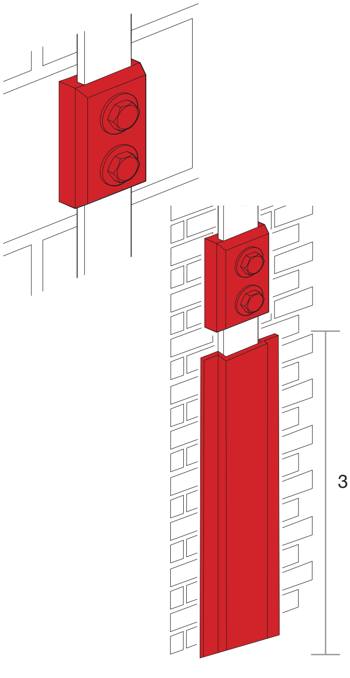
Down conductors

General considerations for the down conductors are as follows unless the LPS is isolated:

- There should be at least two down conductors around the building
- The down conductors should be as equally spaced as possible
- Wherever possible the down conductors should be installed at each exposed corner of the building
- The down conductors can be fixed to any wall or surface which is non-combustible, if the surface is combustible refer to BS EN 62305 for guidance
- Down conductors must not be sited in gutters or down pipes
- The down conductor ideally will follow the shortest and most direct path to earth
- The down conductor should as far as possible be straight and vertical
- Wherever possible avoid any re entrant loops where this is not possible the separation distance shown in figure 22 Is required as a minimum, if this cannot be achieved another design for the down conductor system should be considered
- A test joint should be fitted on each down conductor to enable disconnection from the Earth network and provide access for earth resistance measurement and maintenance

Figure 21



The bottom 3mtrs of the down conductor should be protected within a metal guard or PVC covering at least 3 mm thick to deter vandalism and theft figure 21.

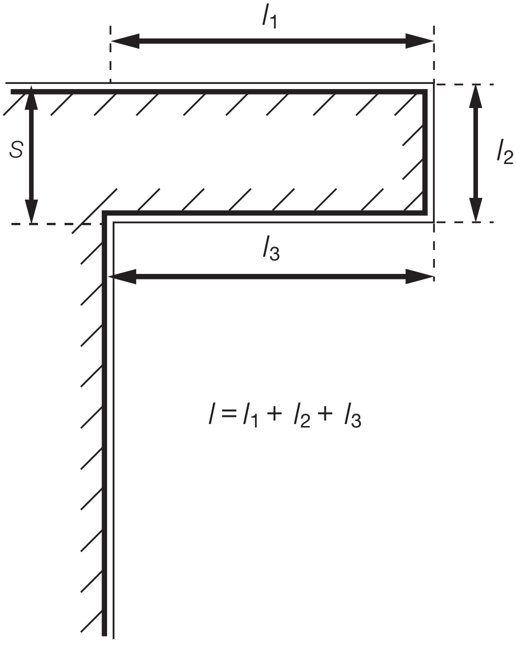
The test clamp should be fixed above the capping wherever possible figure 21.

If the air termination is a metal rod on a non conductive mast, at least one down conductor is needed for each mast

No additional down conductors are required for masts made of metal or interconnected reinforcing steel (If complying to requirements on Pg 3).

If the air termination consists of one or more catenary wires at least one down conductor is needed at each supporting structure.

Figure 20



The calculated separation distance 'S' should be less than height 'l_2'.

Positioning the down conductors

There should be multiple down conductors following the shortest possible path to earth.

Typical values of the distance between down conductors, subject to architectural and practical constraints are given in the table below.

Table 5.4 - Typical down conductor spacing's and distance between ring conductors

Class of LPS	Typical Ring Distances (M)
I	10
II	10
III	15
IV	20

It may not be practically possible to space the down conductors exactly as required, so the spacing's can be adjusted by ±20% but the average spacing of all down conductors must conform to the typical distances for the class of LPS.

If it is not possible to place down conductors at a side or part side of the building the down conductors that should be on that side should be placed as additional down conductors compensating for the other sides. The distance between the installed down conductors should not be less than one-third of the required down-conductor distances dependent upon the class of LPS.

Equipotential bonding to conducting parts of the structure should be performed according to BS EN 62305-3, 6.2.

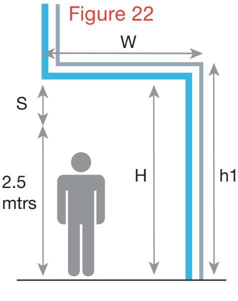
The distance between the down-conductor and the internal services must satisfy the distance requirements covered in the table above.

If the separation distance required to avoid dangerous sparking between the down conductor and the internal services cannot be satisfied, the number of down conductors should be increased until the required separation distance is met.

Protection on a Cantilevered Structure

There is a risk when the down conductor goes into a cantilever that a strike could flash over to the person standing underneath as shown in figure 22. To reduce this risk the separation distance, h in metres, should satisfy the following conditions.

Figure 22



$H > 2.5 + S$

S - Is the separation distance in metres calculated.

2.5 – represents the height of a typical person with their hand in the air.

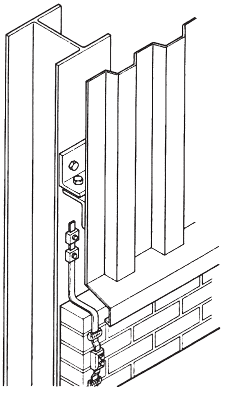
(h1 + w) – length of the conductor

Using natural components as down conductors

The natural components can be used as down conductors provided the components comply with the requirements of BS EN 62305

The Natural components can be used provided there is electrical continuity, where the joints are tightly bolted they can be considered as electrically continuous figure 23.

Figure 23



The facade elements, profile rails and metallic sub-constructions of facades can be used provided their dimensions conform to the requirements for down conductors and metal sheets or metal pipes, not less than 0.5 mm thick.

If the metal façade of the building is to be used as the down conductor then BS 62305 offers specific guidance.

Each overlapping vertical joint at each down-conductor position should be bridged by flexible metal strapping. See figure 24.

Connections between the sheet metal panels should have a minimum contact surface area of 50 sq mm and be capable of be capable of withstanding the mechanical forces of a lightning discharge.

If access to the rear of the façade is not possible and the only type of fixing available for connections between facade sheets and the air termination or down-conductor tapes is pop rivets then these should be at least four 5 mm diameter rivets and used on a length of conductor a minimum of 20mm long. (C.S.A or conductor (connection component) min 50 sq mm)

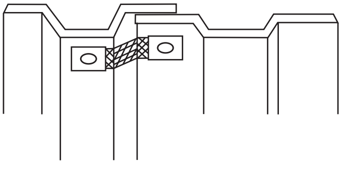


Figure 24

Down conductors not using the natural components of the building

Where down conductors are installed on the building not using the natural components then consideration needs to be given to the separation distance between the internal columns and internal partition walls with conductive parts.

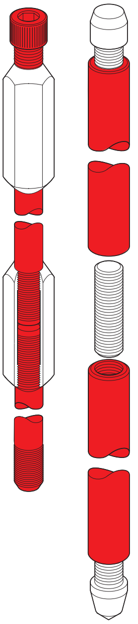
If these conductive columns and partitions do not satisfy the separation distance conditions they must be connected to the air termination system at roof level and to the earthing network at ground level.

Lightning Protection Earthing

In General the LPS earthing system should:

- Be an integrated system for lightning protection, power systems and telecommunication systems
- Have a low overall resistance of 10 ohm's or less
- Have an even spread of readings across all the individual earth electrode terminations to ensure as far as possible the current is evenly distributed
- Have a high resistance to corrosion

Figure 25



Lightning protection earthing equipment is usually made up of Earth rods either copperbonded, solid copper or stainless steel figure 25, copper plates figure 26, lattice mats figure 27 or 25 x 3mm copper conductor.

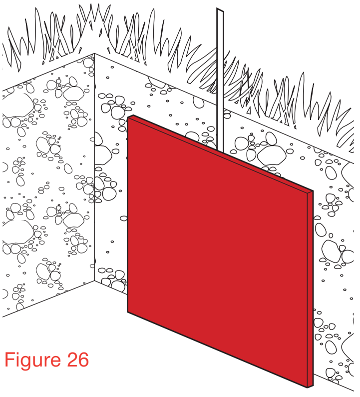


Figure 26

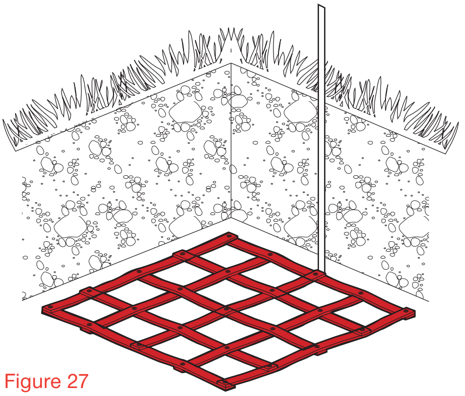


Figure 27

There are three types of LPS Earthing systems types A, B and Foundation Earth Electrodes

Type A - The conventional LPS Earthing system using vertical or horizontal electrodes such as copperbond Earth rods or copper tape

Type B - The ring electrode sited around the periphery of the structure

Foundation earth electrodes
The foundation electrode system installing the conductors in the concrete foundations of the structure

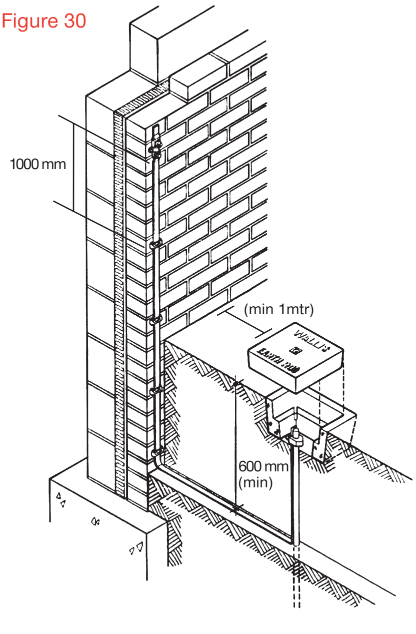
Type A Earthing Arrangement

This is the conventional type of LPS Earthing system where Earthing rods are used to form the earth electrode usually each down conductor connected to an earth rod.

The type A earth termination arrangement is suitable for low structures (below 20 m in height) or an LPS with rods or stretched wires. For an isolated LPS (BS EN 62305 recommends a type B earthing arrangement where the structure is housing extensive electronic systems).

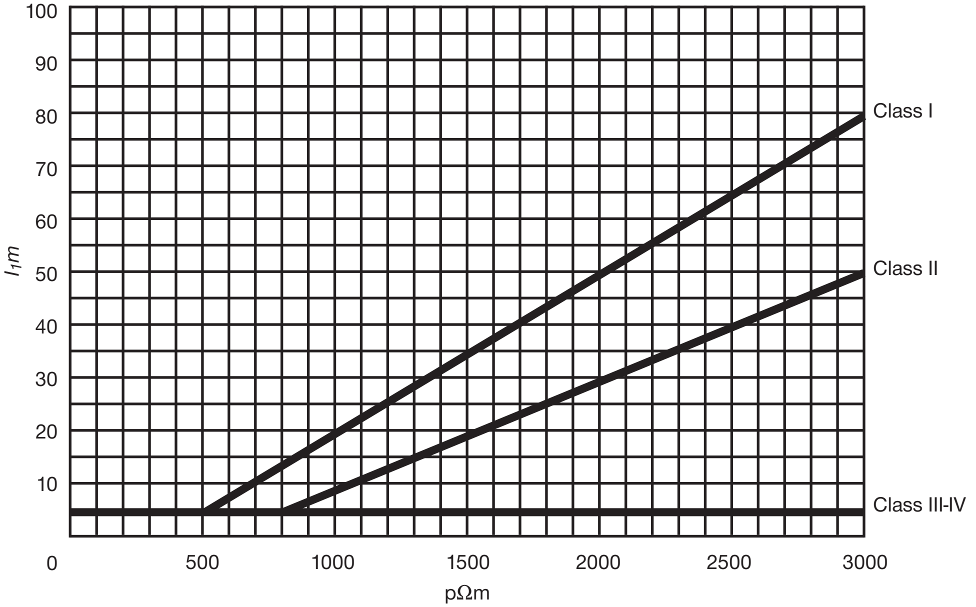
The type A arrangement uses vertical or horizontal earth electrodes. Practically it uses both connected to each down conductor, installed outside the structure (below the foundation) to be protected and housed in a plastic or concrete pit for ease of inspection figure 30.

Figure 30



The minimum number of electrodes is 2.5 metres, regardless of the perimeter of the structure/class of LPS.

The minimum length of each earth electrode at the base of each down-conductor is specified in BS EN 62305 and table below.



Minimum length l_1 of each earth electrode according to class of LPS

It is l_1 for horizontal electrodes - usually Copper Tapes.

Or

$0.5l_1$ for vertical Copperbonded Rods or Solid Copper Rods.

Or

$>l_1$ in the case of a lattice mat measuring the total length of the conductor in the mat.

Or

If copper plates are to be used the surface area of the plate should be at least equal to either.

The surface area of the length of conductor that would need to be used to satisfy the requirement for a vertical electrode $0.5l_1$.

Or

The surface area of the length of conductor that would need to be used to satisfy the requirement for a lattice mat electrode l_1.

Or

If using vertical and horizontal electrodes, the individual electrode lengths should follow the 0.5l1 and l_1 principle respectively.

Type A earth electrodes should be installed so that the top of the rod is 0.5 m below the surface, this distance is to reduce the effects of step potential at ground level.

The Earth rod should be housed in an inspection pit, commonly concrete or plastic for ease of inspection and registering the location during and after installation figure 30.

Type B Earthing Arrangement

The type B Earthing arrangement is most suitable for:

- Structures built on rocky ground
- Structures housing sensitive electronics/equipment
- Large structures

The type B earthing is recommended as either a ring conductor outside the perimeter of the structure which it's recommended should be in contact with the soil for at least 80% of its total length.

The alternative is to use a foundation earth electrode which can be in a mesh form.

It is recommended that the type B earthing network whichever method is chosen should be integrated as a meshed network buried to a minimum depth of 5 mtrs.

The reinforced concrete floor slab can be used around the structure.

If the required resistance cannot be achieved by this method the vertical or radial electrodes can be added to the network.

For ease of testing after installation an inspection pit with an earth bar should be installed where the legs of the ring and conductor routing onto the ring from the each test clamps join figure 31.

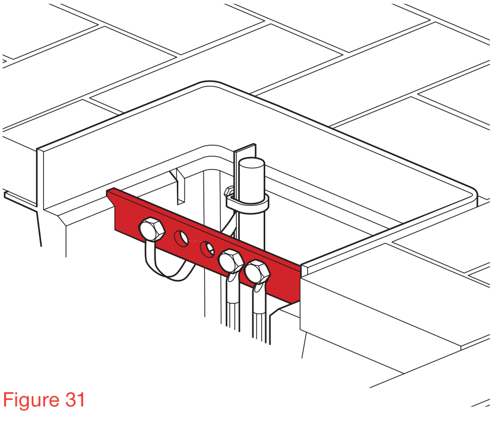


Figure 31

Any internal down conductors should be connected to the internal foundation using a test clamp for ease of maintenance.

Foundation Earth Electrodes

Once all the services are connected its unlikely the installer will be able to measure the earthing resistance of the foundation earth in isolation.

The use of the foundation as an earth electrode is allowable only where the reinforcement network is below any insulating or waterproof membrane.

Where a foundation is used as an earth-termination the reinforcing bars must be clamped or welded together to ensure electrical continuity.

Alternatively an additional meshed network of conductors can be installed to ensure continuity. The additional network should be connected to the reinforcing bars by clamps or welded joints every 20 m throughout the system.

The earthing system whether using reinforcing bars or additional conductors or a combination of both must be connected to every down conductor and internal steelwork.

Internal Lightning Protection System

The internal LPS is important to fully complete the installation to fulfil the requirements of BS EN 62305.

The main reason for installing an internal LPS is to avoid any dangerous sparking within the building.

The sparking is caused by current flow and the difference in potential between internal conductive components such as steelwork and the external LPS on the outside of the building or from the use of the internal steelwork as part of the LPS.

The earthing system whether using reinforcing bars or additional conductors or a combination of both must be connected to every down conductor and internal steelwork.

Risk Management – BS EN 62305-2:2012

The Part 2 of BS EN 62305 provides a comprehensive mathematical model to evaluate and manage the risk posed by lightning strikes.

The risk assessment is extremely time consuming to calculate by hand so Wallis can offer to do the assessment using our in house software.

The basics of the calculation can be briefly explained as follows taking into account.

The Sources of Lightning

S1: flashes to a structure
S2: flashes near a structure
S3: flashes to a line
S4: flashes near a line

The likely Damage

D1: injury to living beings by electric shock
D2: physical damage
D3: failure of electrical and electronic systems

The likely Losses

L1: loss of human life (including permanent injury)
L2: loss of service to the public
L3: loss of cultural heritage
L4: loss of economic value (structure, content, and loss of activity).

The following Table 2 from BS EN 62305 explains the link between Sources, Damages & Losses:

Table 2 – BS EN 62305
Sources of damage, types of damage and types of loss according to the point of strike

Lightning flash	Structure	
Source of damage	Type of damage	Type of loss
S1	D1	L1, L4a
	D2	L1, L2, L3, L4
	D3	L1b, L2, L4
S2	D3	L1b, L2, L4
S3	D1	L1, L4a,
	D2	L1, L2, L3,L4
	D3	L1b, L2, L4
S4	D3	L1b, L2, L4

Note:
a Only for properties where animals may be lost.
b Only for structures with risk of explosion and for hospitals or other structures where failures of internal systems immediately endangers human

Risk: The risks to be evaluated in a structure may be as follows

R1: risk of loss of a human life (including permanent injury)
R2: risk of loss of service to the public
R3: risk of loss of cultural heritage
R4: risk of loss of economic value.

Risk Management

a. Basic Procedure

The following procedure shall be applied:

i. Identification of the structure to be protected and its characteristics
ii. Identification of all the types of loss in the structure and the relevant corresponding risk R (R1 to R4); – evaluation of risk R for each type of loss R1 to R4
iii. Evaluation of need of protection, by comparison of risk R1, R2 and R3 with the tolerable risk RT
iv. Evaluation of cost effectiveness of protection by comparison of the costs of total loss with and without protection measures. In this case, the assessment of components of risk R4 shall be performed in order to evaluate such costs.

b. Structure to be considered for risk assessment includes

i. The structure itself
ii. Installations in the structure
iii. Contents of the structure
iv. Persons in the structure or in the zones up to 3 m from the outside of the structure
v. Environment affected by damage to the structure.

Protection does not include connected lines outside of the structure.

c. Tolerable Risk RT

The calculated risks R1, R2 & R3 shall be compared with tolerable risk. The permissible values for the tolerable risk are mentioned in the Table 4 BS EN 62305.

Table 4 – Typical values of tolerable risk R_T

Types of loss		R_T (y^{-1})
L1	Loss of human life or permanent injuries	10^{-5}
L2	Loss of service to the public	10^{-4}
L3	Loss of cultural heritage	10^{-4}

If $R \leq R_T$, lightning protection is not necessary. If $R > R_T$, protection measures shall be adopted in order to reduce $R \leq R_T$ for all risks to which the structure is subjected.

The manual calculations are time consuming. It is recommended to use available Lightning Protection Risk Management Software to perform these calculations.

CONSULTANTS HANDBOOK INDEX

Designing the Lightning Protection System (LPS):

Roof Termination Network:

Down Conductors:

Lightning Protection Earthing:

Risk Management – BS EN 62305-2:2012

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