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Key Changes in SS555:2018 Part 1 on General Principles



Presenter: Mah King Kheong

Date: 29th August 2018

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Significant Technical Changes

- No longer covers protection of services to structure.
- Introduction of isolated interfaces as measures to reduce electric and electronic systems failure.
- A new lightning parameter, first negative impulse current, for calculation purposes.
- More detailed specification on expected surge overcurrents for low voltage power systems and for telecommunication systems.

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Local Modifications and Information

- Annex ZA contains modifications to the IEC 62305-1

- Annex ZB contains Singapore lightning data

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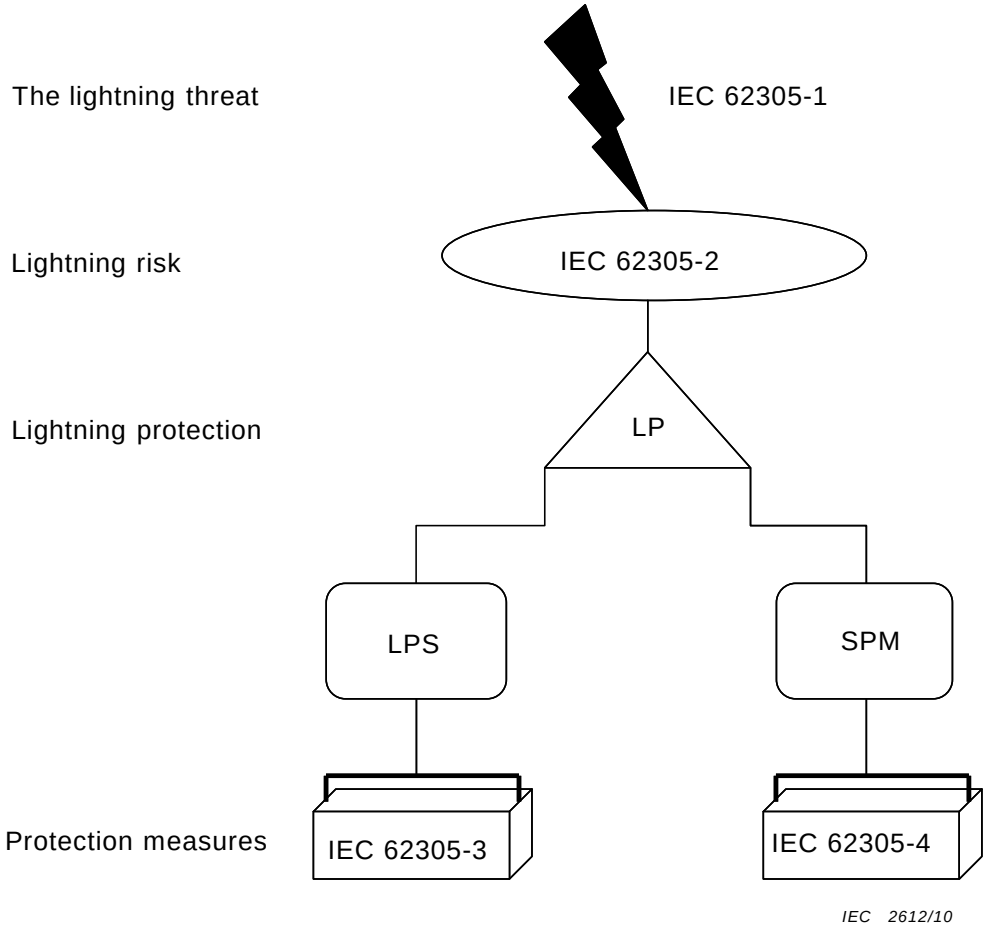
Changes due to Exclusion of Protection of Services

- Introduction

All measures for protection against lightning form the overall lightning protection. For practical reasons the criteria for design, installation and maintenance of lightning protection measures are considered in two separate groups.



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Changes due to Exclusion of Protection of Services

- Clause 1 Scope: “Protection against lightning of services connected to a structure” has been removed.

- Clause 3 Terms and Definitions:
  - Added
    - 3.23 line
    - 3.24 telecommunication Lines
    - 3.25 power lines
  - Changed/Removed
    - ~~Services to be protected~~
    - Lightning flash to ~~an object~~ a structure
    - Lightning flash near ~~an object~~ a structure

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Changes due to Exclusion of Protection of Services

- Introduction
  - Replaced “service(s)” with “line(s)”
- Clause 5 Damage due to lightning
  - Changes in Clause 5.1.1 Effects of Lightning on a structure
    - Connected ~~services~~ lines (power lines, telecommunication lines, pipeline)
  - Changes in Clause 5.1.2 Sources and types of damages
    - S3: flashes to the ~~services~~ lines connected to the structure
    - S4: flashes near the ~~services~~ lines connected to the structure
  - Removed
    - entire section on Damage to a Service

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Changes due to Exclusion of Protection of Services

- Clause 5 Damage due to lightning
  - 5.2 Types of loss
    - Removed
      - Losses which may appear in a service
      - Table depicting Damages and loss in a service according points of strike of lightning
- Clause 7 Protection measure
  - 7.3 Protection to reduce physical damage
    - Removed “Shielding wire (for services)”
  - 7.4 Protection measures to reduce failure to electrical and electronic systems
    - Removed protection measure for services
- Clause 8 Basic criteria for protection of structures ~~and services~~
  - Removed Clause on “failure of service and connected systems”

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Changes due to Exclusion of Protection of Services

- Clause 8 Basic criteria for protection of structures ~~and services~~
  - Para 1 : An ideal protection for structures would be to enclose the structure to be protected within an earthed and perfectly conducting continuous shield of adequate thickness, and to provide adequate bonding, at the entrance point into the shield, of the ~~services~~ lines connected to the structure.
  - Changes in Figure 3 and 4 annotation
    - S3: flash to a ~~service~~ line connected to the structure
    - S4: flash near a ~~service~~ line connected to the structure
    - ~~Services~~ lines connected to the service
    - Incoming ~~services~~ lines
  - Removed Clause on “Protection of services”

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Changes due to Exclusion of Protection of Services

- Clause 8 Basic criteria for protection of structures ~~and services~~
  - Clause 8.4 Protection of Structures
    - Changes in 8.4.1 Protection to reduce damage and life hazard
      - inside the structure, by equipotential bonding of ~~services~~ lines at entrance point into the structure.

  - Removed Clause on “Protection of services”

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Changes due to Exclusion of Protection of Services

- Annex E Surge due to lightning at different installation point
  - Changes
  - E.3 Surges relevant to ~~services~~ lines connected to structure
    - E.3.1 Surges due to flashes to ~~services~~ lines
      - For direct lightning flashes to connected ~~services~~ lines, partitioning of the lightning current in both directions of the line and the breakdown of insulation should be taken into account.
    - E.3.2 Surges due to flashes near the ~~services~~ lines
      - Surges from flashes near ~~services~~ lines have energies much lower than those associated with flashes to lines (source of damage S3).

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Isolated interfaces as measures to reduce electric and electronic systems failure

- Clause 3 Terms and Definitions
  - Added
    - Isolating interfaces
- Clause 7 Protection Measures
  - Added to Clause 7.2 Protection Measures to reduce injury to living beings ~~due to touch and step voltages~~ from electric shock
    - Added to possible protection measures
      - Lightning equipotential bonding (EB)
  - Added to Clause 7.3 Protection Measures to reduce damage
    - Added to possible protection features
      - Air and earth termination system
      - Down-conductor system
      - Lightning equipotential bonding (EB)
      - Electrical insulation against eternal LPS
  - Clause 7.4 Protection measures to reduce failure to electrical and electronic systems
    - Added
      - Isolating interfaces

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Isolated interfaces as measures to reduce electric and electronic systems failure

- Clause 8 Protection Measures
  - Changes in Clause 8.3 Lightning Protection Zones (LPZ)
    - LPZ 1 zone where the surge current is limited by current sharing and by isolating interfaces and/or SPDs at the boundary. Spatial shielding may attenuate the lightning electromagnetic field.
    - LPZ 2,…n zone where the surge current may be further limited by current sharing and by isolating interfaces and/or additional SPDs at the boundary. Additional spatial shielding may be used to further attenuate the lightning electromagnetic field.
  - Changes in Clause 8.4.2 Protection to reduce failure of internal systems
    - Effective protection against overvoltages, causing failures of internal systems, may also be achieved by means of isolating interfaces and/or a coordinated SPD system, limiting overvoltages below the rated impulse withstand voltage of the system to be protected.
    - Isolating interfaces and SPDs shall be selected and installed according to the requirements of IEC 62305-4

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First negative impulse current parameter

- Clause 8 Protection Measures
  - Clause 8.2 Lightning Protection Level
    - Table 3 – Maximum values of lightning parameters according to LPL

Table 3 – Maximum values of lightning parameters according to LPL

First positive impulse			LPL			
Current parameters	**Symbol**	**Unit**	**I**	**II**	**III**	**IV**
Peak current	I	kA	200	150	100	
Impulse charge	Q_{SHORT}	C	100	75	50	
Specific energy	**W/R**	MJ/Ω	10	5,6	2,5	
Time parameters	T_1 / T_2	µs / µs	10 / 350			
First negative impulse			**LPL**			
Current parameters	**Symbol**	**Unit**	**I**		**II**	**III**
Peak current	I	kA	100		75	50
Average steepness	di/dt	kA/µs	100		75	50
Time parameters	T_1 / T_2	µs / µs	1 / 200			
Subsequent impulse			**LPL**			
Current parameters	**Symbol**	**Unit**	**I**	**II**	**III**	**IV**
Peak current	I	kA	50	37,5	25	
Average steepness	di/dt	kA/µs	200	150	100	
Time parameters	T_1 / T_2	µs / µs	0,25 / 100			

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First negative impulse current parameter

- Annex A Parameters of Lightning Current
  - Clause A.3 Fixing the maximum current parameters for LPL I
    - A.3.3 First negative impulse
    - Annex A Parameters of Lightning
- Annex B Time functions of the lightning current for analysis purposes
  - Table B.4 Parameters calculated for different LPL

Parameters	First positive impulse			First negative impulse			Subsequent negative impulse		
	LPL			LPL			LPL		
	I	II	III-IV	I	II	III-IV	I	II	III-IV
I (kA)	200	150	100	100	75	50	50	37,5	25
k	0,93	0,93	0,93	0,986	0,986	0,986	0,993	0,993	0,993
T_1 (µs)	19	19	19	1,82	1,82	1,82	0,454	0,454	0,454
T_2 (µs)	485	485	485	285	285	285	143	143	143

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First negative impulse current parameter

- Annex B Time functions of the lightning current for analysis purposes
  - Fig B.3 Shape of current rise of first negative impulse
  - Fig B.4 Shape of current tail of first negative impulse
  - Fig B.7 Amplitude density of the lightning current according to LPL I (includes first negative stroke)

Note that the first negative impulse is not to be used for test purposes.

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Specifications for expected surge overcurrents for low voltage power systems and for telecommunication systems

- Annex E Surges due to lightning at different installation points
  - Table E.2 Expected surge overcurrents due to lightning flashes on low voltage system
  - Table E.3 Expected surge overcurrents due to lightning flashes on telecommunication systems

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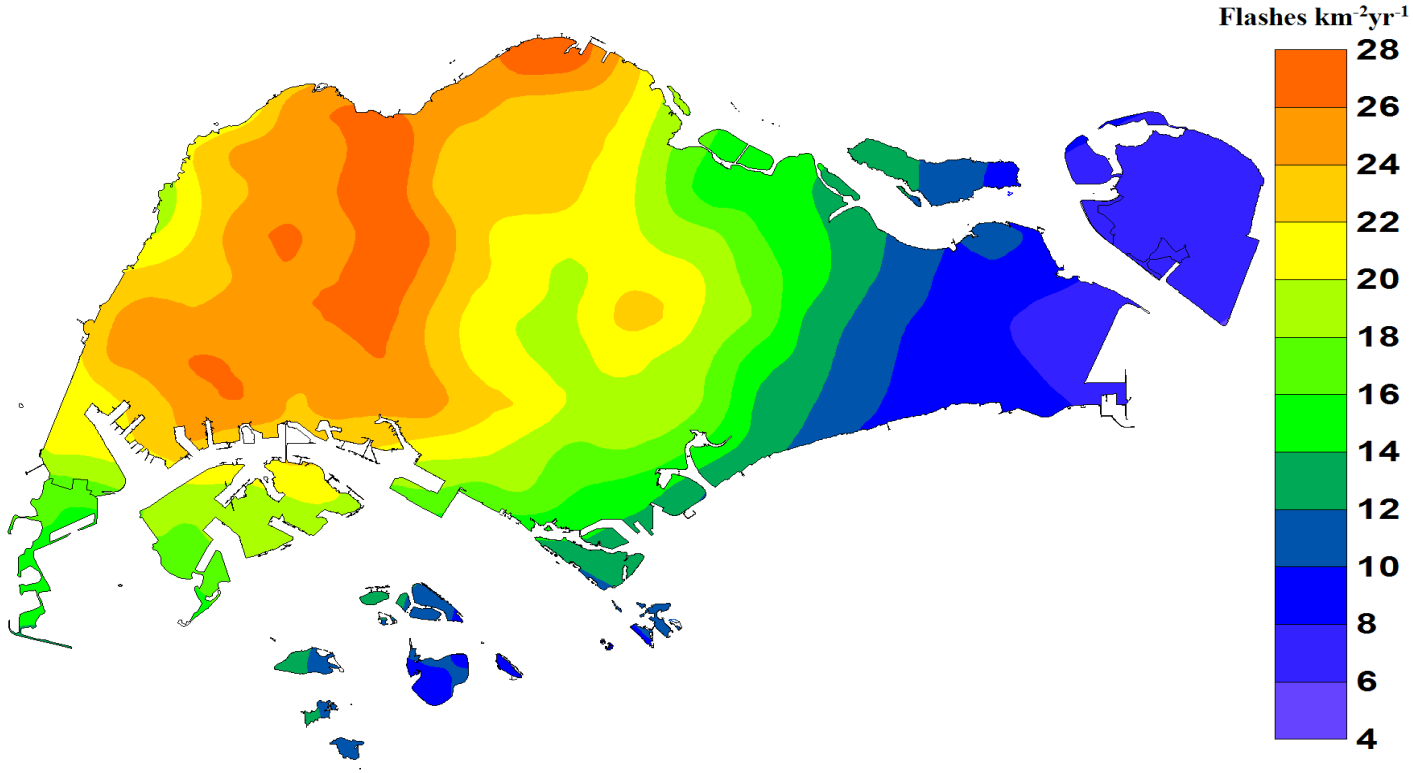
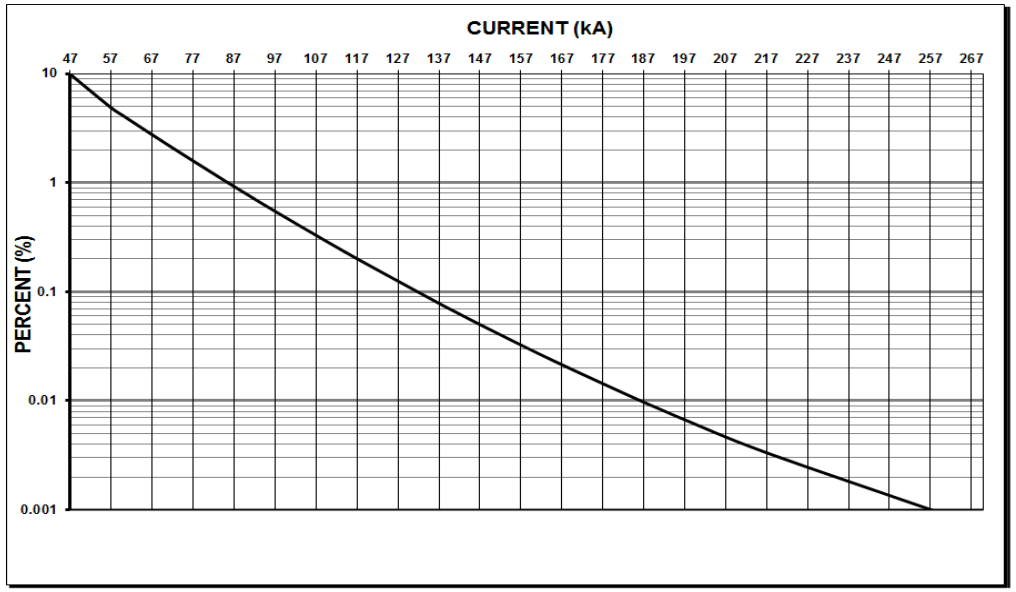
Annex ZB Singapore Lightning Data Information

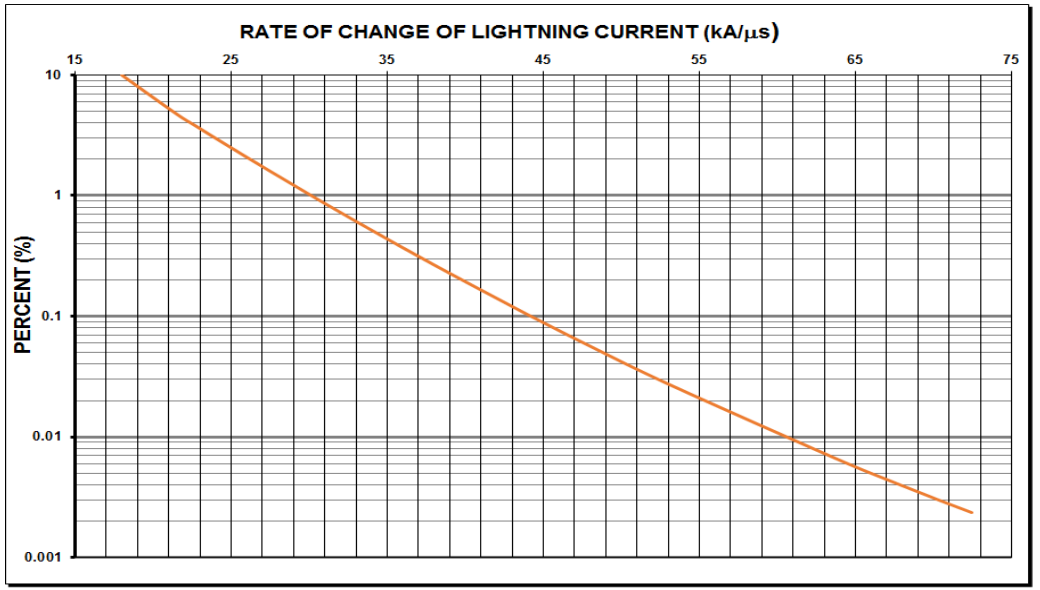
- New ground flash density map using Malaysian and Singapore Lightning Detection System data.



Annex ZB Singapore Lightning Data Information

- Updated cumulative distribution of first lightning stroke current magnitude.
- Newly added cumulative distribution of rate of change of first stroke current di/dt.





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Changes In
Part 2 : Risk Management



Presenter: Er. Chua Hian Koon

Date: 29 Aug 2018

Significant Technical Changes

1) Risk assessment for services connected to structures is excluded from the scope.
2) Injuries of living beings caused by electric shock inside the structure are considered.
3) Tolerable risk of loss of cultural heritage is lowered from 10^{-3} to 10^{-4}. Extended damage to surroundings structures / environment is considered.

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Significant Technical Changes

5) Improved equations for evaluation of
   - collection areas relevant to flashes nearby a structure,
   - collection areas relevant to flashes to and nearby a line,
   - probabilities that a flash can cause damage,
   - loss factors even in structures with risk of explosion,
   - risk relevant to a zone of a structure,
   - cost of loss.
6) Tables are provided to select the relative amount of loss in all cases.
7) Impulse withstand voltage level of equipment was extended down to 1kV.

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1) Risk assessment for services connected to structures is excluded from the scope

4.2 Risk and risk components
4.3 Composition of risk components

$R_X = N_X . P_X . L_X$

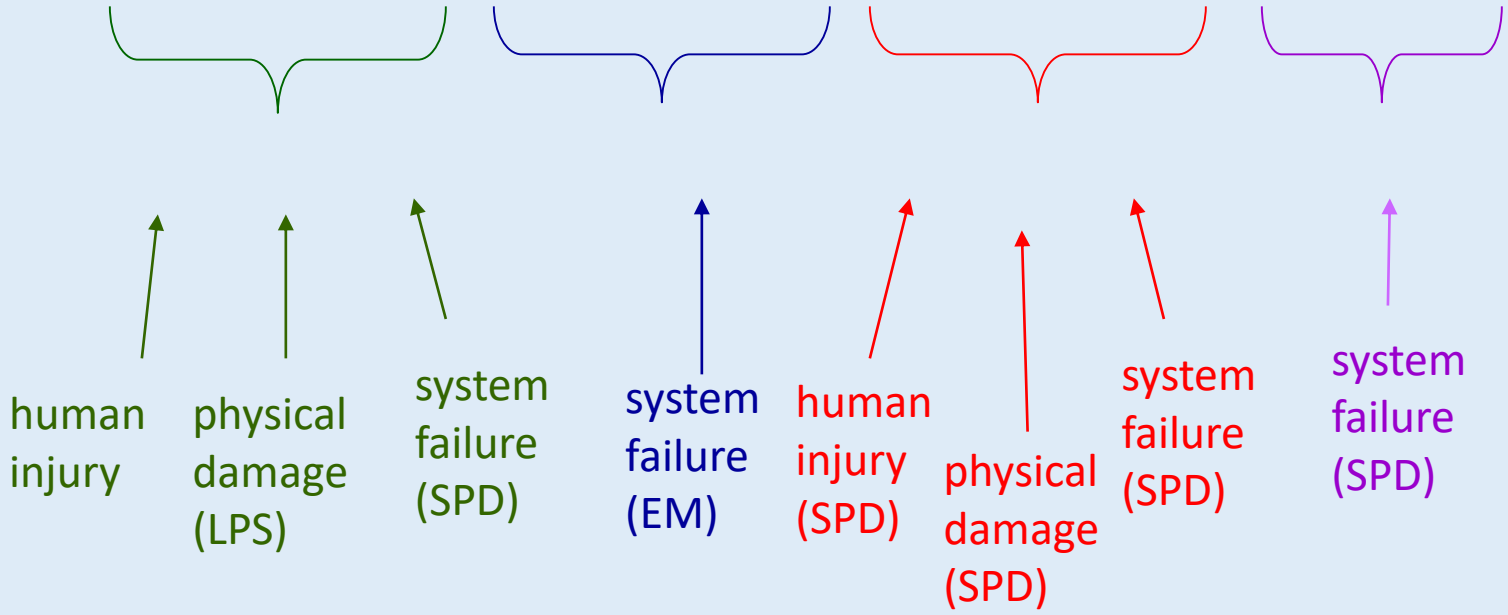
N_X is the number of dangerous events
P_X is the probability of damage
L_X is the consequent loss

X take A, B, C, M, U, V, W or Z

Risk (R_1 to R_4) for Structure RETAINED:

$$R = R_{\text{Direct on structure}} + R_{\text{Near structure}} + R_{\text{Direct on line}} + R_{\text{Near line}} < R_T$$

$$R_{1,2,3,4} = R_A + R_B + R_C + R_M + R_U + R_V + R_W + R_Z$$



4.4 Composition of risk components related to a service (OLD)

$R'_X = N_X . P'_X . L'_X$

N_X is the number of dangerous events
P'_X is the probability of damage
L'_X is the consequent loss

X take B, C, V, W or Z

REMOVED: ANNEX E (OLD)
Assessment of the amount of loss *L'x* in a service

Risk (R_2 , R_4) for Service EXCLUDED:

$$R' = R'_{\text{Direct on structure}} + R'_{\text{Direct on service}} + R'_{\text{Near service}} < R'_T$$

$$R'_{2,4} = R'_B + R'_C + R'_V + R'_W + R'_Z$$

EXCLUDED

- R'_2 risk of loss to the public in a service
- R'_4 risk of loss of economic value in a service

2) Injuries of living beings caused by electric shock inside the structure are considered

Table B.1 – Values of probability P_{TA} that a flash to a structure will cause shock to living beings due to dangerous touch and step voltages

Additional protection measure	P_{TA}
No protection measures	1
Warning notices	10^{-1}
Electrical insulation (e.g. at least 3 mm cross-linked polyethylene) of exposed parts (e.g. down-conductors)	10^{-2}
Effective soil equipotentialization	10^{-2}
Physical restrictions or building framework used as a down-conductor system	0

ADDED

$$P_A = P_{TA} \times P_B \qquad (B.1)$$

$$P_U = P_{TU} \times P_{EB} \times P_{LD} \times C_{LD} \qquad (B.8)$$

NEW

Table B.6 – Values of probability P_{TU} that a flash to an entering line will cause shock to living beings due to dangerous touch voltages

Protection measure	P_{TU}
No protection measures	1
Warning notices	10^{-1}
Electrical insulation	10^{-2}
Physical restrictions	0

3) Tolerable risk of loss of cultural heritage is lowered from 10^{-3} to 10^{-4}

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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^{-3}
L3	Loss of cultural heritage	10^{-4}

(WAS 10^{-3})

The value of tolerable risk of loss of economic value ($R_T = 10^{-3}$) is introduced, to be used when data for cost/benefit analysis are not available.

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4) Extended damage to surroundings structures or to the environment is considered

Annex C (Informative) Assessment of amount of loss L_X

NOTE 1 When the damage to a structure due to lightning may also involve surrounding structures or the environment (e.g. chemical or radioactive emissions), a more detailed evaluation of L_X that takes into account this additional loss should be performed.

- **C.3 Loss of human life (L1), C.6 Economic Loss (L4)**

When the damage to a structure due to lightning involves surrounding structures or the environment (e.g. chemical or radioactive emissions), additional loss (L_E) should be taken into account to evaluate the total loss (L_{FT}):

$$L_{FT} = L_F + L_E \qquad \text{(C.5)}$$

where

$$L_E = L_{FE} \times t_e/8\,760 \qquad \text{(C.6)}$$

L_{FE} being the loss due to physical damage outside the structure;

t_e being the time of presence of people in the dangerous place outside the structure.

or circulation

5) Improved equations for evaluation of

- *N* **collection areas** relevant to flashes nearby a structure
- *N* **collection areas** relevant to flashes to and nearby a line
- *P* **probabilities** that a flash can cause damage
- *L* **loss factors** even in structures with risk of explosion
- *Rz* **risk relevant to a zone** of a structure
- *C* **cost of loss**

Risk $R=N.P.L,$

Cost $C=R.c_t$

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N Collection Areas to and nearby a Structure

Annex A (Informative) Assessment of annual number *N* of dangerous events

250m

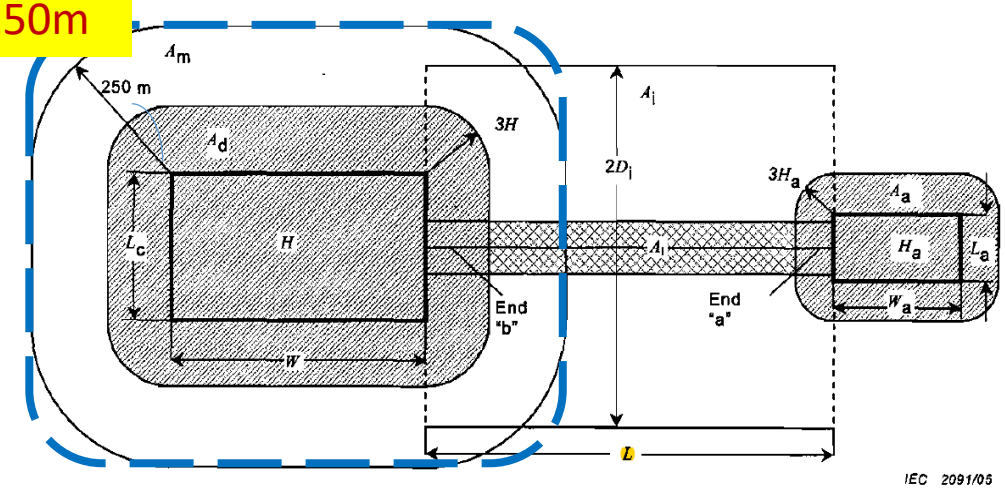

Fig A.5 (OLD)

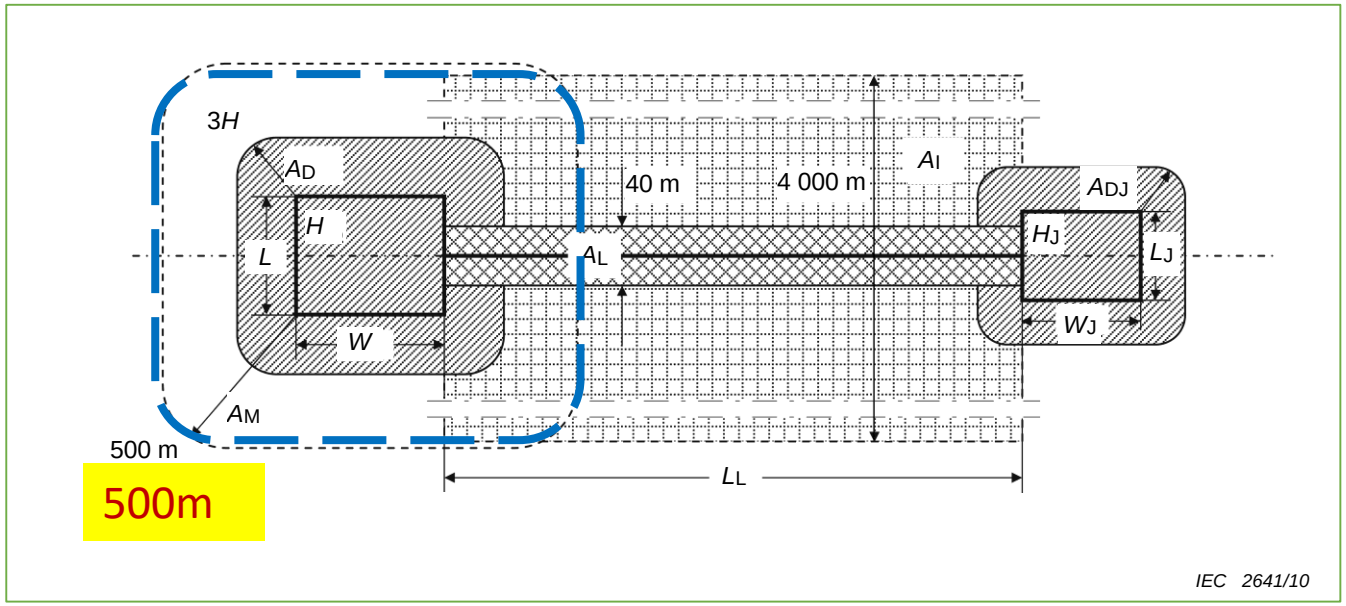

Fig A.5 (NEW)

A_M flashes near the structure: 500m ~~*250m*~~ from perimeter

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N Collection Areas to and nearby a Line

Annex A (Informative) Assessment of annual number *N* of dangerous events

Direct strike to line

- Direct aerial Al (Lc-3(Ha+Hb))6Hc
  Direct buried Al (Lc-3(Ha+Hb)) √ρ
- Near aerial Ai 1000Lc
  Near buried Ai 25Lc√ρ

Table A.3 – Collection areas of service (OLD)

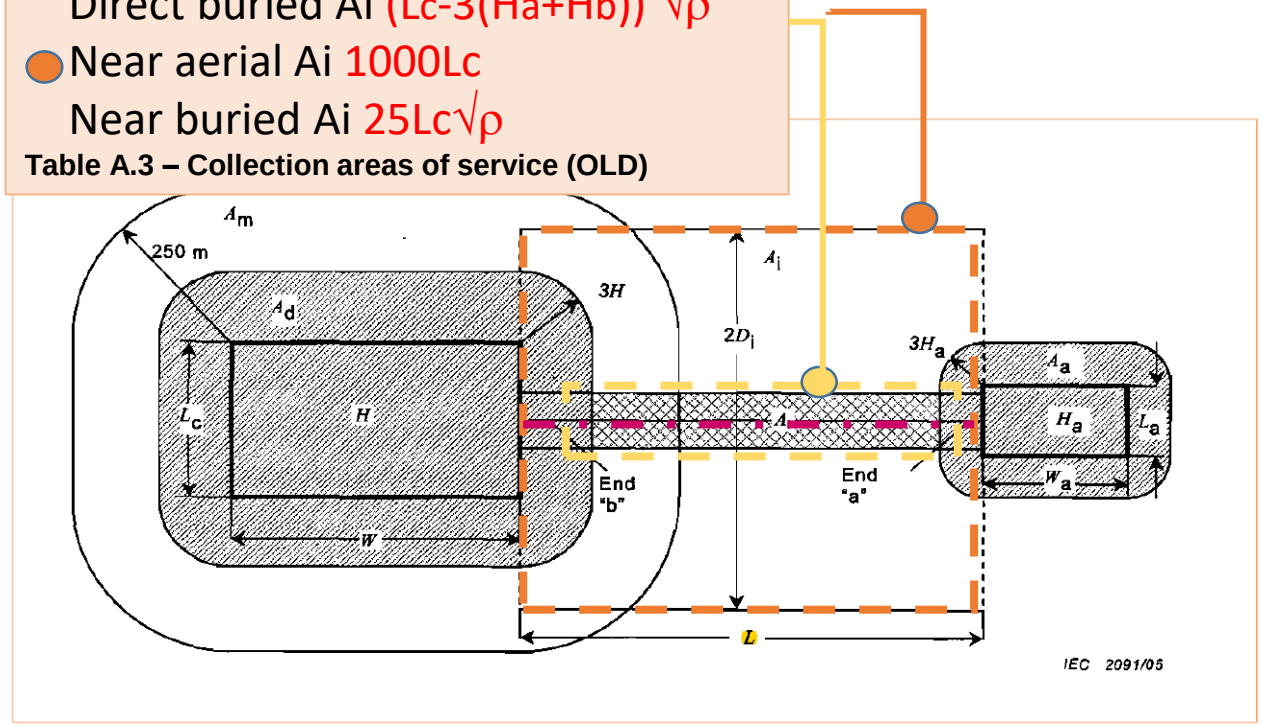

Fig A.5 (OLD)

Strike to line

- Direct strike Al 40 Lc ,
- Near strike Al 4000 Lc,

Table A.2 – Line installation factor Cl (NEW)
Cl =1 (aerial), Cl=0.5, 0.01 (buried)

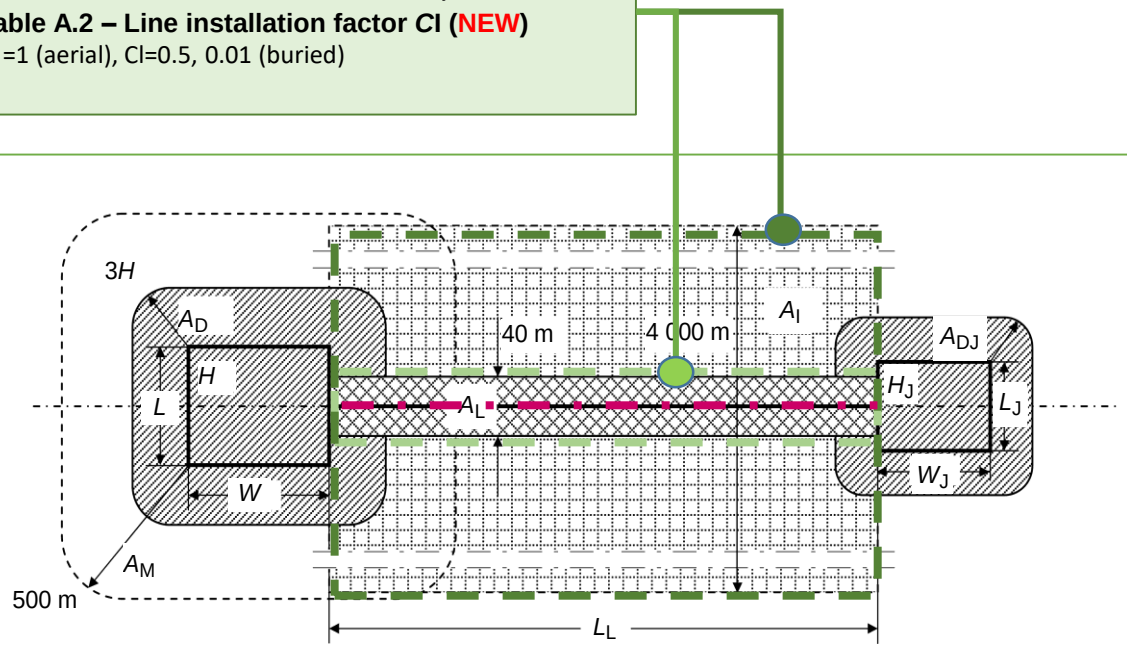

Fig A.5 (NEW)

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P Improved equations for evaluation of Probabilities that a flash can cause damage

Annex B (Informative) Assessment of probability Px of damage

P_B	Table B.2
$P_A = P_{TA} \times P_B$	(B.1), Tables B.1, B.2
$P_C = P_{SPD} \times C_{LD}$	(B.2), Tables B.3, B.4
$P_M = P_{SPD} \times P_{MS}$	(B.3), Table B.3
$P_{MS} = (K_{S1} \times K_{S2} \times K_{S3} \times K_{S4})^2$	(B.4), Table B.5
$P_U = P_{TU} \times P_{EB} \times P_{LD} \times C_{LD}$	(B.8), Tables B.6, B.7, B.8, B.4
$P_V = P_{EB} \times P_{LD} \times C_{LD}$	(B.9), Tables B.7, B.8, B.4
$P_W = P_{SPD} \times P_{LD} \times C_{LD}$	(B.10), Tables B.3, B.8, B.4
$P_Z = P_{SPD} \times P_{LI} \times C_{LI}$	(B.10), Tables B.3, B.9, B.4

L Improved equations for evaluation of loss factors even in structures with risk of explosion

Annex C (Informative) Assessment of amount of loss *Lx*

Table C.1 – Type of loss L1: Loss values for each zone

Type of damage	Typical loss	Equation
D1	$L_A = r_t \times L_T \times n_Z / n_t \times t_z / 8\,760$	(C.1)
D1	$L_U = r_t \times L_T \times n_Z / n_t \times t_z / 8\,760$	(C.2)
D2	$L_B = L_V = r_p \times r_f \times h_z \times L_F \times n_Z / n_t \times t_z / 8\,760$	(C.3)
D3	$L_C = L_M = L_W = L_Z = L_O \times n_Z / n_t \times t_z / 8\,760$	(C.4)

where

L_T is the typical mean relative numbers of victims injured by electric shock (D1) due to one dangerous event (see Table C.2);

L_F is the typical mean relative numbers of victims by physical damage (D2) due to one

or circulation

Rz Improved equations for evaluation of risk relevant to a zone of a structure

- **3.1.2 Structures with risk of explosion**

Structures containing solid explosives materials or hazardous zones as determined in accordance to IEC 60079-10-1 and IEC 60079-10-2.

- 3.1.49 zone 0
- 3.1.50 zone 1
- 3.1.51 zone 2
- 3.1.52 zone 20
- 3.1.53 zone 21
- 3.1.54 zone 22

NEW

Table C.5 – Reduction factor r_f as a function of risk of fire or explosion of structure

Risk	Amount of risk	r_f
Explosion	Zones 0, 20 and solid explosive	1
	Zones 1, 21	10^{-1}
	Zones 2, 22	10^{-3}
Fire	High	10^{-1}
	Ordinary	10^{-2}
	Low	10^{-3}
Explosion or fire	None	0

irculation

C Improved equations for evaluation of cost of loss

Annex D (Informative) Evaluation of costs of loss

- Protection is justified if the annual saving $S_M > 0$.

  The annual saving S_M in money is:

$$S_M = C_L - (C_{PM} + C_{RL}) \qquad \text{(D.6) (same)}$$

- $C_L = \Sigma\ C_{LZ} = R_4 \times c_t$ cost of total loss without protection (improved)
- $C_{PM} = C_P \times (i + a + m)$ annual cost of protection measures (same)
- $C_{RL} = \Sigma\ C_{RLZ} = R'_4 \times c_t$ cost of residual loss in a zone (improved)

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6) Tables are provided to select the relative amount of loss in all cases.

Tables for relative amount of loss reformatted:

***L1* Loss of human life L1**

Tables C.2, C.3, C.4, C.5, C.6

***L2* Loss of service to the public**

Tables C.7, C.8

***L3* Loss of irreplaceable cultural heritage**

Table C.9 equations, Table C.10

***L4* Economic loss**

Table C.11 equations

loss factors considered in structures with risk of explosion

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7) Equipment impulse withstand voltage level extended down to 1kV

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Table B.8 – Values of the probability P_{LD} depending on the resistance R_S of the cable screen and the impulse withstand voltage U_W of the equipment

Line type	Routing, shielding and bonding conditions		Withstand voltage U_W in kV				
			1	1,5	2,5	4	6
Power lines or Telecom lines	Aerial or buried line, unshielded or shielded whose shield is not bonded to the same bonding bar as equipment		1	1	1	1	1
	Shielded aerial or buried whose shield bonded to the same bonding bar as equipment	5Ω/km < R_S ≤ 20 Ω/km	1	1	0,95	0,9	0,8
		1Ω/km < R_S ≤ 5 Ω/km	0,9	0,8	0,6	0,3	0,1
		R_S ≤ 1 Ω/km	0,6	0,4	0,2	0,04	0,02

NEW

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Finally, for information

REMOVED **Annex F** (OLD) on **Switching overvoltages**

REMOVED **Annex I** (OLD) on **Case study for services – Telecommunication line**

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Changes in Part 3 : Physical damage to structures and life hazard



Presenter: Er Professor Liew Ah Choy

Date: 29 August 2018

Significant Technical Changes

1) Minimum thicknesses of metal sheets or metal pipes given in Table 3 for air-termination systems are assumed as not able to prevent hot-spot problems.
2) Steel with electro-deposited copper is introduced as material suitable for LPS.
3) Some cross-sectional areas of LPS conductors were slightly modified.
4) For bonding purposes, isolating spark gaps are used for metal installations and SPD for internal systems.

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Significant Technical Changes

5) Two methods – simplified and detailed – are provided for evaluation of separation distance.
6) Protection measures against injuries of living beings due to electric shock are considered also inside the structure.
7) Improved information for LPS in the case of structures with a risk of explosion are given in Annex D (normative).

8) The modifications to the International Standard IEC 62305-3 are given in Annex ZA. To facilitate identification, the affected text of the International Standard which is to be changed is indicated by a left marginal bar adjacent to it.

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Metal sheets covering the structure to be protected

Table 3 – Minimum thickness of metal sheets or metal pipes in air-termination systems

Class of LPS	Material	Thickness[a] *t* mm	Thickness[b] *t'* mm
I to IV	Lead	–	2,0
	Steel (stainless, galvanized)	4	0,5
	Titanium	4	0,5
	Copper	5	0,5
	Aluminium	7	0,65
	Zinc	–	0,7

[a] *t* prevents puncture.

[b] *t'* only for metal sheets if it is not important to prevent puncture, hot spot or ignition problems.

- **the thickness of the metal sheet is not less than the value *t'* given in Table 3 if it is not important to prevent puncture of the sheeting or to consider ignition of any readily-combustible materials underneath,**
- **the thickness of the metal sheet is not less than the value *t* given in Table 3 if it is necessary to take precautions against puncture or to consider hot spot problems,**

NOTE 1 Where hot spot or ignition problems may arise, it should be verified that the temperature rise of the inner surface at the point of strike does not constitute a danger. Hot spot or ignition problems can be disregarded when the metal sheets lies inside an LPZ0B or higher.

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Material	Configuration	Dimensions		
		Earth rod diameter mm	Earth conductor mm^2	Earth plate mm
Copper Tin plated copper	Stranded		50	
	Solid round	15	50	
	Solid tape		50	
	Pipe	20		
	Solid plate			500 × 500
	Lattice plate [c]			600 × 600
Hot dipped galvanized steel	Solid round	14	78	
	Pipe	25		
	Solid tape		90	
	Solid plate			500 × 500
	Lattice plate [c]			600 × 600
	Profile	[d]		
Bare steel[b]	Stranded		70	
	Solid round		78	
	Solid tape		75	
Copper coated steel	Solid round	14 [f]	50	
	Solid tape		90	
Stainless steel	Solid round	15 [f]	78	
	Solid tape		100	

[a] Mechanical and electrical characteristics as well as corrosion resistance properties shall meet the requirements of the future IEC 62561 series.

[b] Shall be embedded in concrete for a minimum depth of 50 mm.

[c] Lattice plate constructed with a minimum total length of the conductor of 4,8 m.

[d] Different profiles are permitted with a cross-section of 290 mm2 and a minimum thickness of 3 mm, e.g. cross profile.

[e] In case of a type B arrangement foundation earthing system, the earth electrode shall be correctly connected at least every 5 m with the reinforcement steel.

[f] In some countries the diameter may be reduced to 12,7 mm.

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Steel with electro-deposited copper is introduced as material suitable for LPS.

Table 7 – Material, configuration and minimum dimensions of earth electrodes

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Table 8 – Minimum dimensions of conductors connecting different bonding bars or connecting bonding bars to the earth-termination system

Class of LPS	Material	Cross-section mm2
I to IV	Copper	16 ~~(14)~~
	Aluminium	25 ~~(22)~~
	Steel	50

Table 9 – Minimum dimensions of conductors connecting internal metal installations to the bonding bar

Class of LPS	Material	Cross-section mm2
I to IV	Copper	6 ~~(5)~~
	Aluminium	10 ~~(8)~~
	Steel	16

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6.3.2 Simplified approach

Number of down-conductors n	kc
1 (only in case of an isolated LPS)	1
2	0,66
3 and more	0,44
NOTE Values of Table 12 apply for all type B earthing arrangements and for type A earthing arrangements, provided that the earth resistance of neighbouring earth electrodes do not differ by more than a factor of 2. If the earth resistances of single earth electrodes differ by more than a factor of 2, kc = 1 is to be assumed.	

Table 12 – Isolation of external LPS – Approximated values of coefficient kc

In typical structures for the application of Equation (4), the following conditions have to be considered:

- kc depends on the (partial) lightning current flowing on the down-conductor arrangement (see Table 12 and Annex C);
- l is the vertical length, in metres, along the down-conductor, from the point where the separation distance is to be considered, to the nearest equipotential bonding point.

Further information on partitioning of the lightning current amongst down-conductors is given in Annex C.

NOTE The simplified approach usually leads to results being on the safe side.

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8 Protection measures against injury to living beings due to touch and step voltages

8.1 Protection measures against touch voltages

In certain conditions, the vicinity of the down-conductors of an LPS, may be hazardous to life even if the LPS has been designed and constructed according to the above-mentioned requirements.

The hazard is reduced to a tolerable level if one of the following conditions is fulfilled:

a) under normal operation conditions there are no persons within 3 m from the down-conductors;
b) a system of at least 10 natural down-conductors complying with 5.3.5 is employed;
c) the contact resistance of the surface layer of the soil, within 3 m of the down-conductor, is not less than 100 kΩ.

NOTE A layer of insulating material, e.g. asphalt, of 5 cm thickness (or a layer of gravel 15 cm thick) generally reduces the hazard to a tolerable level.

If none of these conditions is fulfilled, protection measures shall be adopted against injury to living beings due to touch voltages as follows:

– insulation of the exposed down-conductor is provided giving a 100 kV, 1,2/50 μs impulse withstand voltage, e.g. at least 3 mm cross-linked polyethylene;
– physical restrictions and/or warning notices to minimize the probability of down-conductors being touched.

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8.2 Protection measures against step voltages

In certain conditions, the vicinity of the down-conductors may be hazardous to life even if the LPS has been designed and constructed according to the above-mentioned rules.
The hazard is reduced to a tolerable level if one of the following conditions is fulfilled:

a) under normal operation conditions there are no persons within 3 m from the down-conductors;
b) a system of at least 10 (natural) down-conductors complying with 5.3.5 is employed;
c) the contact resistance of the surface layer of the soil, within 3 m of the down-conductor, is not less than 100 kΩ.

NOTE A layer of insulating material, e.g. asphalt, of 5 cm thickness (or a layer of gravel 15 cm thick) generally reduces the hazard to a tolerable level.

If none of these conditions is fulfilled, protection measures shall be adopted against injury to living beings due to step voltages as follows:

- equipotentialization by means of a meshed earth-termination system;
- physical restrictions and/or warning notices to minimize the probability of access to the dangerous area, within 3 m of the down-conductor.

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Annex D
(normative)
~~(previously informative)~~

Additional information for LPS in the case of structures with a risk of explosion

(Improved information given)

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Annex ZA
(normative)

National differences

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5.3.6 Test joints

At the connection of the earth-termination, a test joint should be fitted on each down-conductor, except in the case of natural down-conductors combined with foundation earth electrodes.

For maintenance purposes involving natural down conductor system, at least two test joints should be provided.

For measuring purposes, the joint shall be capable of being opened with the aid of a tool. In normal use it shall remain closed.

Recommended heights of test joints are as follows:
Type 1: Expose down conductor [2.5m]
Type 2: Natural down conductor and flushed mounted test joint [1.5m]

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5.4 Earth-termination system

5.4.1 General

When dealing with the dispersion of the lightning current (high frequency behaviour) into the ground, whilst minimizing any potentially dangerous overvoltages, the shape and dimensions of the earth-termination system are the important criteria. In general, a low earthing resistance (if possible lower than **10 Ω** when measured at low frequency) is recommended.

Each individual earth electrode of an interconnected earth electrode system of (n) number of earth electrodes should on its own have a resistance to earth not exceeding the product obtained by multiplying 10 Ω by n.

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6 Internal lightning protection system

6.1 General

The internal LPS shall prevent the occurrence of dangerous sparking within the structure to be protected due to lightning current flowing in the external LPS or in other conductive parts of the structure.

Dangerous sparking may occur between the external LPS and other components such as:

- **metal installations;**
- **internal systems;**
- **external conductive parts and lines connected to the structure.**

NOTE 1 Sparking occurring within the structure with danger of explosion is always dangerous. In this case additional protective measures are required which are under consideration (see Annex D).

NOTE 2 For protection against overvoltages of internal systems, refer to IEC 62305-4.

Dangerous sparking between different parts can be avoided by means of

- **equipotential bonding in accordance with 6.2, or**
- **electrical insulation between the parts in accordance with 6.3.**

- Equipotential bonding of air-termination system at roof level with steel reinforcement of building structure for a conventional down conductor system is recommended to reduce the high transient voltage created by the rate of rise of lightning current and high impedance path of the down conductors. Lightning current injected into the air-termination system would be distributed through the large amount of parallel paths formed by the down conductors and reinforcing rods creating a cage of potential equalization for the whole building. This will result in a lower local voltage differences and the risk of electric shock due to touch voltages will be corresponding reduced.

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8.3 Protection in open spaces

8.3.2 Designated protected zone

When identifying the open areas for lightning protection, the size of the open spaces, the number of people using these spaces and the frequency of usage will be considered. Based on these considerations, **three types of designated areas have been identified.**

Type A: Small defined open spaces where full protection can be provided. Some examples of these include playgrounds and hard courts in residential estates. **[No change]**

Type B: Open habitable roof spaces where people are regularly present and where full protection can be provided. Some examples of these are:

- penthouse open terrace;
- roof gardens;
- roof multi-storey car parks;
- roof amenities such as sport facilities, swimming pools, café, etc.

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8.3.2 Designated protected zone – cont'd

Type C: Large open spaces where full protection is not practicable. Some examples of these are:

- school fields;
- public parks;
- beaches;
- golf courses;
- vacant lands used for ad-hoc activities such as fun fairs, trade fairs, etc. **[No change]**

8.3.4 For Type B open spaces where people are regularly present and full protection can be provided, LPS design for the protection of people against direct lightning strikes and injuries from electric shock due to touch and step voltages shall be adopted to reduce the hazard to a tolerable level.

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8.3.4 – cont'd

The LPS design may use overhead protection structures in the form of trellis, higher surrounding structures, lightning rods or catenary wires to ensure such habitable open spaces fall within protected zones established by the air termination where applicable.

The use of natural air-termination components, such as metallic fences, lighting masts, etc. can also be made. The height of the air-termination systems shall take into account a person's height allowance of 2,5 m along with the necessary separation distances (see also Figure E.3).

Adequate insulation of exposed lightning conductors or concealment within structures shall be considered in the design to reduce the potential touch voltage hazards to a tolerable level.

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8.3.4 – cont'd

Equipotential bonding of steel rebar within reinforced concrete slab with LPS to prevent dangerous step voltages shall be considered in the design to reduce the potential step voltage hazard to a tolerable level.

If nothing of this kind is available, a localised lightning detection and warning device should also be provided to alert users of approaching storms. In conjunction, signs shall be provided at entrances drawing attention to the danger of lightning strikes during inclement weather. People should stop all outdoor activities and seek shelter in a substantial building or metal bodied hard-top vehicle.

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8.4 Additional measures for habitable rooftop spaces (e.g. roof gardens, penthouse terraces)

8.4.1 Exposed metal fixtures such as railings, staircases, windows, antennae and M&E services (e.g. ducts, pipes, cable containments) fall under 3 categories:

a) Metal fixtures which do not fall within the protected zones of the air-termination systems: These should be connected to the LPS as part of the LPS.

b) Metal fixtures which fall within the protected zones of the air-termination systems but not within the requirements of separation distances (clause 6.3): These should be bonded to the LPS.

c) Metal fixtures which fall within the protected zones of the air-termination systems and the requirements of separation distances (clause 6.3): These should not be bonded to the LPS but should be bonded to the floor rebars of the structure.

NOTE For more information on protection of flush-mounted or protruding roof fixtures, see Annex E.

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8.4 Additional measures for habitable rooftop spaces (e.g. roof gardens, penthouse terraces) – cont'd

8.4.2 The LPS design should also ensure that air termination elements and conductors of the LPS such as exposed lightning protection tapes and down-conductors, are not located within easy reach of users of these habitable rooftop spaces. Where building design poses constraints, insulation of exposed lightning tape should be provided to prevent direct user contact.

Signs shall be provided near conductors drawing attention to the risks of side flashes and electric shock due to touch and step voltages during lightning strikes to a LPS.

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8.5 LPS Signs

8.5.1 LPS Warning Signs (minimum size of 210mm by 297mm) shall be provided at entrances to habitable and non-habitable maintenance roof spaces to draw attention to the danger of lightning strikes from approaching and during thunderstorm.



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8.6 Protection of corners and edges of flat roofs and parapet walls of tall buildings

8.6.1 Lightning strikes at corners and edges of flat roofs and parapet walls of tall buildings in Singapore are common even though LPS are provided. This may cause injury to persons due to spalling concrete falling from heights. Conductive metal covering shall be provided at exposed corners of concrete structures of 45 m and above to allow lightning current to be diverted through the down conductor system to the earth termination system. For structures below 45 m in lieu of metal capping, suitable finials should be provided at exposed corners.

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8.6 Protection of corners and edges of flat roofs and parapet walls of tall buildings – cont'd

Equipotential bonding of the metallic covering or finials to the roof air termination system and the rebars of the concrete structure shall be effected at intervals not greater than the separation requirements of the down conductors. This is to prevent sparking between the metallic covering and the rebars. The minimum thickness of metal cover shall be in accordance to Table 3 for such an application.

The installation of the metallic coverings and air finials to the roof air termination system shall be designed and installed to withstand wind loading in accordance to Eurocode 3:1993 Design of Steel Structures and Eurocode 9:1999 Design of Aluminium Structures.

Explanation: Addresses local requirements and how roof air termination system should be secured and installed.

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Annex E

Convert Annex E from Informative to Normative.

Explanation: It contains good engineering solutions for the design, construction, maintenance and inspection of LPS that can be adopted by the industries.

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E.2.2.2 *Insert* the following paragraph at the end of E.5.2.2.2 a)

Notwithstanding the above, air termination systems against flashes to the sides of structures should be provided down to a height of 45 m.

The use of studs connected to the embedded mesh of side conductors can be considered for the protection against flashes to the sides of the structure. The spacing of the studs shall conform to the requirements of the respective lightning protection classes given in Table 2.

Explanation: Addresses local requirements as the lightning ground flash density in Singapore is very much higher than elsewhere.

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E.5.2.4.2.8 Para 2 *Remove* the following sentences:

To protect the people on the ground from direct lightning flashes, air-termination rods conforming to the rolling sphere method, may also be necessary. These rods can be replaced by natural air-termination components, such as fences, lighting masts, etc. The height of the air-termination systems shall take into account people's height allowance of 2,5 m along with the necessary separation distances (see also Figure E.3).

If nothing of the kind is available, people should be made aware that during a thunderstorm they may be exposed to a direct lightning flash.

Explanation: This part has been addressed under the National Difference Clause 8.3.2 "Designated Protected Zone", Type B (Open habitable roof spaces).

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E.5.6.2.2, Para 5 *Insert* the following after paragraph 5:

While aluminium tapes are not disallowed for mandatory compliance, it is advised that aluminium tapes should not be attached directly to calcareous building surfaces such as concrete, limestone and plaster as this may hasten the corrosion of the aluminium tape. Additionally, bare aluminium tapes shall not be embedded within concrete elements of the building and in earth, except if these are completely sleeved with a durable, close-fitting insulating sleeve.

As a precaution, mitigation measures in the LPS design shall be taken to prevent the direct contact of the aluminium tape with bare calcareous building surfaces as far as possible, such as with the use of saddles at closer intervals or painting of the surfaces. Alternatively, it is advised that potential corrosion effects may be reduced through increases in material size, using corrosion resistant components, or taking other corrosion protection measures. In such cases, during the lifecycle of the building, more regular inspection intervals of the LPS than the recommended intervals required may be implemented to ensure the continued integrity of the LPS.

Explanation: Addresses local requirements because aluminium tapes are used widely in local industry practice as LPS conductors in air termination and down conductor systems.

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E.7.1, Para 3 *Replace* paragraph 3 with:

During installation of the LPS, especially during installation of components which are concealed in the structure and will become inaccessible.

Photographs of all concealed equipotential bonding between metal fixtures, steel rebars of concrete and LPS shall be documented. Some examples of metal fixtures include railings, windows and façades.

Insert the following at paragraph 3:

During the installation, the earthing resistance of the foundation earth electrodes of an interconnected earth electrode system must be recorded.

Explanation: Addresses documentation of LPS works during installation.

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E.7.2.5, Para 3 *Insert* the following after paragraph 3:

The LPS inspection report shall be endorsed by a lightning protection specialist who shall be a Professional Engineer (Electrical) registered with Professional Engineer Board.

Explanation: Addresses local requirements.

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ZB.9.2 Large tents and marquees

Where large temporary structures of this type are used for such purposes as exhibitions and entertainments involving large numbers of people, consideration should be given to their protection against lightning and the touch/step potential differences caused by effects of lightning.

Where such structures are manufactured from non-metallic materials, the simplest form of protection will usually consist of one or more horizontal air terminals suspended above them and connected solidly to earth. A non-metallic extension of the vertical supports provided for such structures may, if convenient and practicable, be used for supporting a network of horizontal air terminals but a clearance of not less than 1.5 m should be maintained between the conductor and the fabric of the enclosure. Downconductors should be arranged outside the structure away from exits and entrances and be connected to earthing rods that, in turn, should be connected to a ring conductor in such a manner as to be inaccessible to the general public. Those types of tented structure that have metal frameworks should have these efficiently bonded to earth at intervals of not more than 20 m of perimeter.

Where such structures are manufactured from electrically conducting fabric material of sufficient electrical conductivity and current carrying capacity, the conducting roof material can act as the lightning air terminal. Metallic supports where used can serve as the downconductors. Where non-metallic supports are used, separate downconductors must be provided. These should be connected to earthing rods that, in turn, should be connected to a ring conductor in such a manner as to be inaccessible to the general public. The provision of a groundsheet of electrically conducting material within the tent will also provide ground potential equalization. The groundsheet should also be bonded to the metallic support downconductors. Ground potential equalization can also be achieved by the use of rectangular wooden floor boards with metallic strips wrapping around their sides. Such boards, typically of 2.4m by 1.2m in size, shall be laid compactly side by side for electrical continuity.

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ZC.3.3 Indoor and outdoor swimming pools

Certain locations are extremely hazardous during thunderstorms and should be avoided if at all possible. Statistics show that more than 10% of lightning-related injuries and deaths are water related (e.g. fishing, boating and swimming). Swimming pool facilities are connected to a large surface area via underground water pipes, gas lines, electric and telephone wiring, etc. Hence, lightning strikes to the ground anywhere on this metallic network may cause shocks elsewhere. Indoor and outdoor pools are treated the same with regard to lightning dangers.

Note: Where closure of the indoor pool cannot be avoided, additional steps should be taken to ensure equipotential bonding is effected. Special advice should be sought on its design.

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Changes in Part 4 : Electrical & Electronic Systems within Structures



Presenter: Er. Teh Siaw Peng

Date: 29 August 18

Significant Technical Changes

- Isolating interfaces capable of reducing conducted surges on lines entering the structure are introduced.
- Minimum cross-sections for bonding components are slightly modified.
- First negative impulse current is introduced for calculation purposes as electromagnetic source of harm to the internal systems.
- Selection of SPD with regard to voltage protection level is improved to take into account oscillation and induction phenomena in the circuit downstream of SPD.

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Significant Technical Changes

- Annex C dealing with SPD coordination is withdrawn and referred back to SC 37A.
- A new informative Annex D is introduced giving information on factors to be considered in the selection of SPDs.

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Isolating Interfaces to Reduce Conducted Surges on Lines

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8. Isolating Surfaces

- Devices capable of reducing conducted surges on lines
  - Isolation Transformers with earthed screen between windings
  - Metal Free Fibre Optic Cables
  - Opto-Isolators
- Isolating interfaces may be used to reduce the effects of LEMP. Protection of such interfaces against overvoltages, where needed, may be achieved using SPDs.
- The withstand level of the isolating interface and the voltage protection level of the SPD shall be coordinated with the overvoltage categories of IEC 60664-1.

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B.10 Protection by Isolating Interfaces (Annex B)

- Power-frequency interference currents through the equipment and its connected signal lines can be caused by large loops or the lack of a sufficiently low impedance bonding network. To prevent such interference (mainly in TN-C installations), a suitable separation between existing and new installations can be achieved using isolating interfaces, such as:

  - class II insulated equipment (i.e. double insulation without a PE-conductor),
  - isolation transformers,
  - metal-free fibre optic cables,
  - optical couplers.

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Changes in the Minimum Cross Sections for Bonding Components

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5.6 Material and Dimensions of Bonding Components

Table 1 – Minimum cross-sections for bonding components

Bonding component		Material [a]	Cross-section [b] mm²
Bonding bars (copper, copper coated steel or galvanized steel)		Cu, Fe	50
Connecting conductors from bonding bars to the earthing system or to other bonding bars (carrying the full or a significant part of lightning current)		Cu	16
		Al	25
		Fe	50
Connecting conductors from internal metal installations to bonding bars (carrying a partial lightning current)		Cu	6
		Al	10
		Fe	16
Earthing conductors to the SPD (carrying the full or a significant part of lightning current) [c]	Class I	Cu	16
	Class II		6
	Class III		1
	Other SPDs [d]		1

[a] Other material used should have cross-sections ensuring equivalent resistance.

[b] In some countries, smaller conductor sizes may be used, provided that they fulfil the thermal and mechanical requirements – see Annex D of IEC 62305-1:2010.

[c] For SPDs used in power applications, additional information for connecting conductors is given in IEC 60364-5-53 and IEC 61643-12.

[d] Other SPDs include SPDs used in telecommunication and signalling systems.

14
22
50

5
8
16

5
3
1

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Introduction of
First Negative Impulse current (Stroke)

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Introduction of First Negative Impulse current (Annex A – A.3, A.4)

- First negative impulse current (stroke) is introduced for calculation purposes as an electromagnetic source of harm to the internal systems.
- The primary electromagnetic sources of harm to the electronic system are the lightning current and the magnetic field. Partial lightning currents flow through the incoming services. Magnetic fields generated by the 1st positive stroke, 1st negative stroke and subsequent strokes are considered in the assessment of the effects of inductive couplings.
- For some inductive coupling effects, the first negative impulse leads to the highest induced voltages. The magnetic induction effects are mainly caused by the rising front of the magnetic field.

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Selection of SPDs - Improved

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Selection of SPDs (Annex C – C.2)

- Selection of SPD with regard to voltage protection level is improved to take into account oscillation and induction phenomena in the circuit downstream of SPD.
- During the operating state of an SPD, the voltage between the SPD terminals is limited to *U*P/F (***see next slide***) at the location of the SPD. If the length of the circuit between the SPD and the equipment is too long, propagation of surges can lead to an oscillation phenomenon. In the case of an open-circuit at the equipment's terminals, this can increase the overvoltage up to 2x*U*P/F and failure of equipment may result even if *U*P/F smaller or equal to *U*W.

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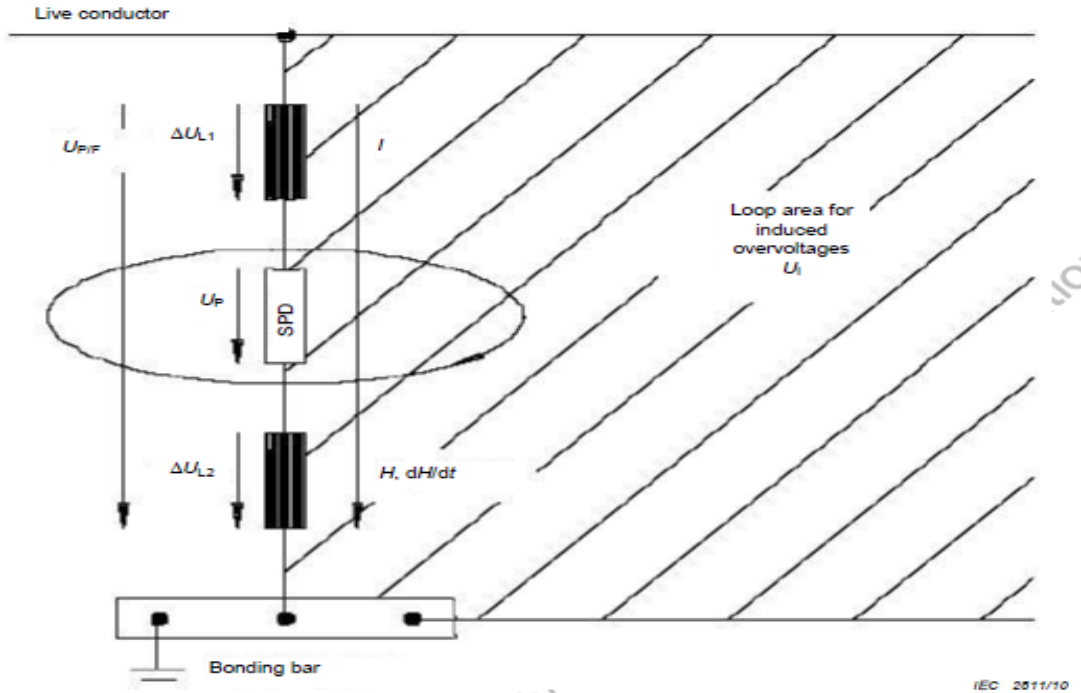
Voltage Protection Level taking into account Oscillation and Induction Phenomena in the Circuit downstream of SPD



Key

I	partial lightning current
U_I	induced overvoltage
$U_{P/F} = U_P + \Delta U$	surge voltage between live conductor and bonding bar
U_P	limiting voltage of SPD
$\Delta U = \Delta U_{L1} + \Delta U_{L2}$	inductive voltage drop on the bonding conductors
H, dH/dt	magnetic field and its time derivative

NOTE The surge voltage $U_{P/F}$ between the live conductor and the bonding bar is higher than the protection level U_P of the SPD, because of the inductive voltage drop ΔU at the bonding conductors (even if the maximum values of U_P and ΔU do not necessarily appear simultaneously). That is, the partial lightning current flowing through the SPD induces additional voltage into the loop on the protected side of the circuit following the SPD. Therefore, the maximum voltage endangering the connected equipment can be considerably higher than the protection level U_P of the SPD.

Figure C.1 – Surge voltage between live conductor and bonding bar

Draft for review by SC2WG3 only

Annex C dealing with SPD coordination is withdrawn and referred back to SC 37A

- SC 37A scope – To prepare international standards for surge protective devices (SPDs) for protection against indirect and direct effects of lightning and/or against other transient overvoltages and for information on their selection and application. These devices are to be used in power, telecommunications and/or signalling networks with voltages up to 1000 V a.c. and 1500V d.c. Requirements for selection and erection of SPDs in electrical installations of buildings as covered by TC 64 are excluded.

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New informative Annex D on Factors to be Considered in the Selection of SPDs

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Factors determining the stress experienced by an SPD

- Location of SPDs
- Methods of lightning strike coupling onto structure
- Distribution of lightning currents within the structure
- Resistance & inductance of services entering the structure
- Additional conductive services connected to the facility
- Type of lightning waveshape
- Additional structures which are interconnected to the primary structure via the power service

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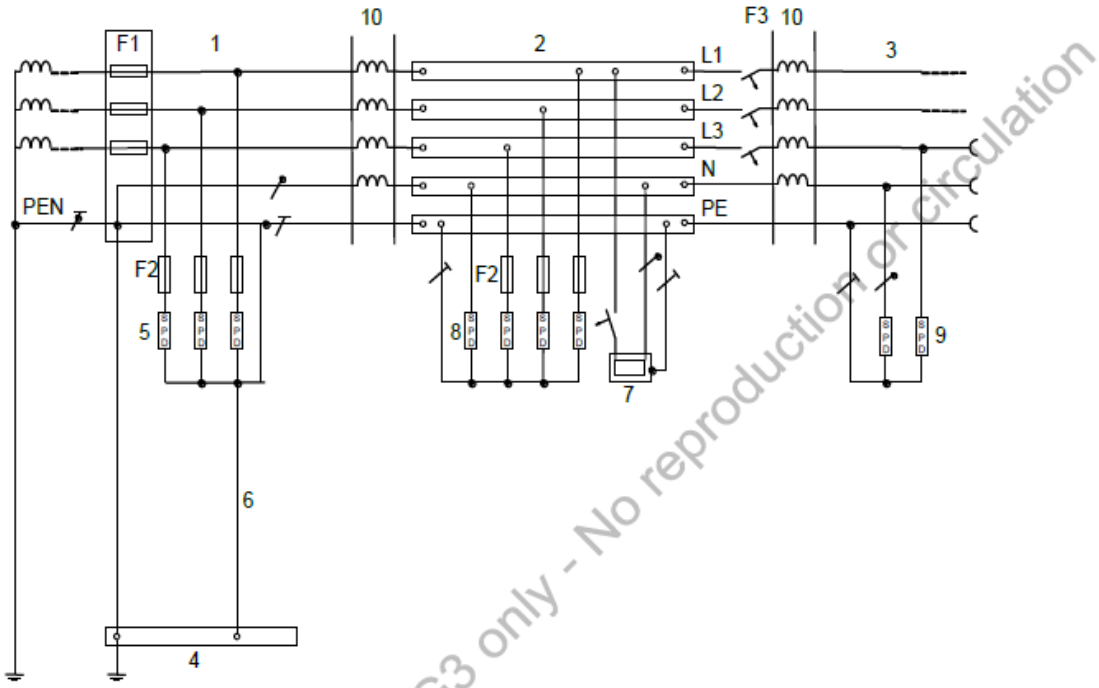
Factors determining the stress experienced by an SPD

- Location of SPDs



Key

1 origin of the installation
2 distribution board
3 distribution outlet
4 main earthing terminal or bar
5 surge protective device, class I or II tested
6 earthing connection (earthing conductor) of the surge protective device
7 fixed equipment to be protected
8 surge protective device, class II tested
9 surge protective device, class II or class III tested
10 decoupling element or line length
F1, F2, F3 overcurrent protective disconnectors

NOTE Refer to IEC 61643-12 for further information.

Figure D.1 – Installation example of test class I, class II and class III SPDs

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Factors determining the stress experienced by an SPD

- Methods of lightning strike coupling onto structure

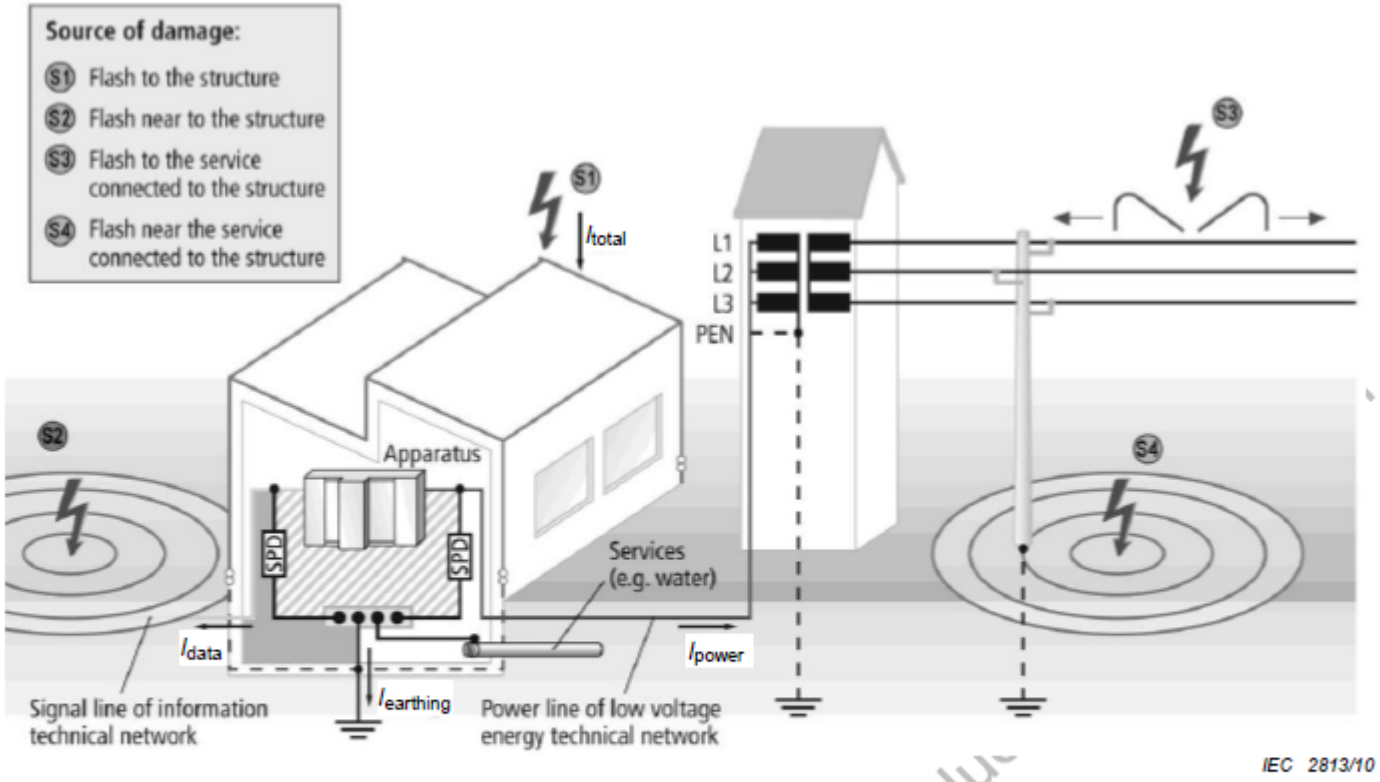

Figure D.2 – Basic example for different sources of damage to a structure and lightning current distribution within a system

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Factors determining the stress experienced by an SPD

- Distribution of Lightning Current Within the Structure

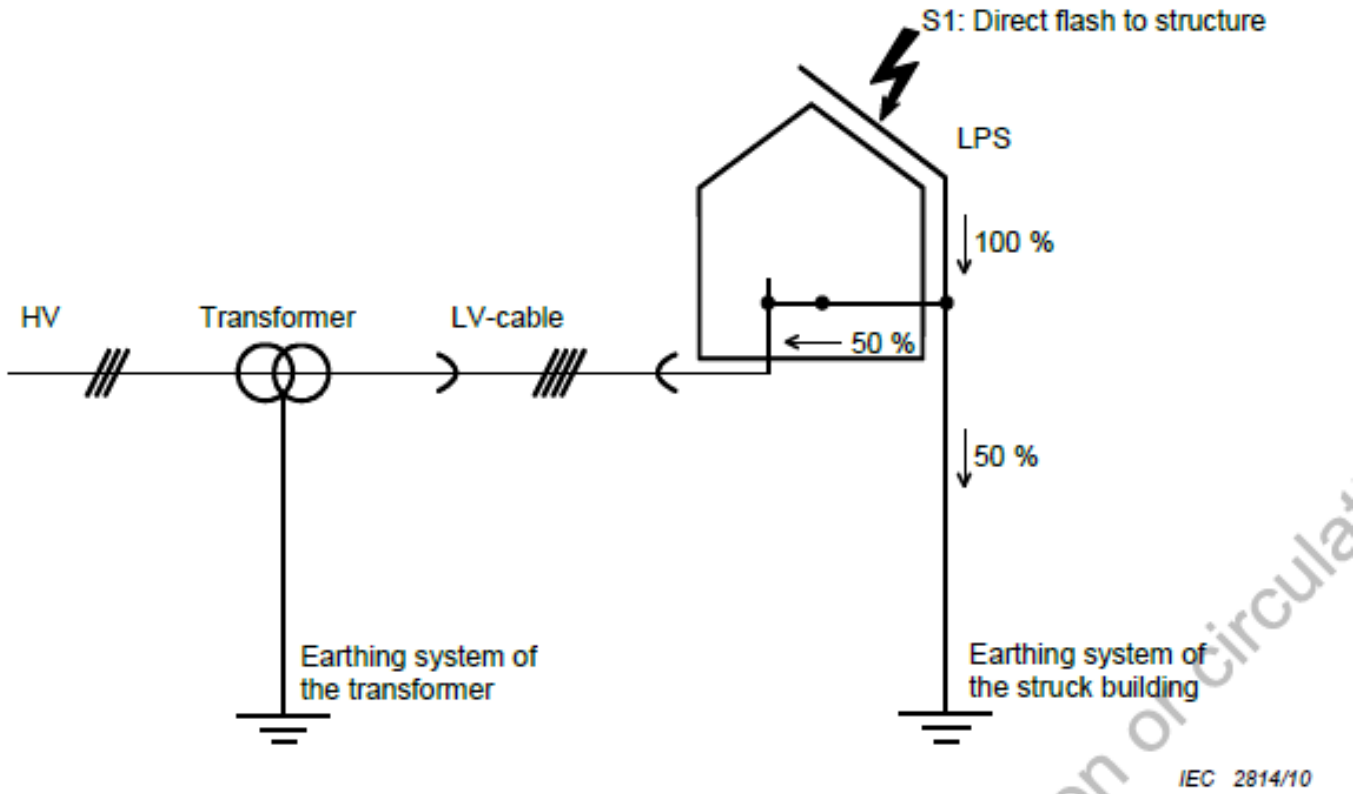

Figure D.3 – Basic example of balanced current distribution

- Number of metallic services supplying the structure
- Earthing practice of the services entering the structure

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Considerations in the selection of SPD ratings

- In general, the approach should be to use a test class I SPD where direct or partial lightning currents are involved and a test class II/III SPD for induced effects.
- The most important aspect in selecting an SPD is its voltage-limiting performance during the expected surge event, and the energy withstand (*I*imp, *I*max, *I*n, *U*OC) which it can handle.
- An SPD with a limiting voltage lower than the withstand voltage of the equipment will ensure equipment protection.
- An SPD with an appropriate withstand energy required at the point of installation would result in a longer SPD operating life

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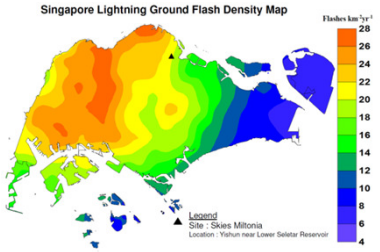
BCA BRIEFING
ON
ADOPTION OF SS555:2018









Building and Construction Authority

We shape a safe, high quality, sustainable and friendly built environment.

Presented By : Tan Keng Swee

Date : 29 Aug 2018

Nos of Slides : 21

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Briefing Outline













1 Lightning Protection System

2 TOP Observations

3 Circulars & TOP Submission – What need to be submitted for LPS?

4 What's upcoming?

Part 1 : Lightning Protection System (LPS)

Building and Construction Authority

Lightning Protection System

1. Approved Document Clause L under Fifth Schedule Building Control Regulation

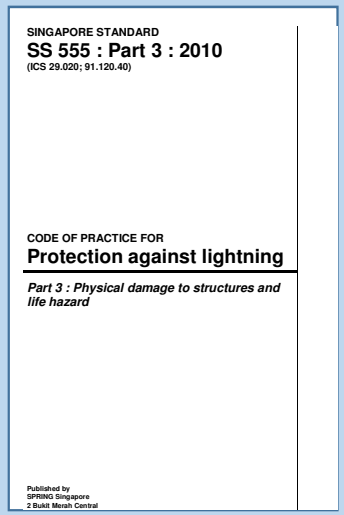
2. SS555:2010 COP Protection Against Lightning Part 3 : Physical Damage to Structures and Life Hazard

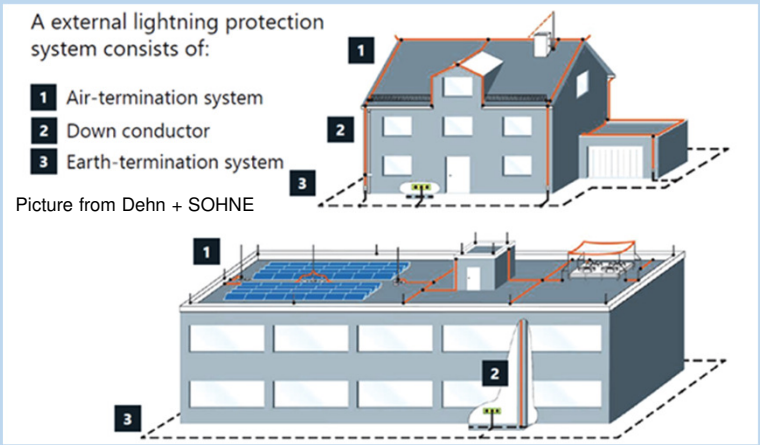
3. SS555:2018 COP Protection Against Lightning Part 3 : Physical Damage to Structures and Life Hazard

Objective of Lightning Protection System is to

- protect a building from the direct effects of a lightning strike and
- protect its occupants from the risk of lightning current being discharged through the building.







Part 1 : Adoption SS555: 2018

Building and Construction Authority

When is the effective date for building to comply with SS555:2018 COP Protection Against Lightning?

- currently, designs which are in accordance with SS555:2010 are deemed to have complied with Approved Document under Building Control Regulation;
- BCA will issue a Circular in Sept/Oct 18 to inform the industries on the adoption of SS555:2018 and
- a grace period of 6 months will be given

Illustration **:**
If circular is issued on 30 Sept 2018, than with effect from 30 Mar 2019, developments whose building plans are submitted on or after this date must comply with the relevant requirements in SS555:2018.

Part 2 : LPS Good Practices

Building and Construction Authority

OBSERVATIONS and FEEDBACKS from PEs

1. PE (Design) & PE(Supervision) are often engaged too late, when the architectural design is firmed up making changes difficult and costly.

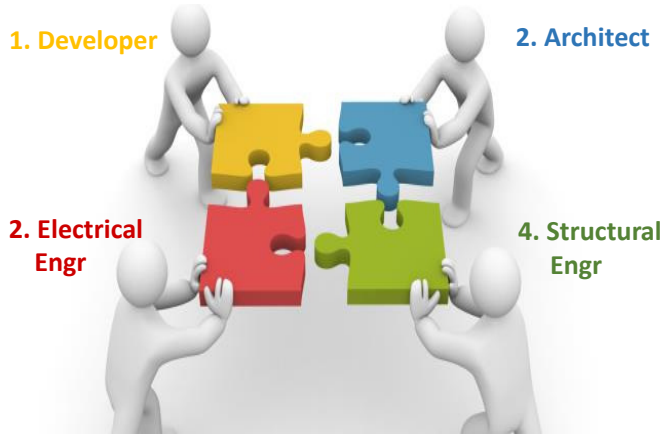
2. Provision of LPS is limited by architectural design.

EARLY Design Engagement

1. Stakeholders – Developer, Architect, Electrical Engineer and Structural Engineer

2. A fully integrated LPS design can be provided for buildings during design development

3. Design for Maintenance (Dfm) to allow proper access for inspection and testing of LPS. LPS is recommended to be maintained regularly.



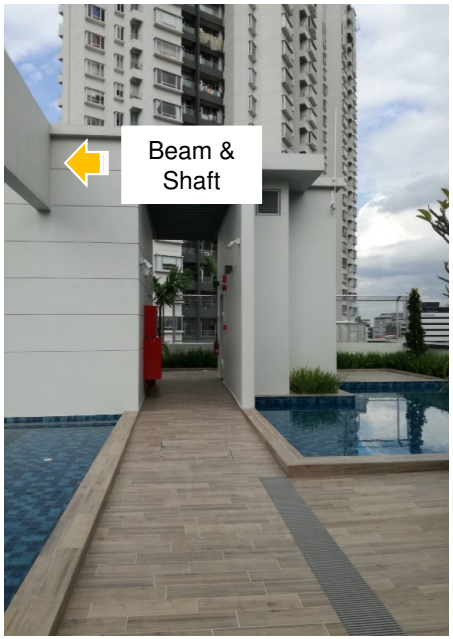
Stakeholder Design Engagement

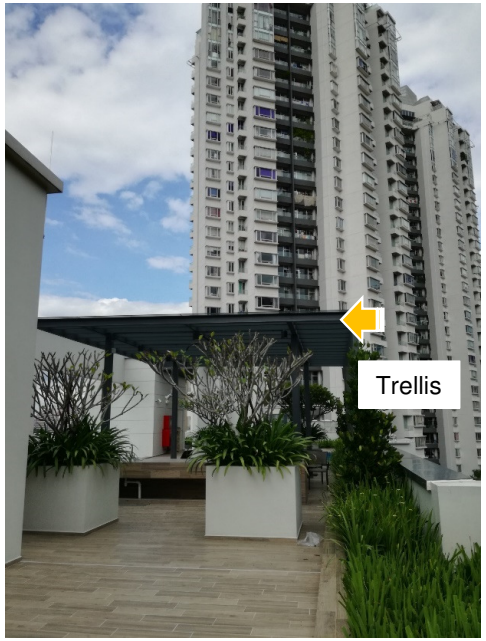
TOP OBSERVATIONS

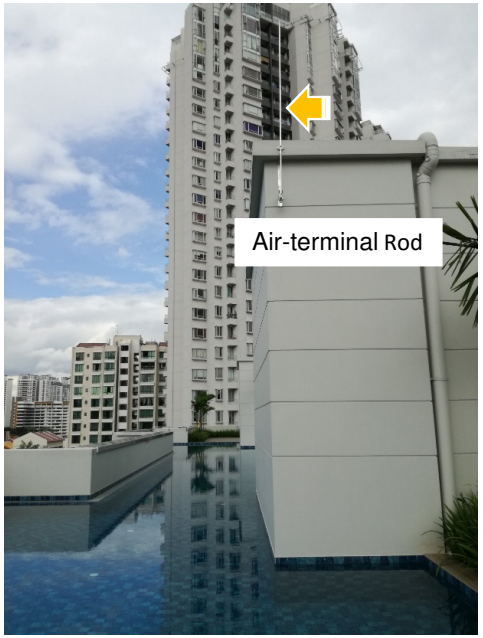
Building and Construction Authority

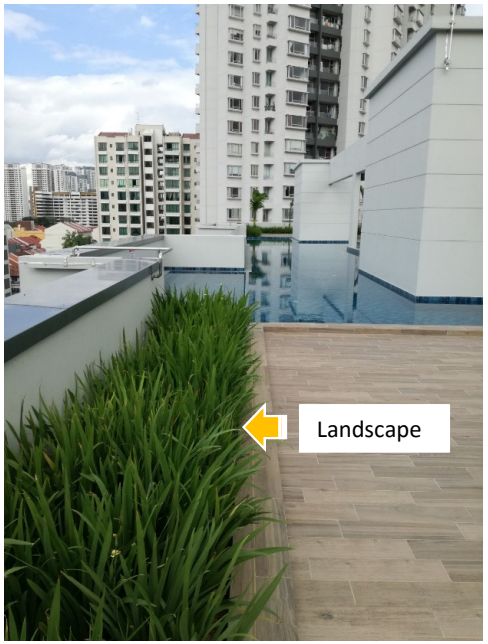
Open Roof Terrace & Swimming Pool

Protection From Lightning Strikes







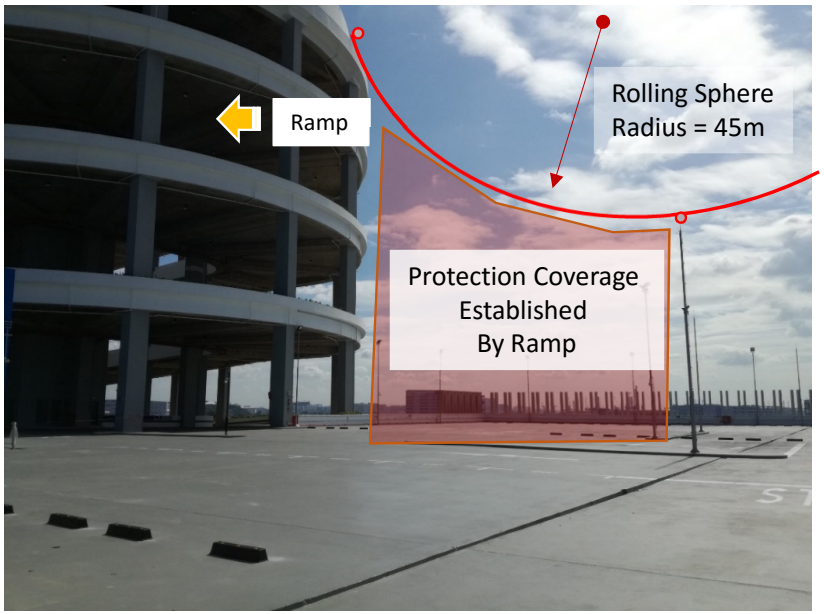


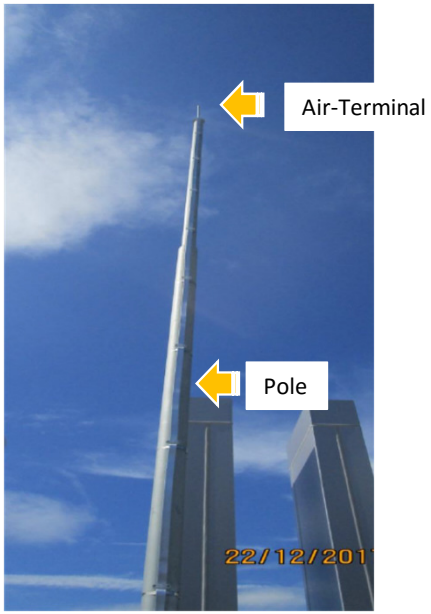
Protection using Overhead Structure, Trellis, Air-Terminal Rod and Landscape

TOP OBSERVATIONS

Building and Construction Authority

Open Multi-Storey Car Park





Protection using Air-Terminal Poles



LPS Warning Sign

TOP OBSERVATIONS – Good Practices

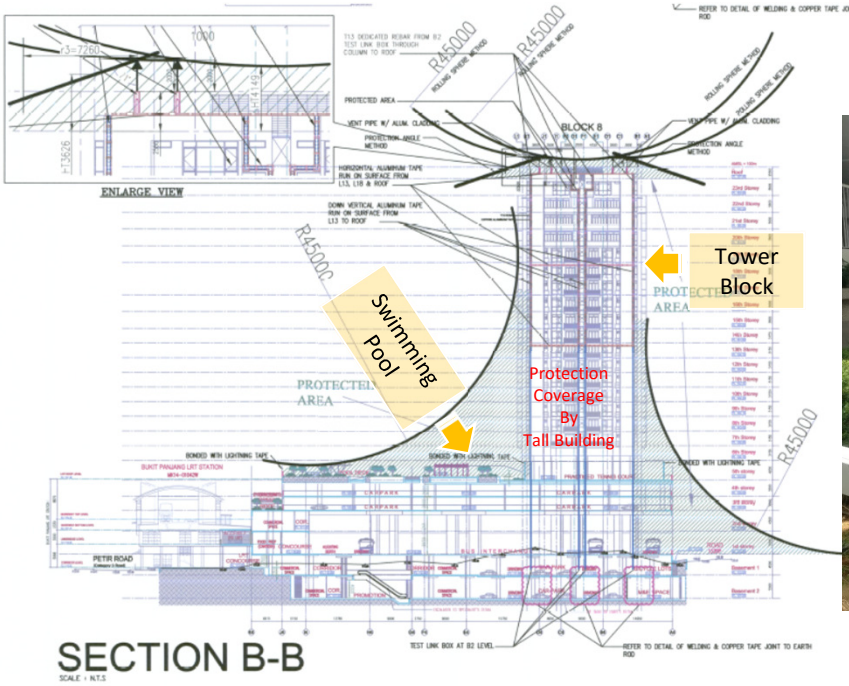
Building and Construction Authority

Open Swimming Pool

Swimming Pool - Protection of Person from Lightning Strikes









Sign

Do not stay in the pool during lightning/thunderstorm

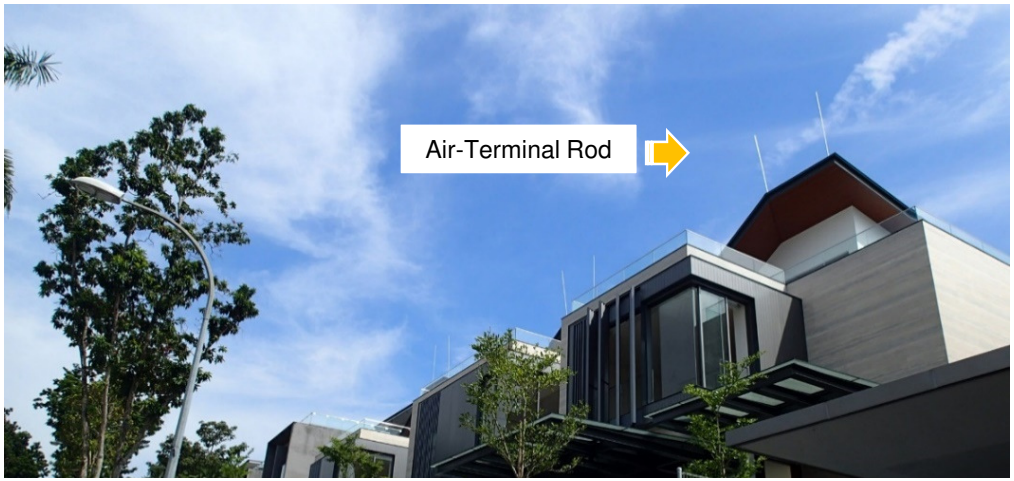
Protection from nearby buildings

TOP OBSERVATIONS

Building and Construction Authority

Landed House Open Terrace

Protection From Lightning Strikes





Protection using Air-Terminal Rods

TOP OBSERVATIONS

Building and Construction Authority

Open Playground & Hardcourt

Protection From Lightning Strikes & Injuries from Touch & Step Voltage







Landscape as Barrier



Shelter



Roof Top Amenities



L 1 Amenities

<u>Protection of Playground & Hardcourt</u>

- Trends in building design with open roof amenities
- Small defined spaces where full protection can be provided.
- Lamp Poles, Shelter and surrounding Flats

TOP OBSERVATIONS – Good Practices

Building and Construction Authority

Provision of trellis for roof top M&E Services

Protection of M&E Fixtures against lightning strike







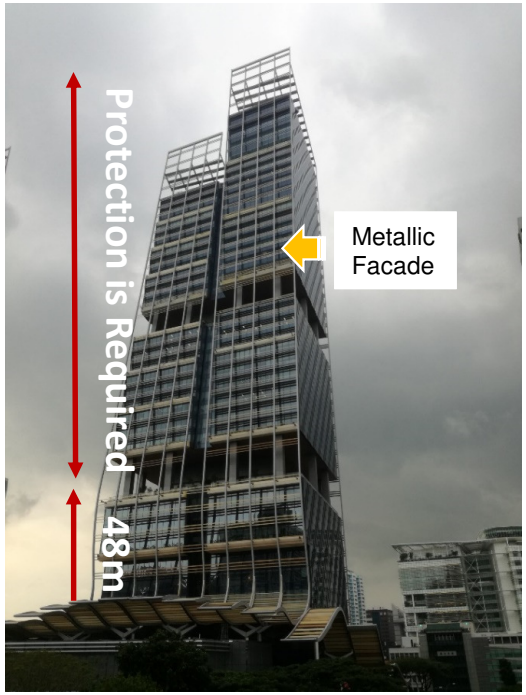
Protection using Overhead Trellis

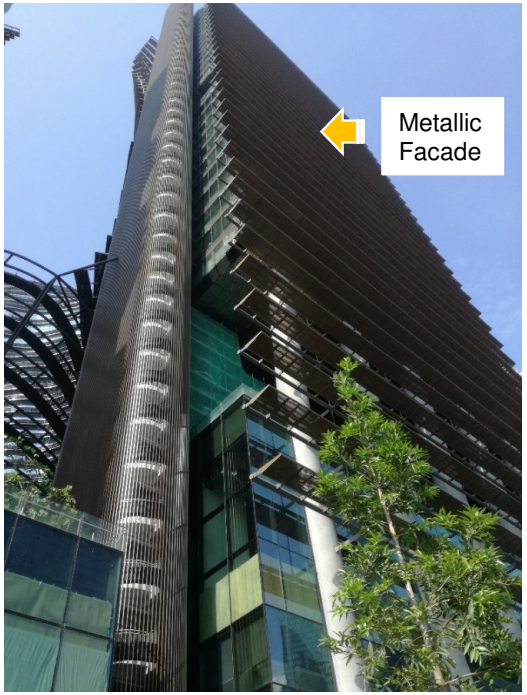
TOP OBSERVATIONS – Good Practices

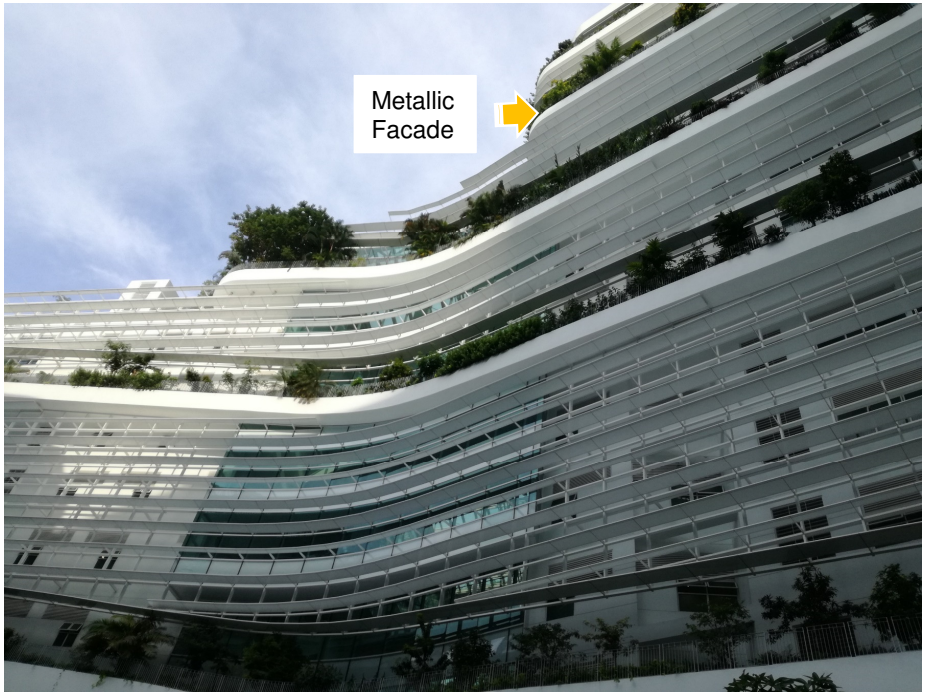
Building and Construction Authority

Protection of vertical sides of high rise buildings.

Metallic Façade As Air-Terminal







Protection using metallic façade as air-terminal

TOP OBSERVATIONS

Building and Construction Authority

Air-Finial

Air-Finial at Pitch of Common Party Wall







Air-terminal should be placed at highest point of building structure

TOP OBSERVATIONS

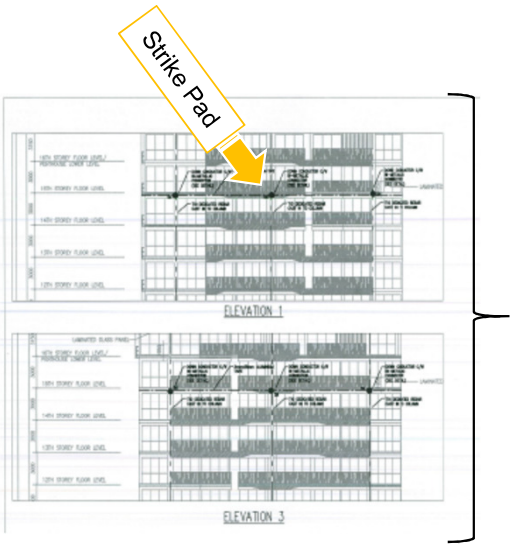
Building and Construction Authority

Strike pads for protection of vertical sides of high rise building

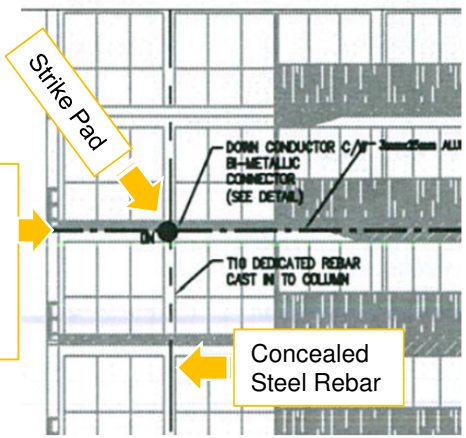
Protection Against Side Flashes to Vertical Side of Building

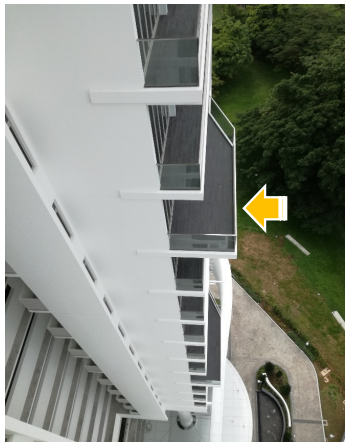
Legends

- Strike Pad
- Concealed Steel Rebar



Concealed Air-Termination (Steel Rebar)







1. Elevation Plans showing strike pads installed on vertical sides of Building

2. Details of Concealed Steel Rebar & Strike Pad

3. Location of strike Pad should be located at Protruding Balconies to intercept lightning



Protection using strike pads and concealed rebar as air-termination system

THINGS TO LOOK OUT DURING DESIGN & TOP

Building and Construction Authority

What are some of the main changes in SSS555:2018?

1. Open Habitable Roof Spaces

Use of overhead structures such as trellis, higher surrounding structures, etc

Examples are penthouse, amenities, garden and multi-storey carpark.

2. Corner & Edges of Roof

Metal covering shall be provided at corners and edges of tall building (H≥45m) for protection from direct lightning strike. For structures less than 45m, suitable finials should be provided at exposed corners.

SS555:2018

3. Vicinity of Lightning Conductor

Exposed tape and down conductor shall not be located within easy reach of users of habitable space.

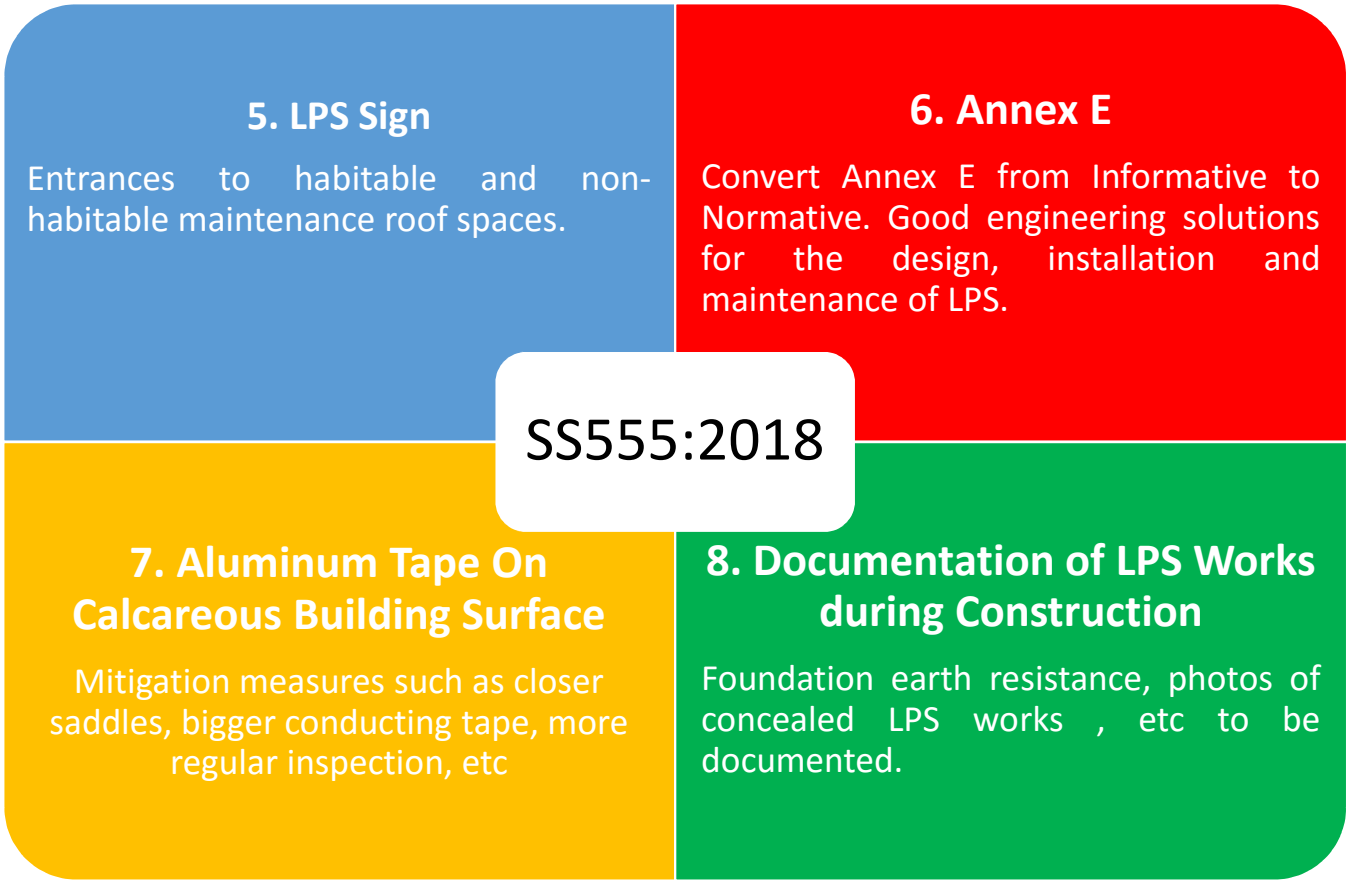
4. Equipotential Bonding of Steel Structure

Equipotential bonding of steel structure between floor and column rebar to exposed metal railings and window frames, etc to reduce step and touch voltage to a tolerable value.

THINGS TO LOOK OUT DURING DESIGN & TOP

Building and Construction Authority

What are some of the main changes in SSS555:2018?



Part 3 : Circular & TOP Submission

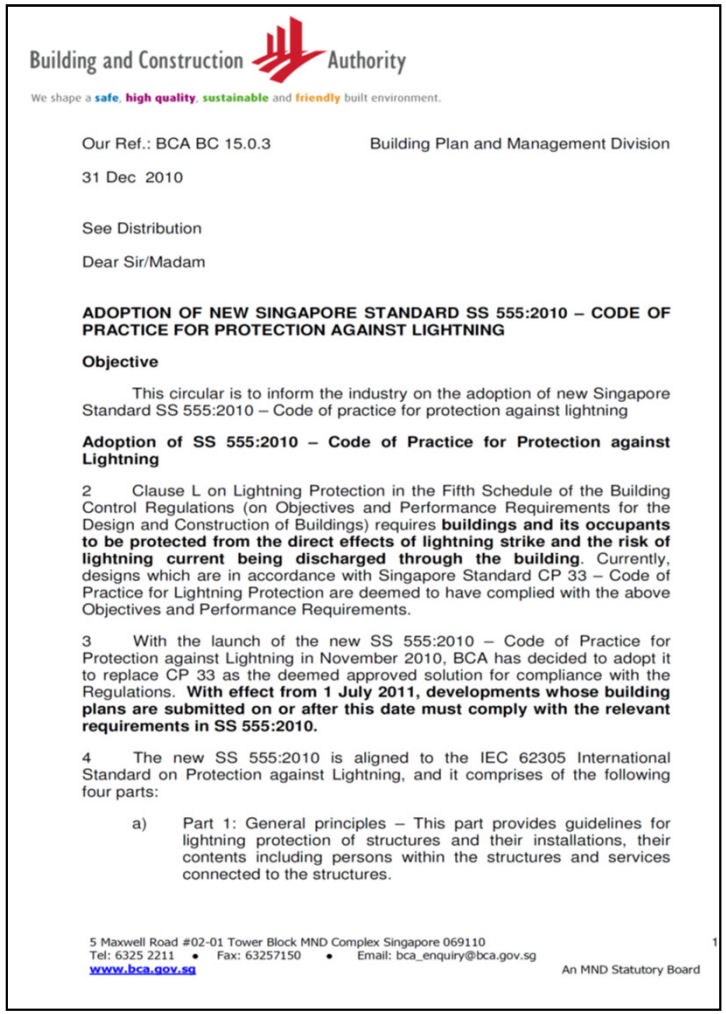
Circular 1 Reference : BCA BC 15.0.3 @ 31 Dec 2010

ADOPTION OF NEW SINGAPORE STANDARD SS555:2010-CODE OF PRACTICE FOR PROTECTION AGAINST LIGHTNING

Approved Document	• Clause L on Lightning Protection System • Fifth Schedule of the Building Control Regulation
Effective Date	• From 1 July 2011, developments whose building plans are submitted on or after this date
Highlights	• Minimum Class 3 Lightning Protection Level • Lightning protection at roof top garden

Reminder

Protection also include open terrace, garden, amenities to avoid any TOP delays.



Building and Construction Authority

We shape a safe, high quality, sustainable and friendly built environment.

Our Ref.: BCA BC 15.0.3 Building Plan and Management Division

31 Dec 2010

See Distribution

Dear Sir/Madam

ADOPTION OF NEW SINGAPORE STANDARD SS 555:2010 – CODE OF PRACTICE FOR PROTECTION AGAINST LIGHTNING

Objective

This circular is to inform the industry on the adoption of new Singapore Standard SS 555:2010 – Code of practice for protection against lightning

Adoption of SS 555:2010 – Code of Practice for Protection against Lightning

2 Clause L on Lightning Protection in the Fifth Schedule of the Building Control Regulations (on Objectives and Performance Requirements for the Design and Construction of Buildings) requires **buildings and its occupants to be protected from the direct effects of lightning strike and the risk of lightning current being discharged through the building**. Currently, designs which are in accordance with Singapore Standard CP 33 – Code of Practice for Lightning Protection are deemed to have complied with the above Objectives and Performance Requirements.

3 With the launch of the new SS 555:2010 – Code of Practice for Protection against Lightning in November 2010, BCA has decided to adopt it to replace CP 33 as the deemed approved solution for compliance with the Regulations. **With effect from 1 July 2011, developments whose building plans are submitted on or after this date must comply with the relevant requirements in SS 555:2010.**

4 The new SS 555:2010 is aligned to the IEC 62305 International Standard on Protection against Lightning, and it comprises of the following four parts:

a) Part 1: General principles – This part provides guidelines for lightning protection of structures and their installations, their contents including persons within the structures and services connected to the structures.

5 Maxwell Road #02-01 Tower Block MND Complex Singapore 069110
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Part 3 : Circular & TOP Submission

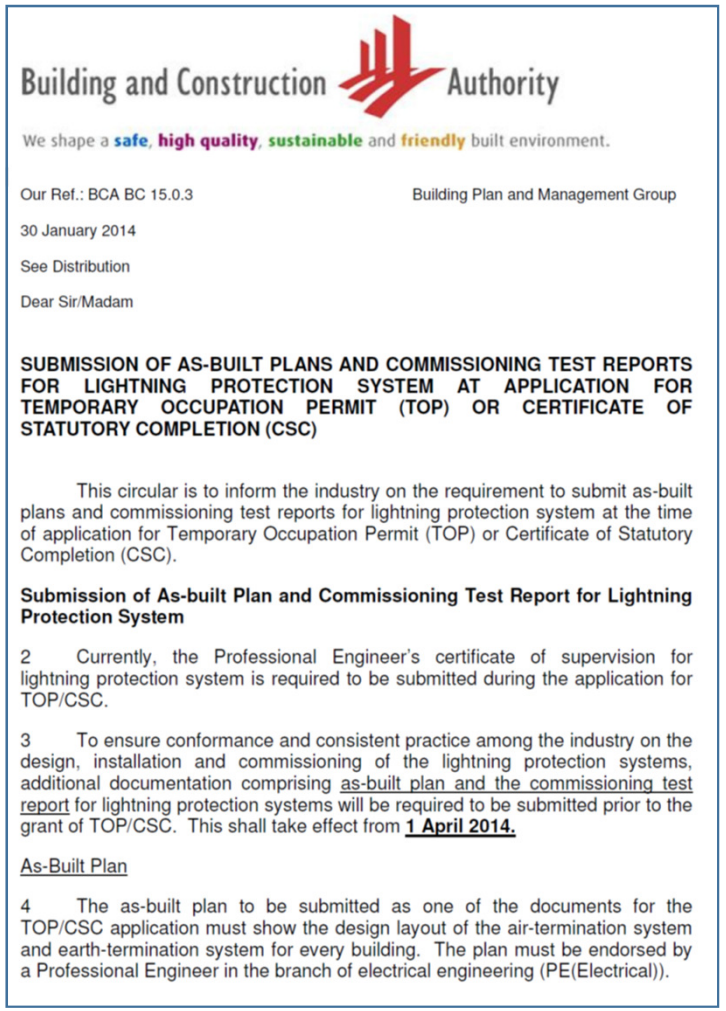
Circular 2 Reference : BCA BC 15.0.3 @ 30 Jan 2014

SUBMISSION OF AS-BUILT PLANS AND COMMISSIONING TEST REPORTS FOR LIGHTNING PROTECTION SYSTEM AT APPLICATION FOR TEMPORARY OCCUPATION PERMIT (TOP) OR CERTIFICATE OF STATUTORY COMPLETION (CSC)

LPS Submission	• As-Built Plans • Commissioning Test Report
Effective Date	• From 1 April 2014, LPS submission will be required prior to grant of TOP/CSC.

Reminder

To finalize the as-built plans, commissioning report and submit early, where possible, to avoid any TOP delays.



Building and Construction Authority

We shape a safe, high quality, sustainable and friendly built environment.

Our Ref.: BCA BC 15.0.3 — Building Plan and Management Group

30 January 2014

See Distribution

Dear Sir/Madam

SUBMISSION OF AS-BUILT PLANS AND COMMISSIONING TEST REPORTS FOR LIGHTNING PROTECTION SYSTEM AT APPLICATION FOR TEMPORARY OCCUPATION PERMIT (TOP) OR CERTIFICATE OF STATUTORY COMPLETION (CSC)

This circular is to inform the industry on the requirement to submit as-built plans and commissioning test reports for lightning protection system at the time of application for Temporary Occupation Permit (TOP) or Certificate of Statutory Completion (CSC).

Submission of As-built Plan and Commissioning Test Report for Lightning Protection System

2 Currently, the Professional Engineer's certificate of supervision for lightning protection system is required to be submitted during the application for TOP/CSC.

3 To ensure conformance and consistent practice among the industry on the design, installation and commissioning of the lightning protection systems, additional documentation comprising as-built plan and the commissioning test report for lightning protection systems will be required to be submitted prior to the grant of TOP/CSC. This shall take effect from **1 April 2014.**

As-Built Plan

4 The as-built plan to be submitted as one of the documents for the TOP/CSC application must show the design layout of the air-termination system and earth-termination system for every building. The plan must be endorsed by a Professional Engineer in the branch of electrical engineering (PE(Electrical)).

Part 3 : TOP Submission Circular 2 Reference : BCA BC 15.0.3 @ 31 Jan 2014

1. What need to be submitted for LPS ?

2. What are As-built Plans and Commissioning Test Report ?

As-Built Plans	• Air-Termination Plan • Earth Pit Plan • Equipotential Plan, Down Conductor & Test Link • Elevation Plan [Open spaces and tall building > 48m]
Commissioning Test Report	• Earth Pit Resistance Measurement • Overall Earth Resistance Measurement • Electrical Continuity Measurement • Rebar used as down conductor [For concealed down conductor]

Part 4 : WHAT'S UPCOMING ?

Building and Construction Authority

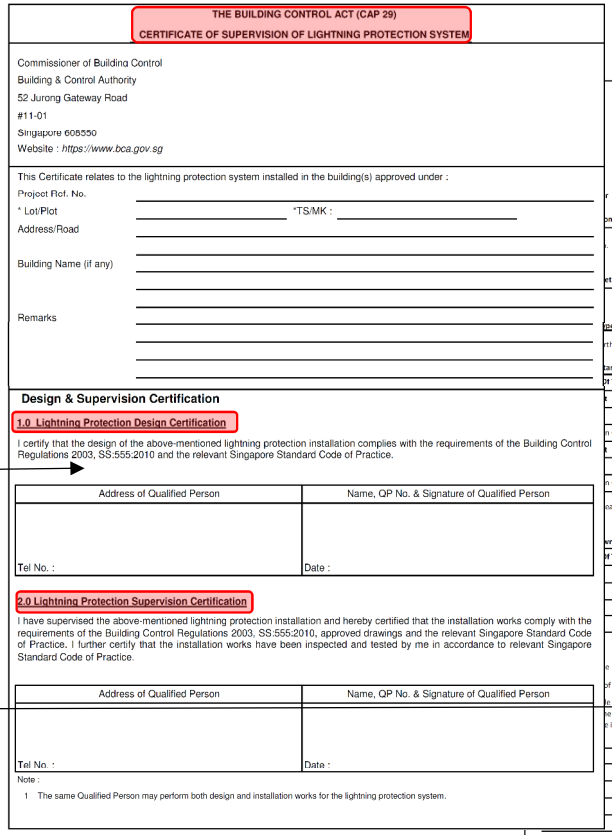
1 LPS

2 TOP Form

3 Commissioning Test Report

ITEMS

- LPS Plan Submission
  [Separate Track from BP/ST]
- CSC 03 Certificate Of Supervision for Lightning Protection System
  - Endorsed by PE(Supervision)
  - Endorsed by PE (Design)
- Standardize Commissioning Test Report for Earth Resistance & Electrical Continuity Test



THE BUILDING CONTROL ACT (CAP 29)
CERTIFICATE OF SUPERVISION OF LIGHTNING PROTECTION SYSTEM

Commissioner of Building Control
Building & Control Authority
52 Jurong Gateway Road
#11-01
Singapore 608550
Website : *https://www.bca.gov.sg*

This Certificate relates to the lightning protection system installed in the building(s) approved under :

Project Ref. No.
* Lot/Plot *TS/MK :
Address/Road
Building Name (if any)
Remarks

Design & Supervision Certification

1.0 Lightning Protection Design Certification

I certify that the design of the above-mentioned lightning protection installation complies with the requirements of the Building Control Regulations 2003, SS:555:2010 and the relevant Singapore Standard Code of Practice.

Address of Qualified Person	Name, QP No. & Signature of Qualified Person
Tel No. :	Date :

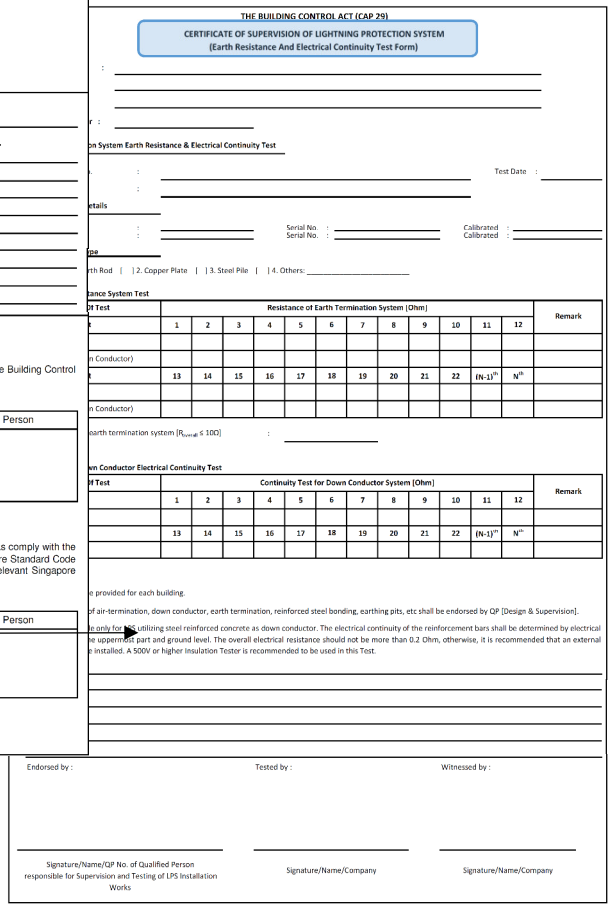
2.0 Lightning Protection Supervision Certification

I have supervised the above-mentioned lightning protection installation and hereby certified that the installation works comply with the requirements of the Building Control Regulations 2003, SS:555:2010, approved drawings and the relevant Singapore Standard Code of Practice. I further certify that the installation works have been inspected and tested by me in accordance to relevant Singapore Standard Code of Practice.

Address of Qualified Person	Name, QP No. & Signature of Qualified Person
Tel No. :	Date :

Note :
1 The same Qualified Person may perform both design and installation works for the lightning protection system.

CSC 03 Certificate Of Supervision for Lightning Protection System



THE BUILDING CONTROL ACT (CAP 29)
CERTIFICATE OF SUPERVISION OF LIGHTNING PROTECTION SYSTEM
(Earth Resistance And Electrical Continuity Test Form)

Endorsed by : Tested by : Witnessed by :

Signature/Name/QP No. of Qualified Person responsible for Supervision and Testing of LPS Installation Works
Signature/Name/Company
Signature/Name/Company

Commissioning Test Report

We shape a **safe**, **high quality**, **sustainable** and **friendly** built environment.

Project parties for Design Engagement





We shape a **safe**, **high quality**, **sustainable** and **friendly** built environment.