Kursus "Lightning & Surge Protection"

Specification L-S9

Cawangan Kejuruteraan Elektrik

2020

Contents

Contents

1. General

L-S9 describes and specifies requirements for the whole lightning protection system installation in accordance with the:-

- Specification
- Supplementary Notes
- BQs
- Conditions of Contract
- Drawings

- Methods and materials used for the construction and installation shall comply in accordance with MS IEC 62305 and IEC 62561

2. Class of Lightning Protection System

- Four classes of LPS (I to IV) corresponding to lightning protection level (LPL)
- Selected on the basis of risk assessment
- Appendix A: Table 1

LPL	Class of LPS
I	I
II	II
III	III
IV	IV

TABLE 1 – Relation between lightning protection levels (LPL) and class of LPS (see MS IEC 62305-1)

3. Air Termination System

3.1 General

- Installed at corners, exposed points and edges
- Methods (one or combination)
  - Protection Angle method
  - Rolling Sphere method
  - Mesh method
- Appendix A: Table 2

3. Air Termination System

	Protection Method		
Class of LPS	Rolling sphere radius *r* m	Mesh size *W* M	Protection angle α°
I	20	5 x 5	See figure below
II	30	10 x 10	
III	45	15 x 15	
IV	60	20 x 20	

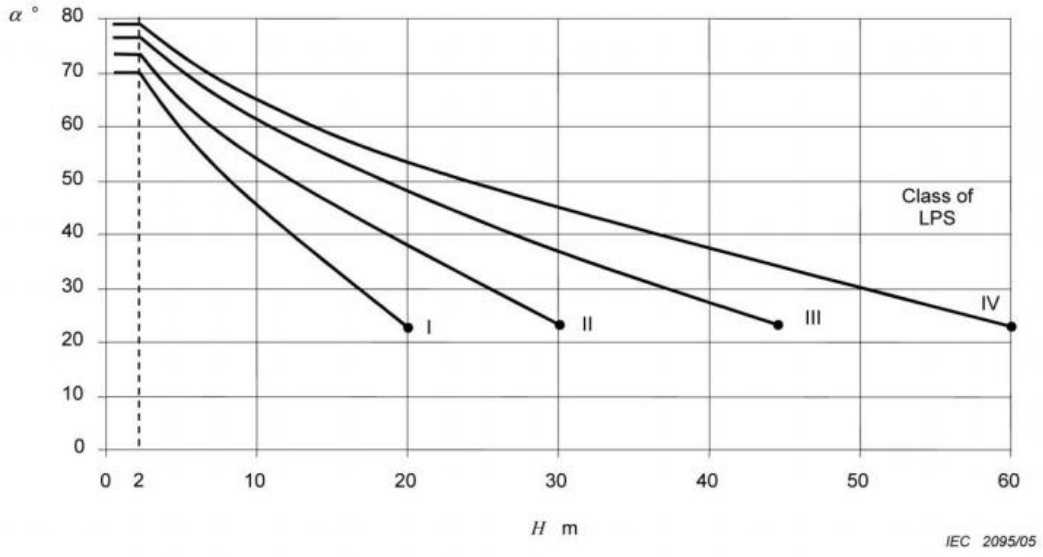
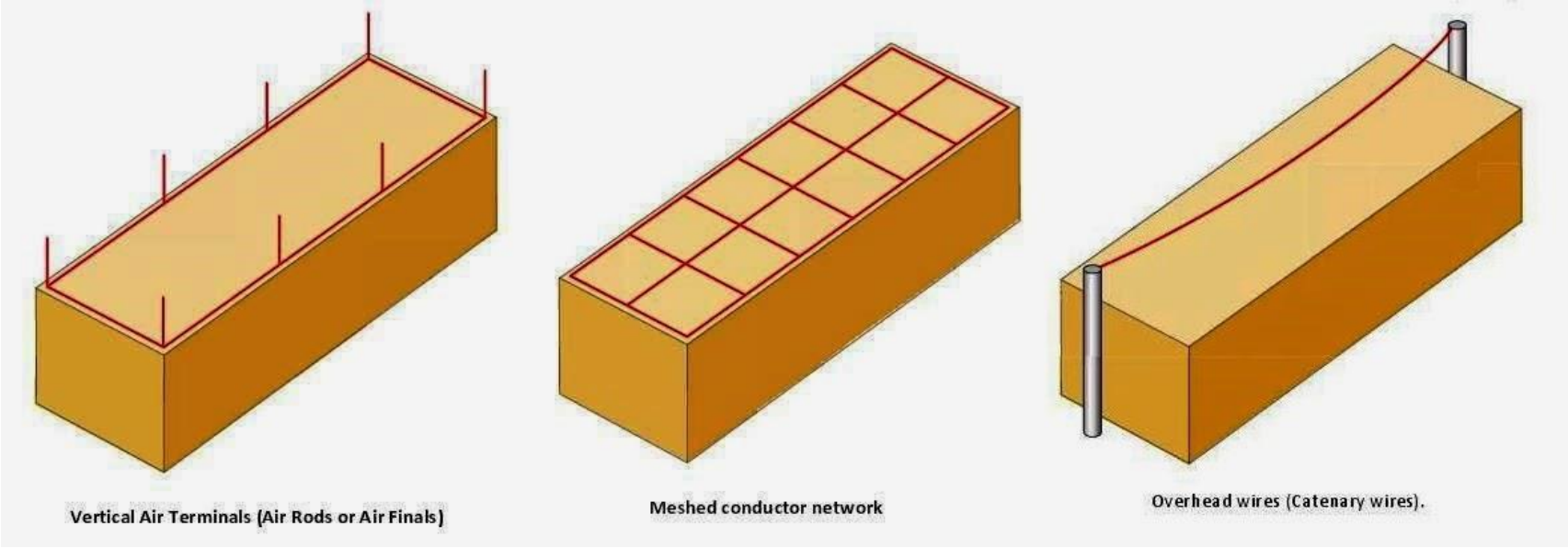


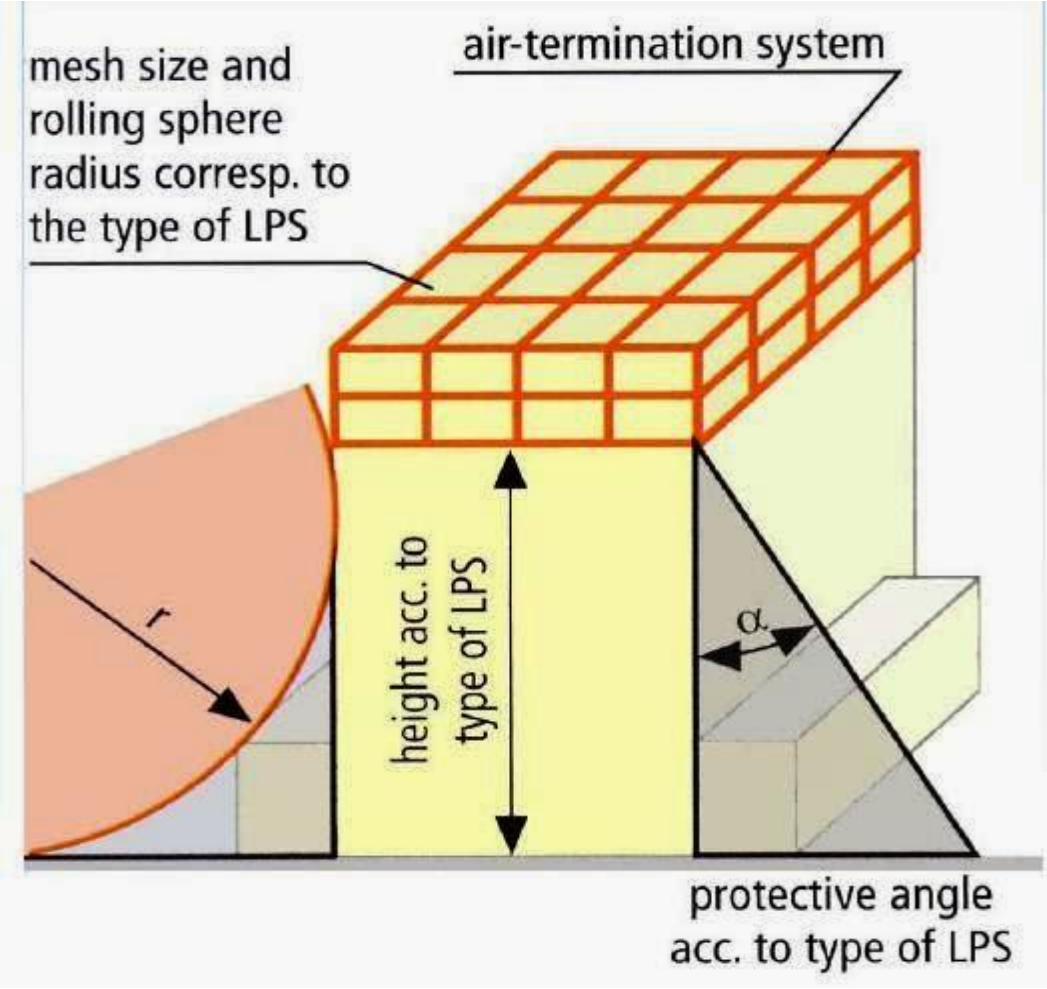
TABLE 2 – Maximum values of rolling sphere radius, mesh size and protection angle corresponding to the class of LPS

3.2 Air Termination System

- Network of vertical and horizontal conductors



3.2 Air Termination System

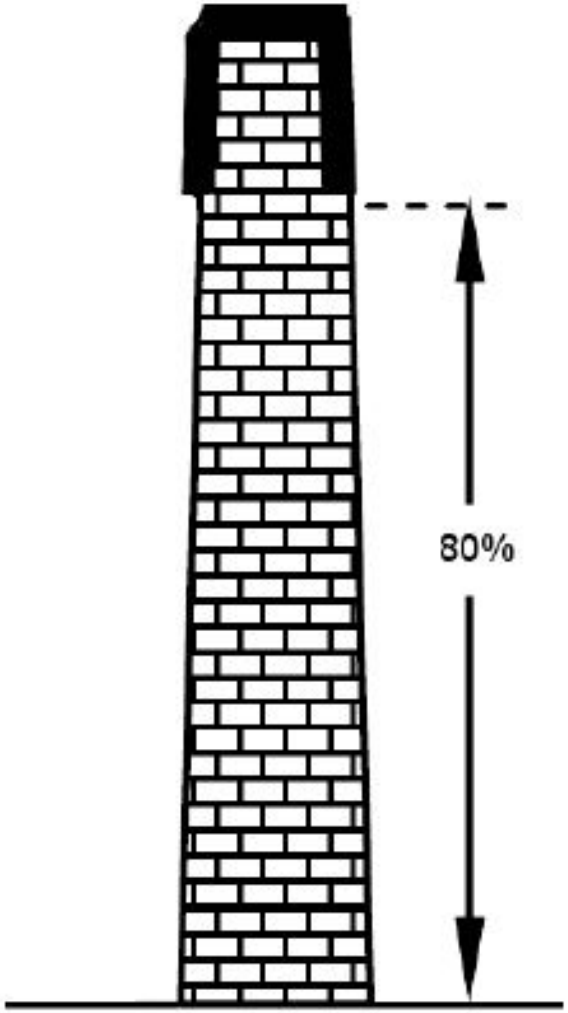


3.2 Air Termination System

- All metallic projections, chimneys, ducts, gutters, vent pipes, guard rails, aerial masts etc **shall be bonded to** and form part of the air termination system.

3.2 Air Termination System

- Structures > 60m,
  air termination install at
  upper part
  (20% height of structure)
  for side flashes protection.
  Metal facade bonded and
  form part of air termination
  system



3.2 Air Termination System

- Unless otherwise specified, air termination system (other than air terminals) shall be of **25mm x 3mm annealed copper tape**
- Should other materials be specified, it shall conform to Table 5 and 6 of MS IEC 62305-3
- Appendix A: Table 5 & Table 6

Copper Tape

Aluminium Tape

3.2 Air Termination System

Material	Use			Corrosion		
	In open air	In earth	In concrete	Resistance	Increased by	May be destroyed by galvanic coupling with
Copper	Solid Stranded	Solid Stranded As coating	Solid Stranded As coating	Good in many environments	Sulphur compounds Organic materials	-
Hot galvanized steel	Solid	Solid	Solid	Acceptable in air, in concrete and in benign soil	High chlorides content	Copper
Stainless Steel	Solid Stranded	Solid Stranded	Solid Stranded	Good in many environments	High chlorides content	-
Aluminium	Solid Stranded	Unsuitable	Unsuitable	Good in atmospheres containing low concentrations of sulphur and chloride	Alkaline solutions	Copper
Lead	Solid As coating	Solid As coating	Unsuitable	Good in atmospheres with high concentration of sulphates	Acid soils	Copper Stainless Steel

NOTE 1 This table gives general guidance only. In special circumstances more careful corrosion immunity considerations are required (see Annex E).

NOTE 2 Stranded conductors are more vulnerable to corrosion than solid conductors. Stranded conductors are also vulnerable where they enter or exit earth/concrete positions. This is the reason why stranded galvanized steel is not recommended in earth.

NOTE 3 Galvanized steel may be corroded in clay soil or moist soil.

NOTE 4 Galvanized steel in concrete should not extend into the soil due to possible corrosion of the steel just outside the concrete.

NOTE 5 Galvanized steel in contact with reinforcement steel in concrete may, under certain circumstances, cause damage to the concrete.

NOTE 6 Use of lead in the earth is often banned or restricted due to environmental concerns.

TABLE 5 – LPS Material and conditions of use

3.2 Air Termination System

Material	Configuration	Minimum cross-sectional areas mm²	Comments [10]
Copper	Solid tape	50 [8]	2 mm min. thickness
	Solid round [7]	50 [8]	8 mm diameter
	Stranded	50 [8]	1.7 mm min. diameter of each strand
	Solid round [3], [4]	200 [8]	16 mm diameter
Tin plated copper [1]	Solid tape	50 [8]	2 mm min. thickness
	Solid round [7]	50 [8]	8 mm diameter
	Stranded	50 [8]	1.7 mm min. diameter of each strand
Aluminium	Solid tape	70	3 mm min. thickness
	Solid round	50 [8]	8 mm diameter
	Stranded	50 [8]	1.7 mm min. diameter of each strand
Aluminium alloy	Solid tape	50 [8]	2.5 mm min. thickness
	Solid round	50	8 mm diameter
	Stranded	50 [8]	1.7 mm min. diameter of each strand
	Solid round [3]	200 [8]	16 mm diameter
Hot dipped galvanized steel [2]	Solid tape	50 [8]	2.5 mm min. thickness
	Solid round [9]	50	8 mm diameter
	Stranded	50 [8]	1.7 mm min. diameter of each strand
	Solid round [3], [4], [9]	200 [8]	16 mm diameter
Stainless steel [5]	Solid tape [6]	50 [8]	2 mm min. thickness
	Solid round [6]	50	8 mm diameter
	Stranded	70 [8]	1.7 mm min. diameter of each strand
	Solid round [3], [4]	200 [8]	16 mm diameter

1) Hot dipped or electroplated minimum thickness coating of 1 µm.
2) The coating should be smooth, continuous and free from flux stains with a minimum thickness coating of 50 µm.
3) Applicable for air-termination rods only. For applications where mechanical stress such as wind loading is not critical, a 10 mm diameter, 1 m long maximum air-termination rod with an additional fixing may be used.
4) Applicable to earth lead-in rods only.
5) Chromium ≥ 16%, nickel ≥ 8%, carbon ≤ 0.07%.
6) For stainless steel embedded in concrete, and/or in direct contact with flammable material, the minimum sizes should be increased to 78mm² (10 mm diameter) for solid round and 75mm² (3 mm minimum thickness) for solid tape.
7) 50 mm² (8 mm diameter) may be reduced to 28 mm² (6 mm diameter) in certain applications where mechanical strength is not an essential requirement. Consideration should, in this case, be given to reducing the spacing of the fasteners.
8) If thermal and mechanical considerations are important, these dimensions can be increased to 60 mm² for solid tape and to 78 mm² for solid round.
9) The minimum cross-section to avoid melting is 16 mm² (copper), 25 mm² (aluminium), 50 mm² (steel) and 50 mm² (stainless steel) for a specific energy of 10 000 kJ/Ω. For further information see Annex E.
10) Thickness, width and diameter are defined at ± 10%.

TABLE 6 – Material, configuration and minimum cross-sectional area of air-termination conductors, air-termination rods and down conductors

3.2 Air Termination System

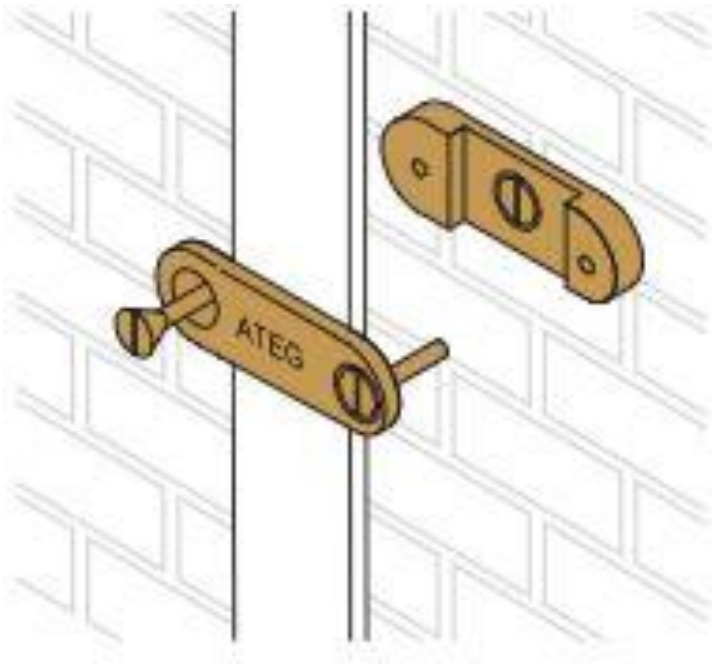
- Secured to the structure by **purpose made conductive** fixtures at intervals < 500mm

DC Tape Clip

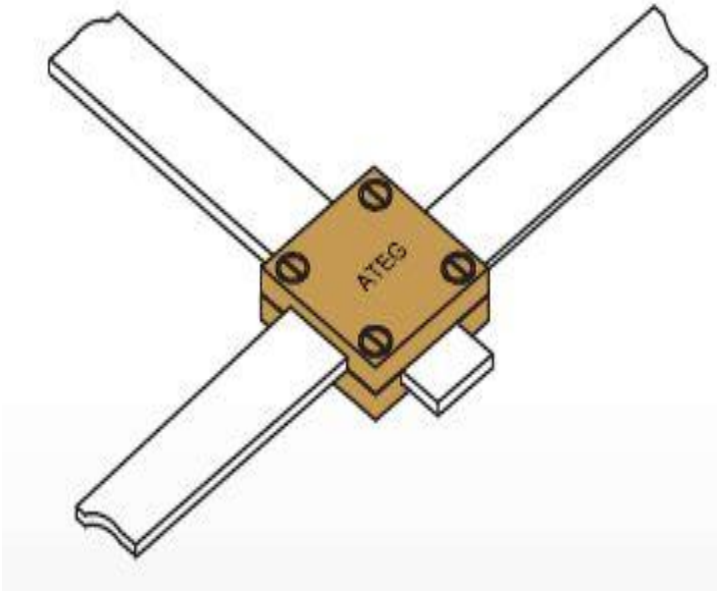
Square Clamp

- Same material as air termination system

3.2 Air Termination System



DC Tape Clip Fixing

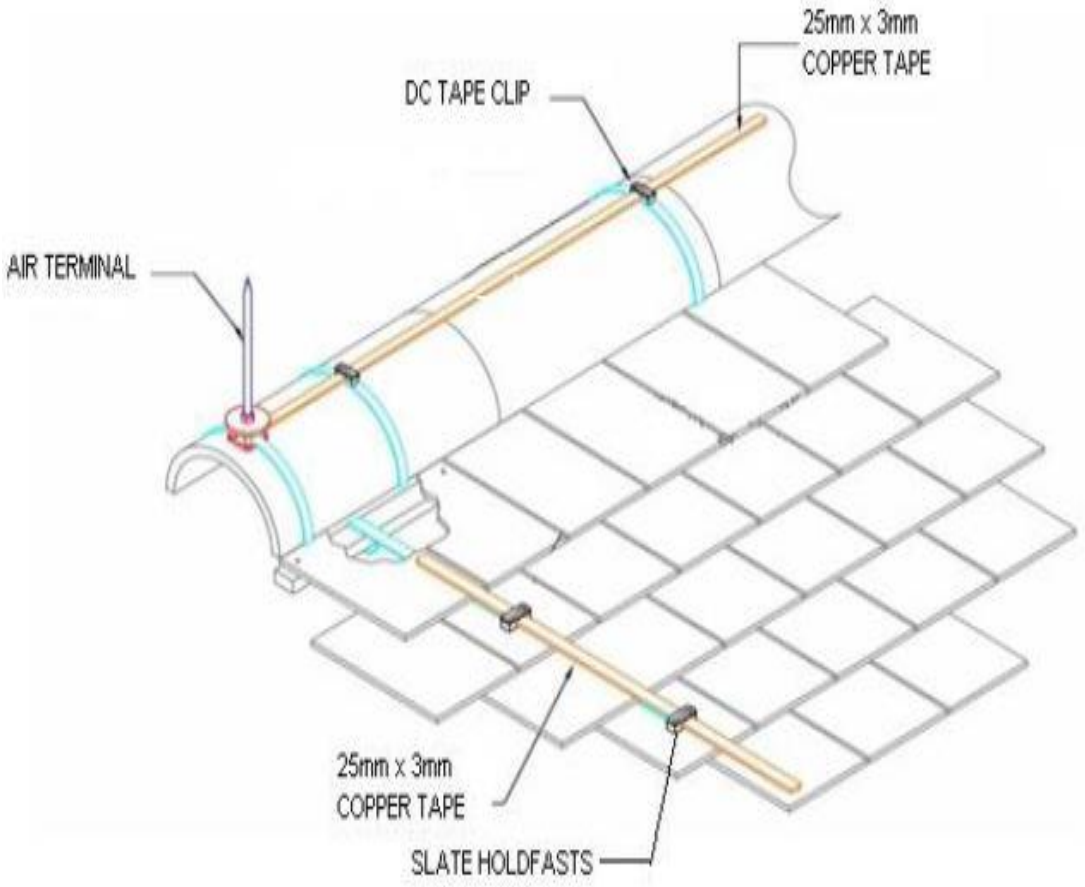


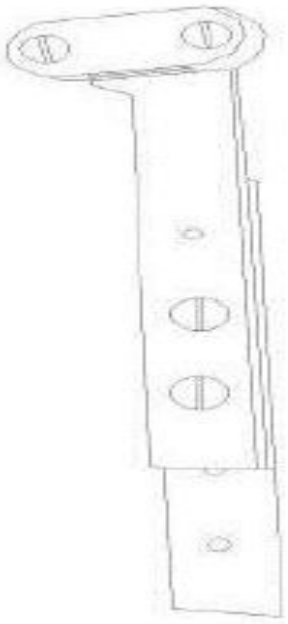
Square Clamp Fixing

Source: KVC

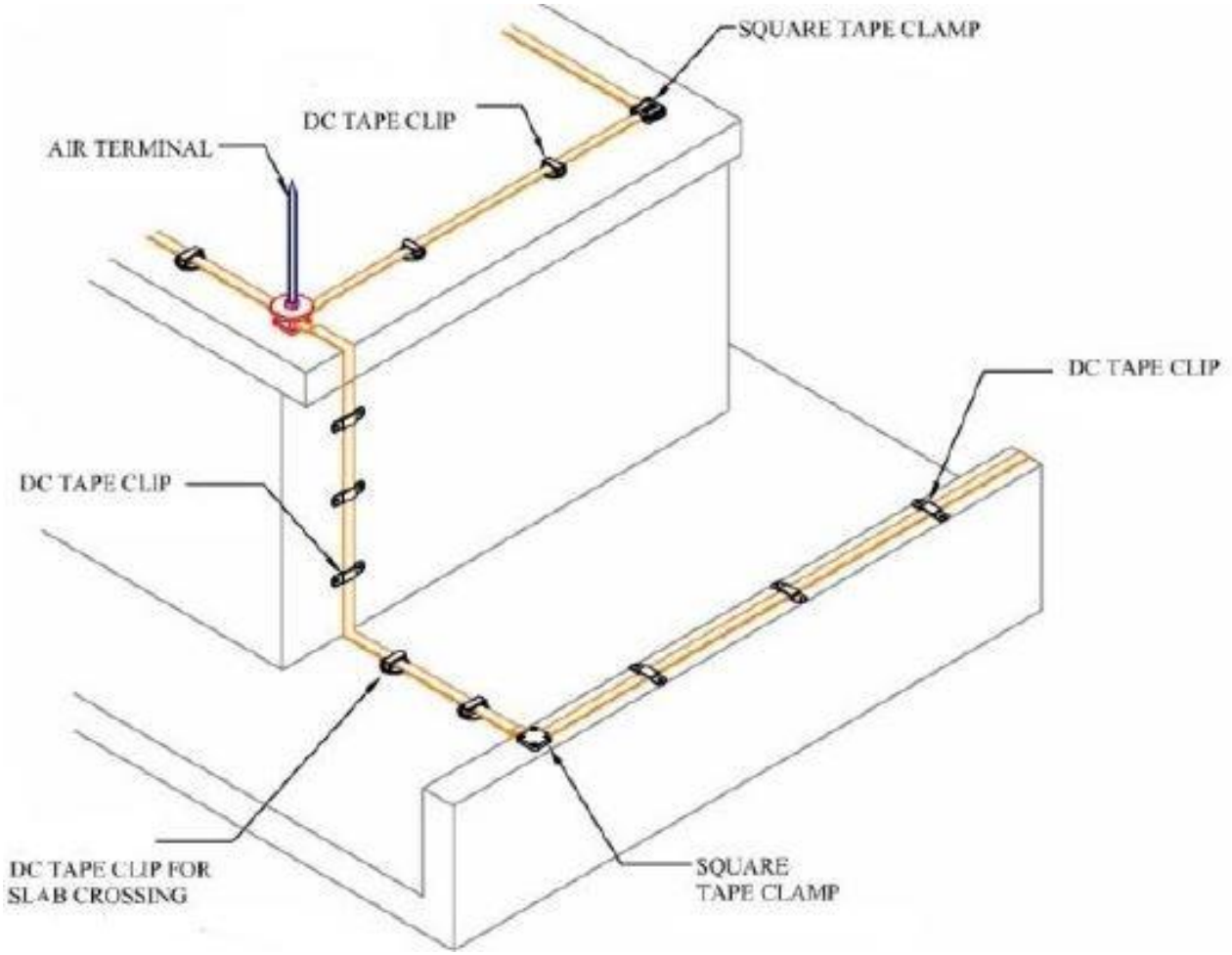
3. Air Termination System

3.2 Air Termination System

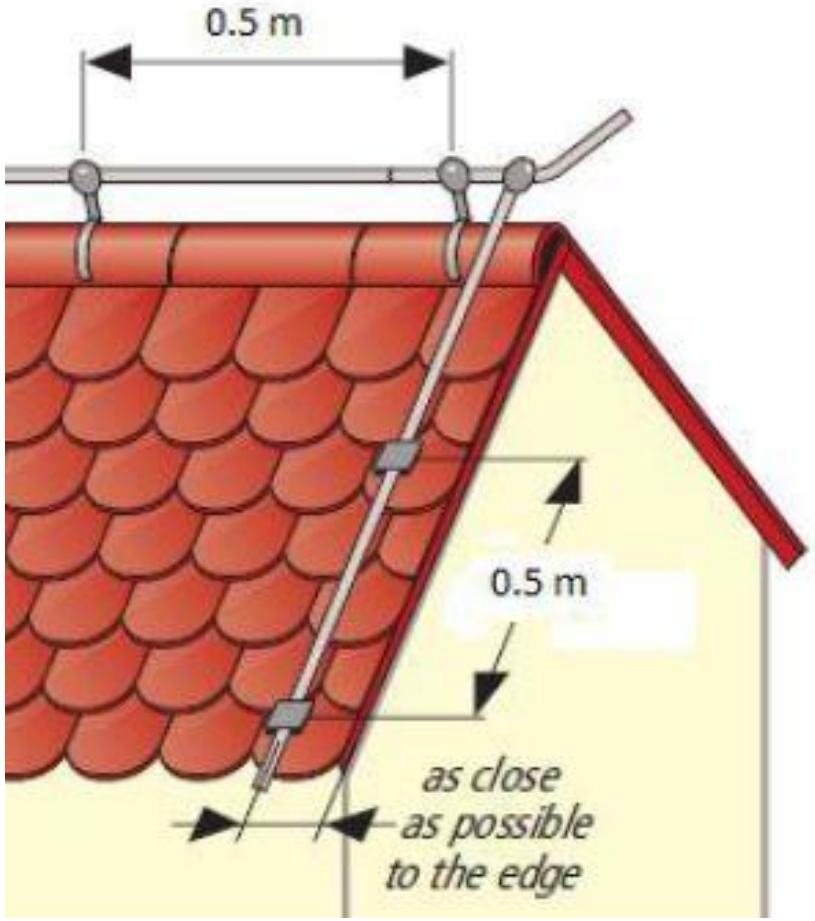




3.2 Air Termination System



3.2 Air Termination System

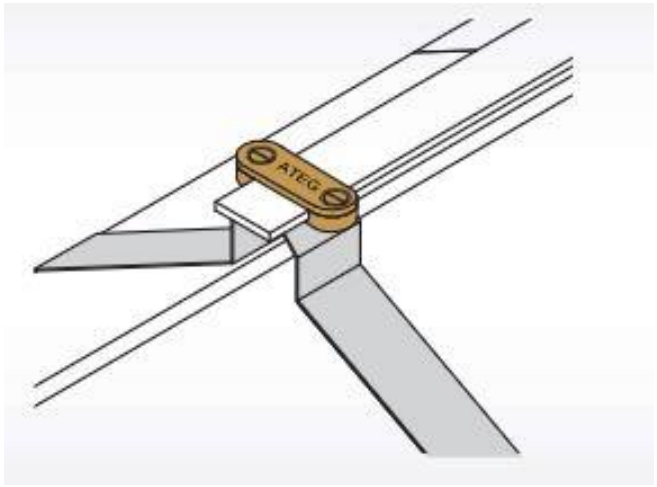


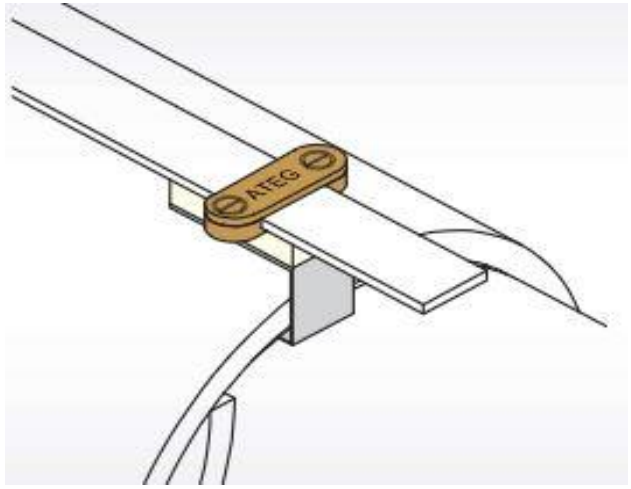
3.2 Air Termination System

Metal cladding roof that **cannot** be considered as air termination component:

- Secured to metal roof structures by **purpose made non-metallic** fixtures at intervals < 500mm

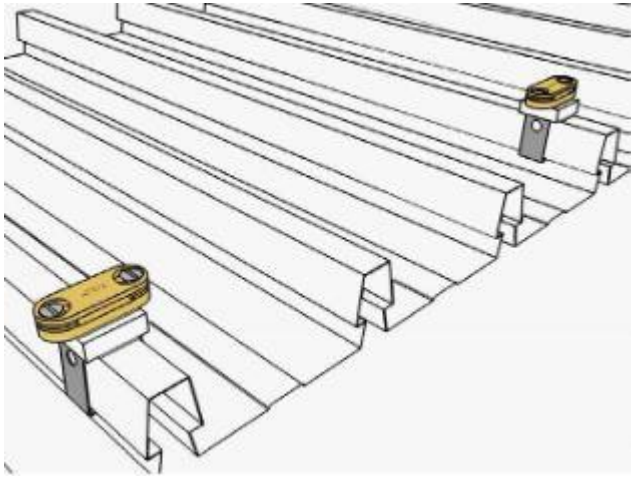
3.2 Air Termination System

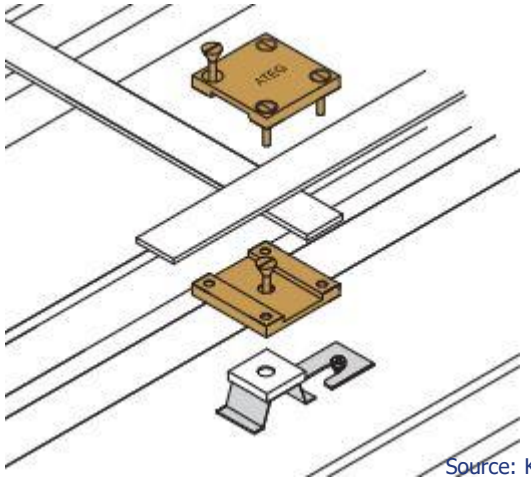




Source: KVC

3.2 Air Termination System





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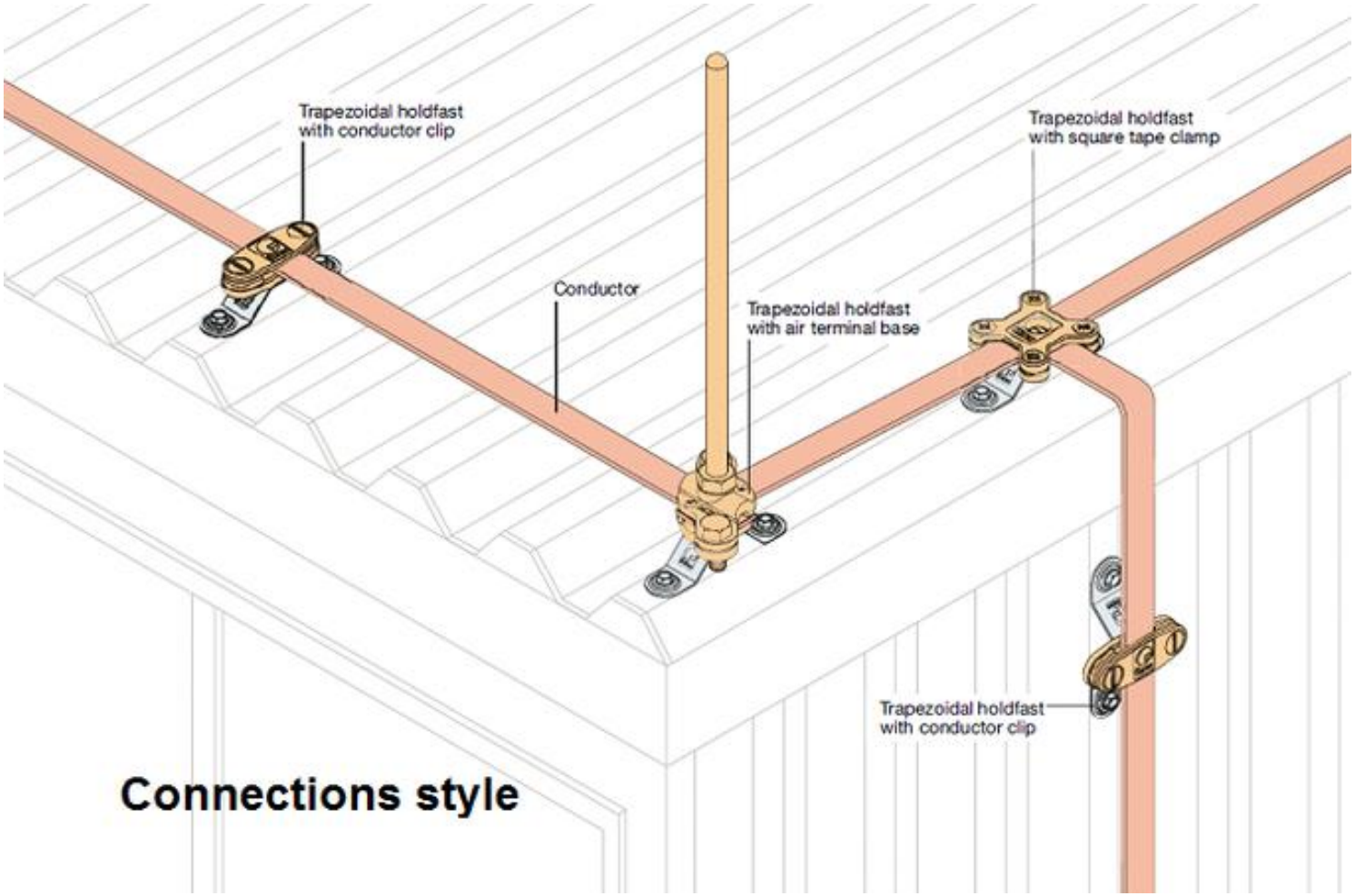
3.2 Air Termination System



3.2 Air Termination System

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3.2 Air Termination System

Metal cladding roof to be used as air termination component:

- The minimum thickness of metal sheets shall conform to Table 3 of MS IEC 62305-3
- Appendix A:Table 3

3.2 Air Termination System

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, hot spot or ignition

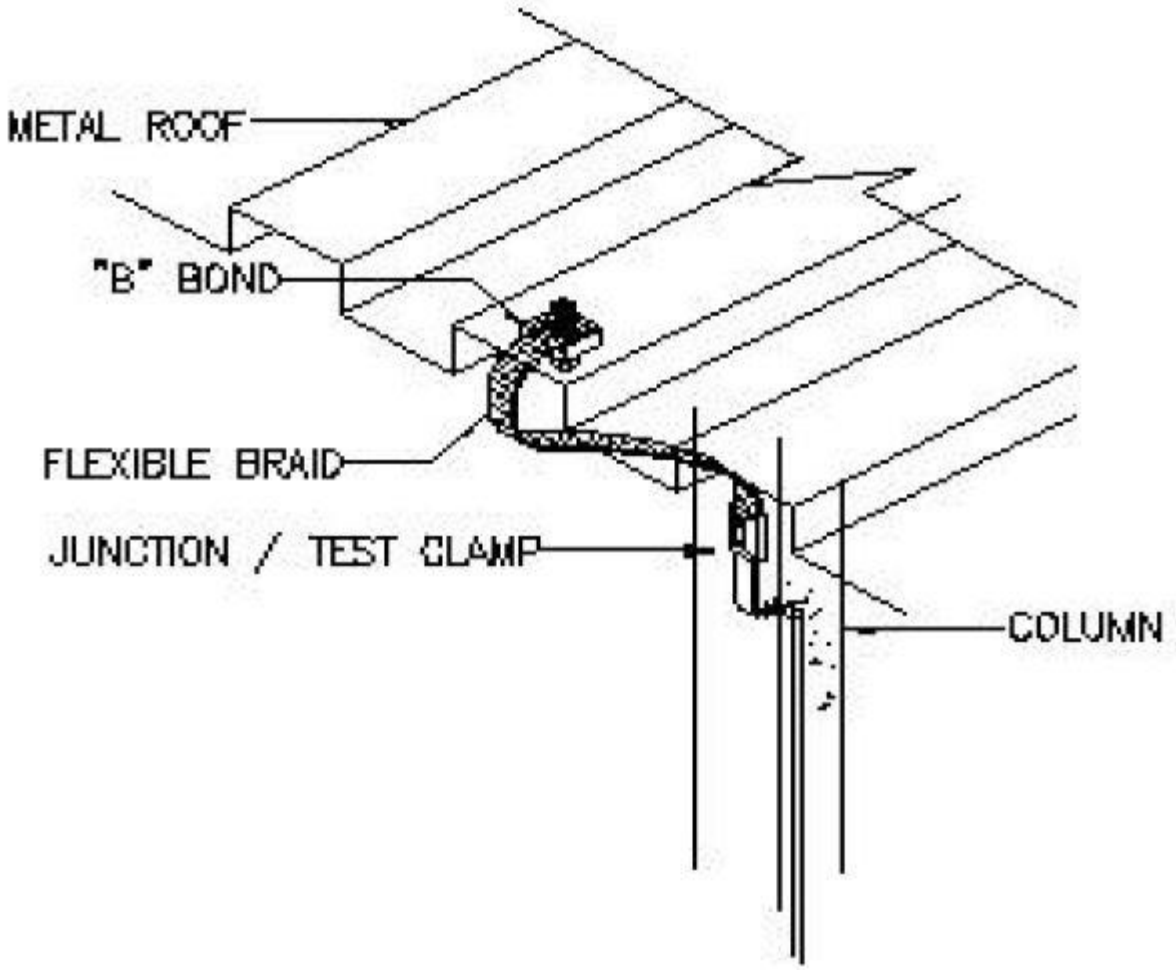
[b] t' only for metal sheet if it is not important to prevent puncture, hotspot or ignition problems.

The metal cladding can be considered as natural air termination components and part of an LPS in accordance with Clause 5.1.3 of MS IEC 62305-3, provided that:

- the electrical continuity between the various parts is made durable (e.g. by means of brazing, welding, crimping, seaming, screwing or bolting);
- the thickness of the metal sheet is not less than the value t' given in Table 3 of MS IEC 62305-3 if it is not important to prevent puncture of the sheeting or to consider ignition of any readily combustible materials underneath (see Appendix : Table 3);
- 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;
- they are not clad with insulating material.

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

3.2 Air Termination System



3.2 Air Termination System

Air termination rods

- Rounded or tapered pointed
- Made of copper
- Min 300mm length and 16mm diameter with lock nut
- Material of the base supporting air rods, similar to air termination system.

3.2 Air Termination System

Air termination rods

4. Down Conductor System

4.1 Down Conductor System

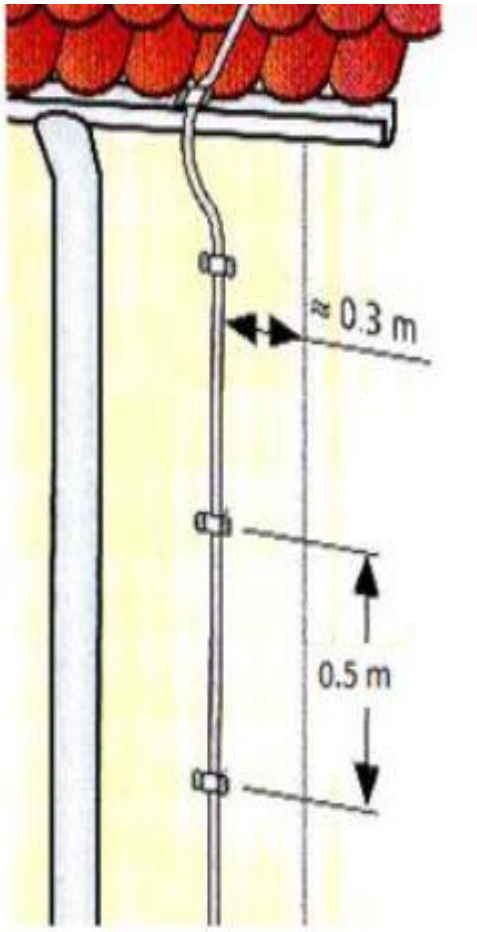
- Unless otherwise specified, down conductor system shall be **25mm x 3mm annealed copper tape.**
- Should other materials be used, it shall conform to Table 5 & 6 of MS IEC 62305-3
- Appendix A: Table 5 & 6

4. Down Conductor System

4.1 Down Conductor System

Shall **not** be:

- Installed in gutters or down spouts even if they are covered by insulating materials
- Routed inside the service ducts



4. Down Conductor System

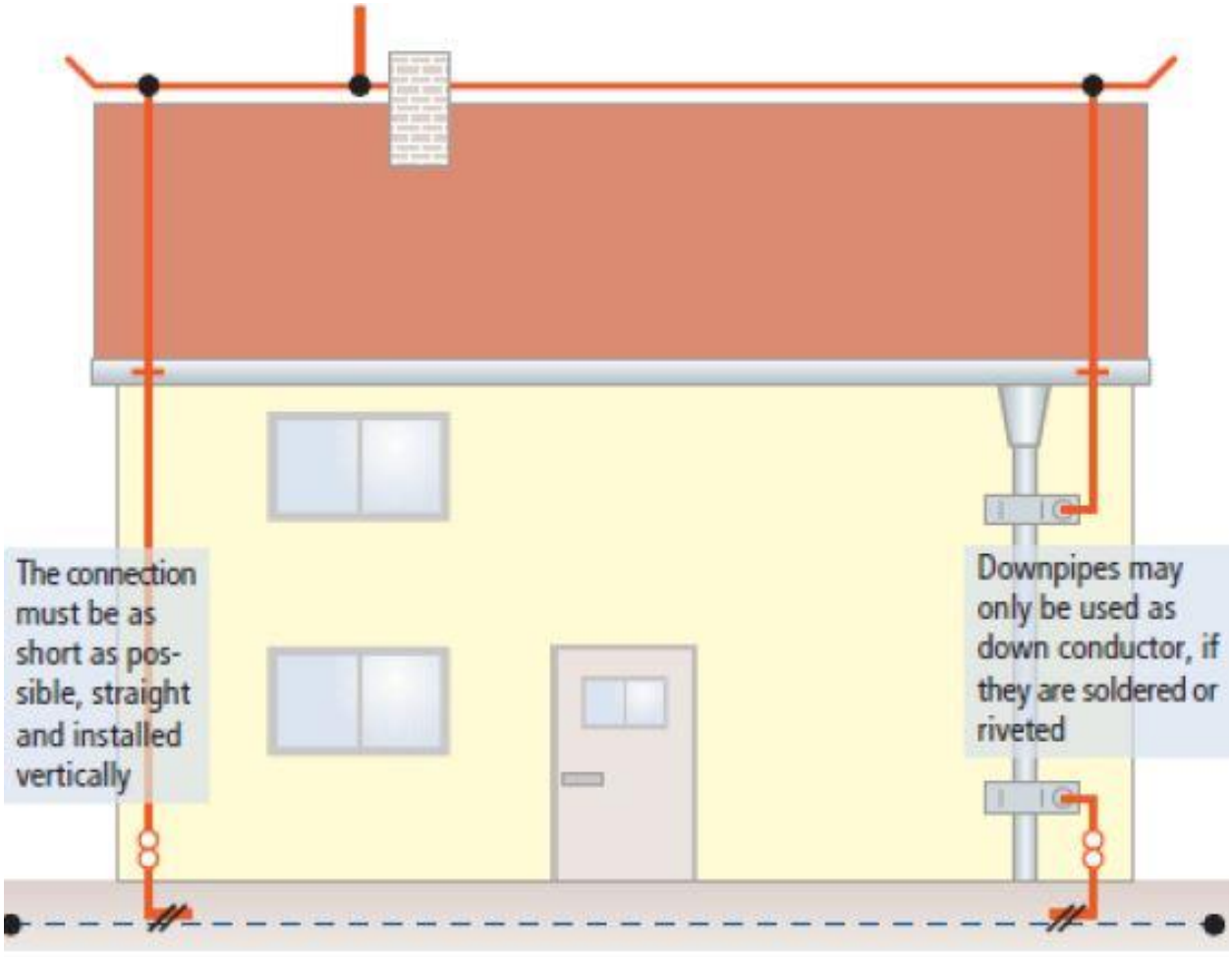
4.1 Down Conductor System

Shall **be**:

- **As direct as possible** between air termination system and earth termination system
- **As straight as possible** along the shortest path **without sharp bends** or upward sections

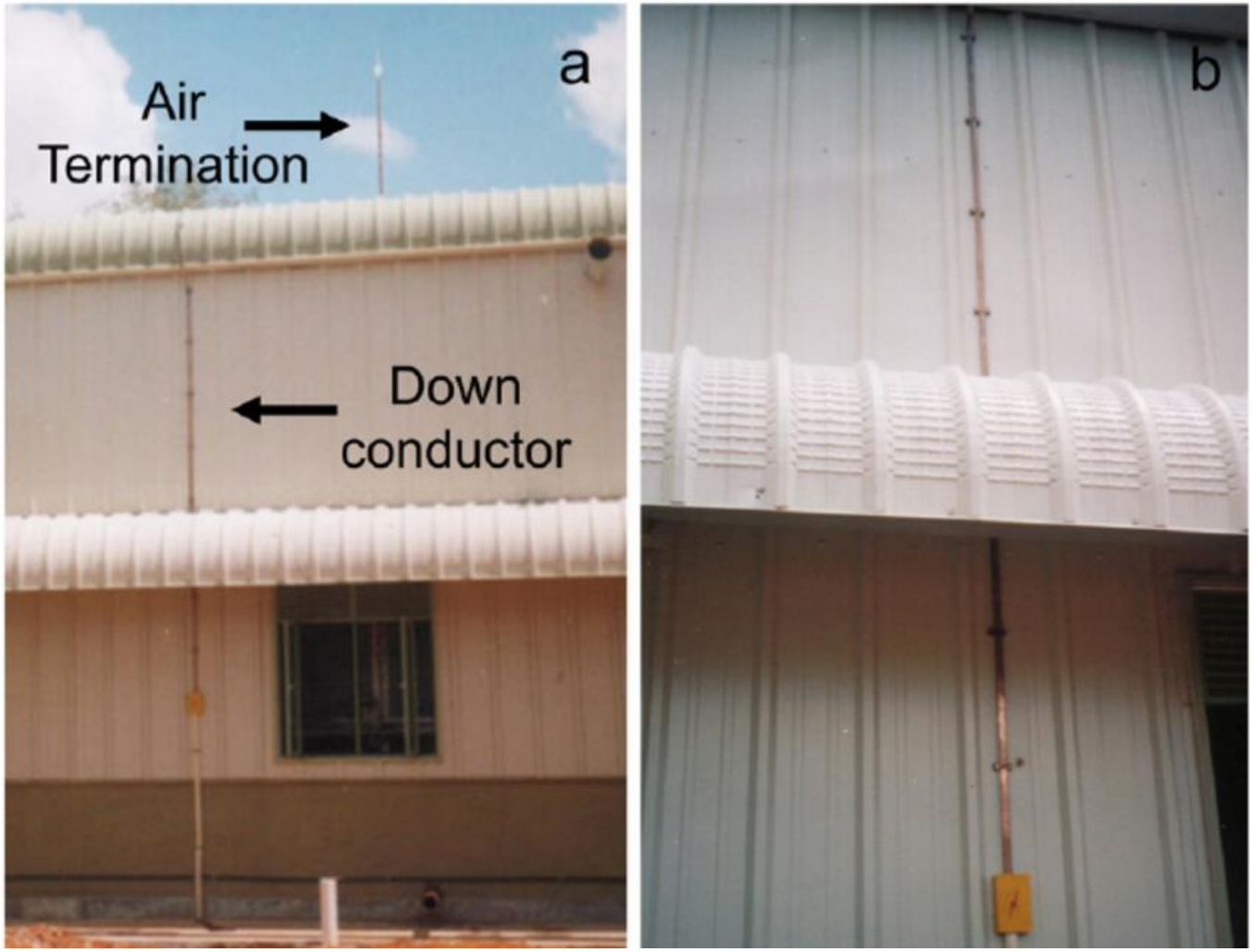
4. Down Conductor System

4.1 Down Conductor System



4. Down Conductor System

4.1 Down Conductor System



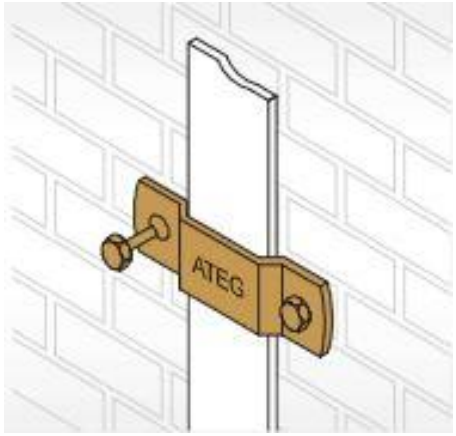
4. Down Conductor System

4.1 Down Conductor System

4.1 Down Conductor System

- Securely fixed at intervals < 500mm using conductive fixtures same material as down conductor system

Tape Clip



Tape Clip Fixing

Source: KVC

4.1 Down Conductor System

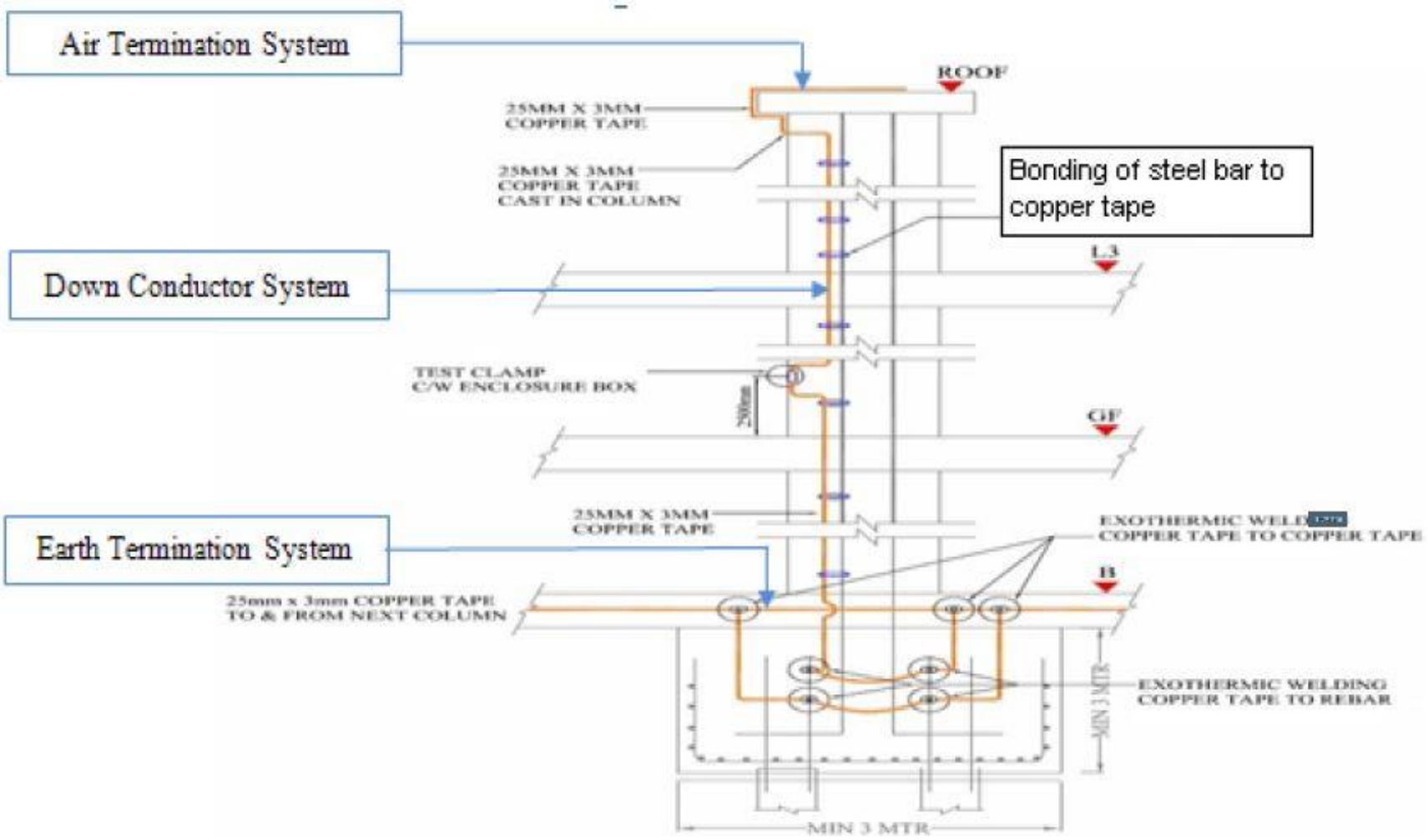
- Avoid deep re-entrant loops, routing round parapet or cornices
- Wall/buidling penetrations : prevent ingress of water/water moisture; provide PVC sleeves

4.1 Down Conductor System

- Exposed down conductors may be painted with same colour as wall finishes.

4. Down Conductor System

4.1 Down Conductor System

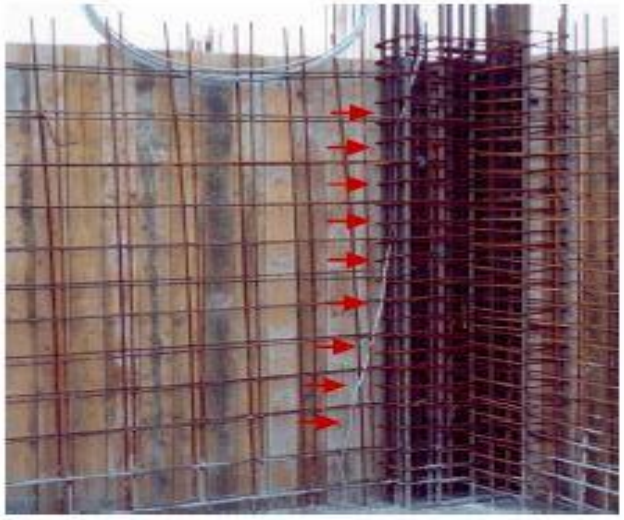


4.1 Down Conductor System

		
Example of Down Conductor installed through the reinforcement.	Example of approved connectors for connecting LPS conductors with the reinforcement.	Example of approved connectors for connecting LPS conductors with the reinforcement.

DOs

4.1 Down Conductor System

	
Non approved connection between earthing tape and reinforcement. The wire will not be able to withstand the lightning current causing explosion and cracks on the concrete.	Down conductor is driven through the reinforcement without having any bonding.

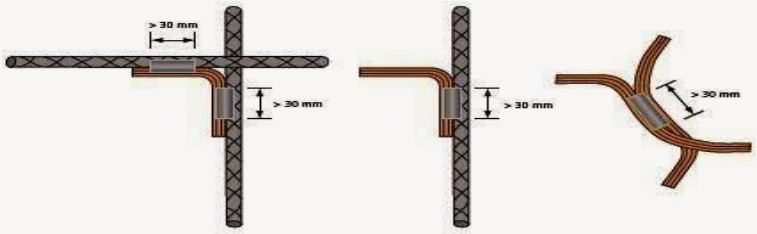
DON'Ts

4. Down Conductor System

4.2 Natural Down Conductor System

Reinforcing bars and structural steelwork

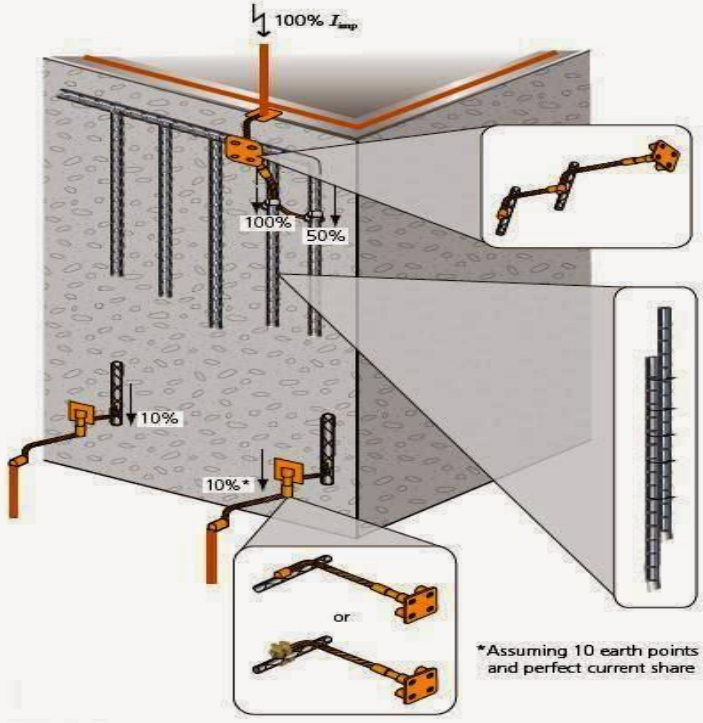
- May be used provided they are electrically continous and adequately earthed



Rebar welding requirements for connections in concrete.

Suitable for connection to air termination

Suitable for connection to ground electrode



Welding

4.2 Natural Down Conductor System

Electrically continouity

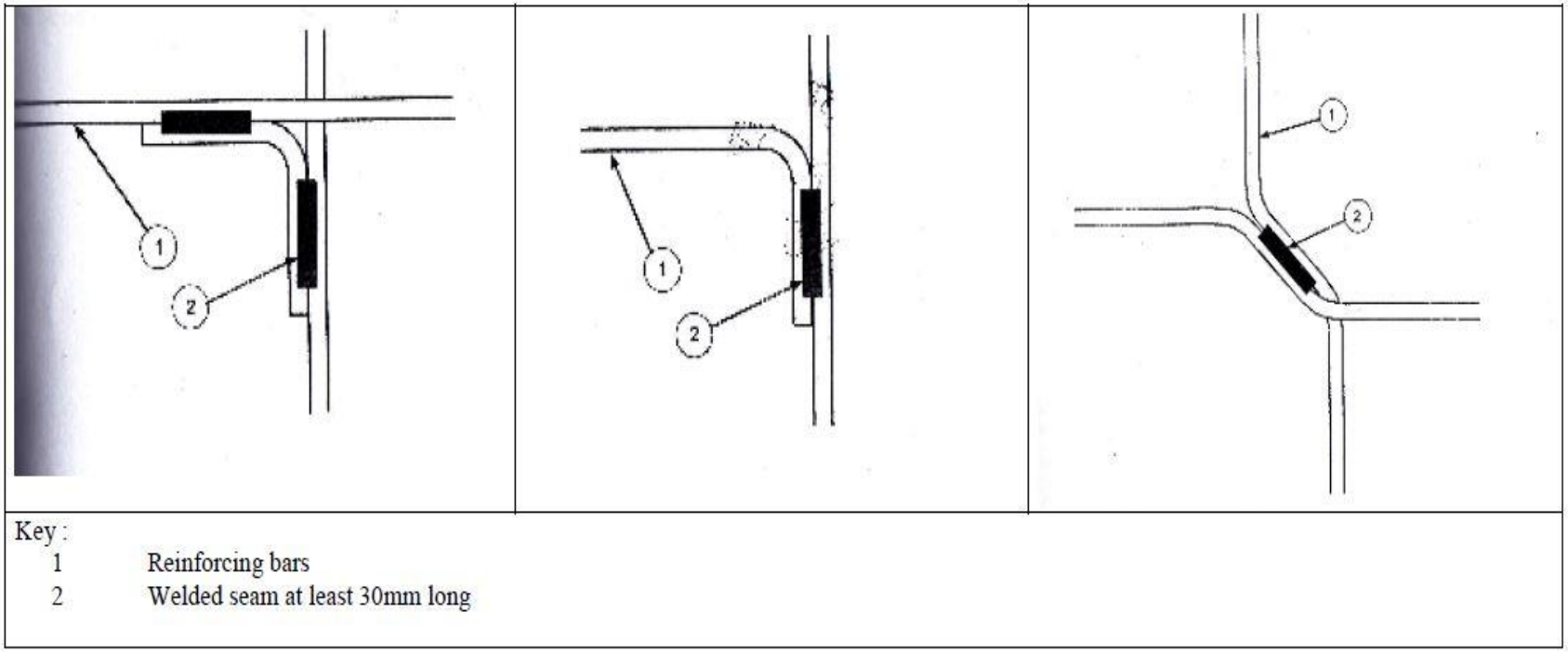
- Interconnections of vertical and horizontal bars are welded or otherwise securely connected
- Vertical bar welded < 30mm length or properly clamped.
- Overall electrical resistance < 0.2 Ohms

4.2 Natural Down Conductor System

- If greater, additional conductor may be used to enhance
- Bonded to the reinforcement bar by purpose made clamps conforming to IEC 62561 at 1 meter interval.
- Appendix A: Table 5 & Table 6

5. Joints and Bonds

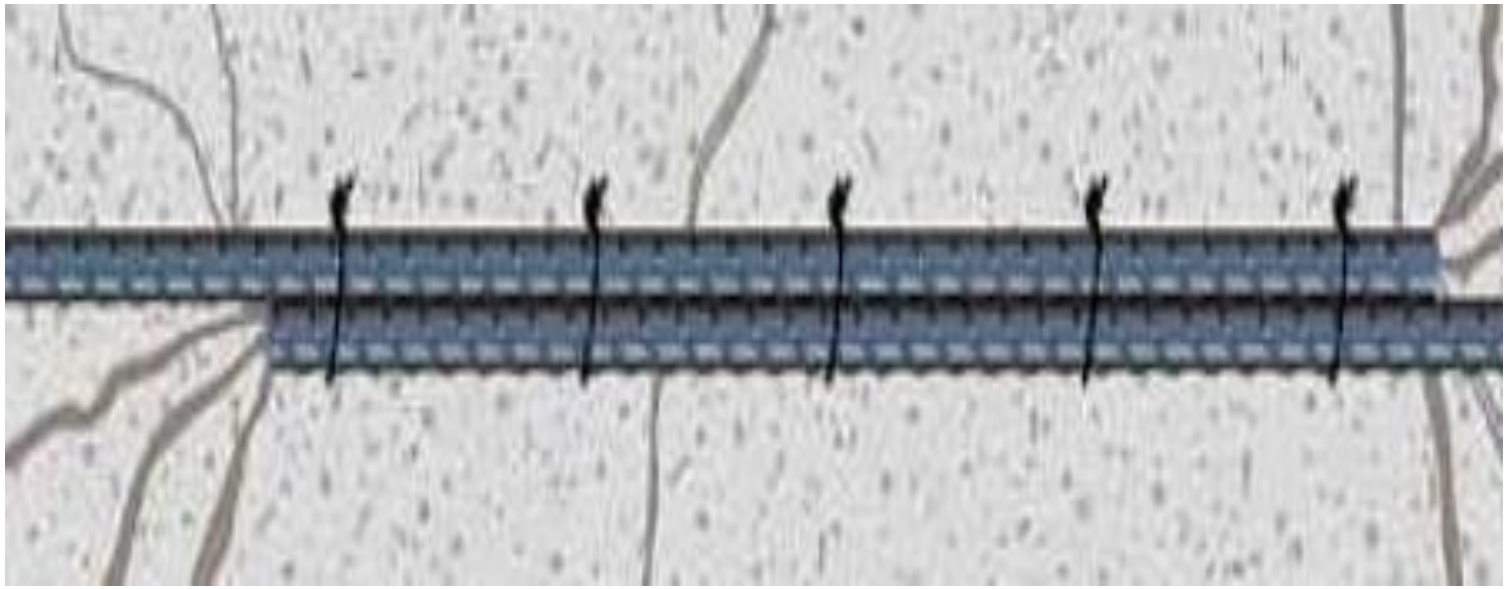
- As few joints as possible
- Purpose made clamps or exhotermic welding or brazing



Key :
1 Reinforcing bars
2 Welded seam at least 30mm long

5. Joints and Bonds

- Overlapping joints: Length of overlap > 200mm

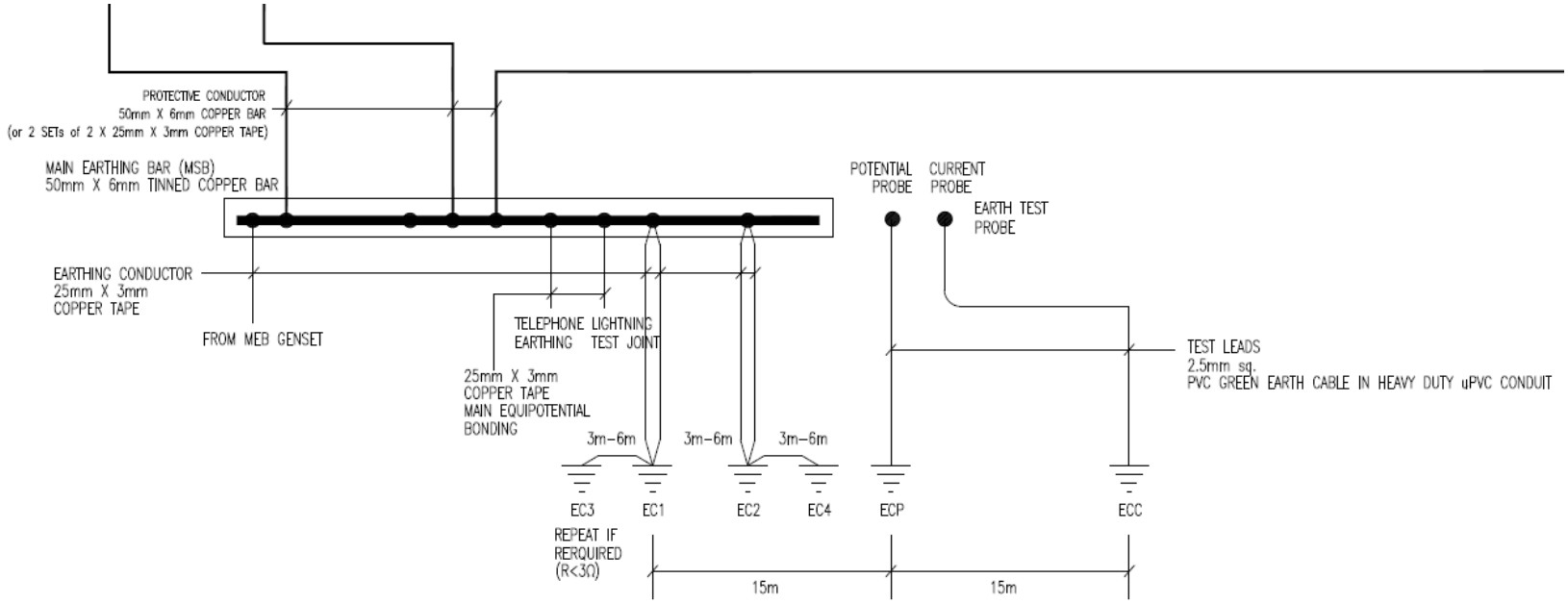


5. Joints and Bonds

- All metal works (e.g water pipes, gas pipes, handrails, air conditioning units, metal cladding, metal roof etc) in the vicinity of LPS **shall be bonded** to avoid danger of side flashing
- Bonding of copper conductor to metallic surface must be done by **bolting** or **riveting**
- Bonding of copper conductor to other materials using **bi-metallic connectors** to prevent electrolytic corrosion

5. Joints and Bonds

- LPS shall be bonded to the Main Earthing Bar as well as any other earthing system present in the structure

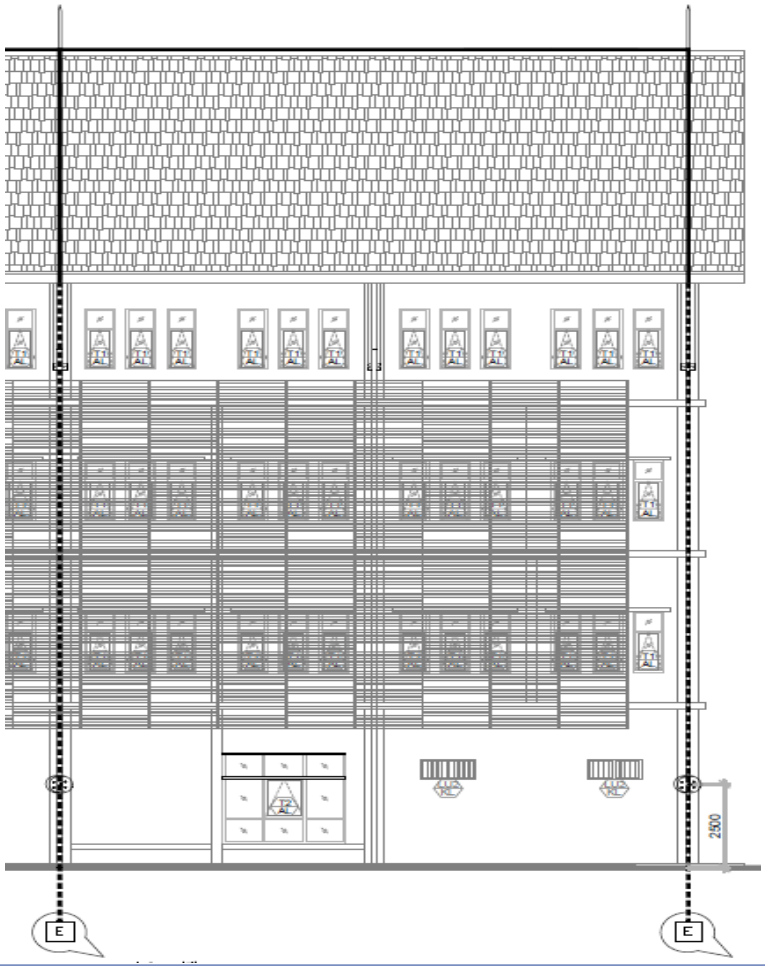


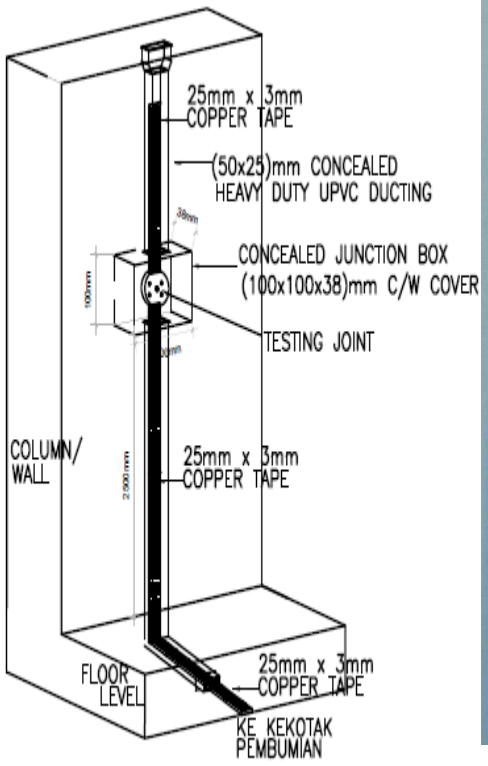
6. Testing Joints

- Shall be provided for each down conductors **except** natural down conductors
- Shall be of purpose made copper clamps or of the **same material of the down conductor**

6. Testing Joints

- Unless otherwise specified, shall be installed at **2500mm above ground level**





7. Fixing, Clamps and Supports

- Shall be purpose made
- Unless otherwise specified, shall be copper alloy, naval brass or gunmetal
- The Electrical Contractor is required to submit installation methods and samples for fixings, clamps and supports for approval before installation

8. Earth Termination System

- Shall be connected to each down conductor at testing joints using **25mm x 3mm** annealed copper tape
- Connection of the down conductor to the earth electrode shall be exhotermic welding or brazing

8. Earth Termination System

Type B arrangement

- A ring conductor in contact with soil at least 80% of its total length OR
- A foundation earth electrode (meshed)

Ring conductor

- Size 25mm x 3mm annealed copper tape
- Buried at a depth at least 500mm
- Distance from external wall 1000mm
- Permanent label “Lightning Protection Earth – Do Not Remove” at 1000mm interval

8. Earth Termination System

Ring Conductor

- The connection of two copper tapes shall be soundly made by exothermic welding or brazing

Resistance

- Each earth termination connected to down conductor ≤10 Ohm
- Combined resistance for the whole LPS ≤10 Ohm

Bonding Conductor

- Connection between earth termination at the testing joint and the Main Earthing Bar using 25mm x 3mm annealed copper tape

9. Earth Electrodes

- Copper-jacketed steel core rods with 16mm diameter
- 1500mm length, driven 3000mm in depth (2 rods needed)
- If R > 10, add more earth electrode in parallel until required value is reached
- The distance between the earth electrodes more than than the driven depth (> 3000mm) but less than twice the driven depth (<6000mm)
- Interconnection between different earth electrodes by using 25mm x 3mm annealed copper tape

9. Earth Electrodes

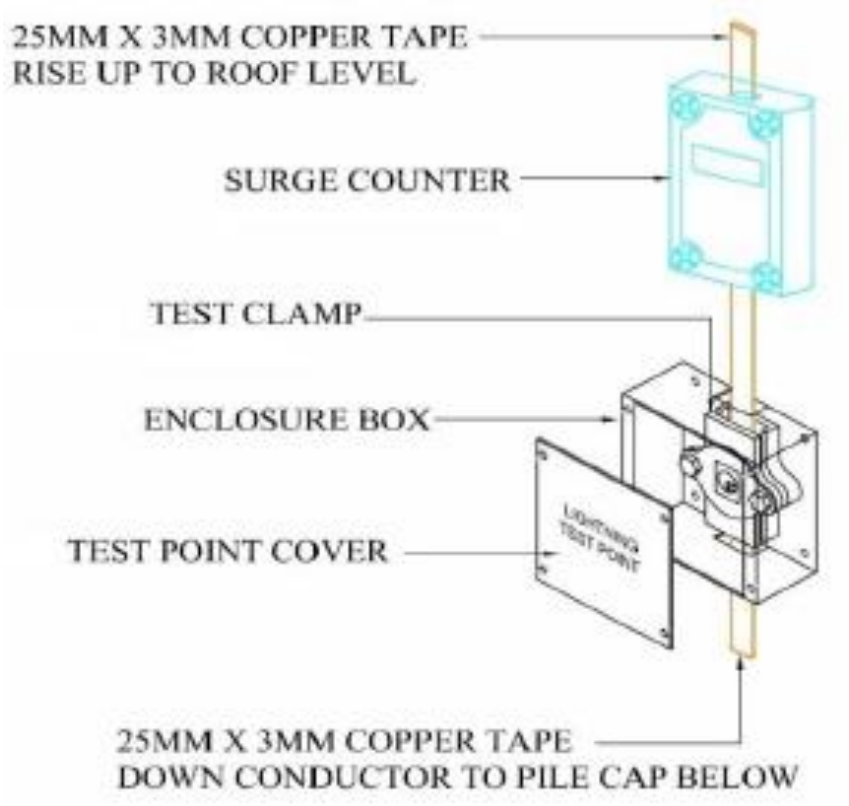
- Connection of the copper tape to earth electrode by exhotermic welding or brazing
- Provided with heavy duty type inspection chamber with removable cover
- Permanent label “Lightning Protection Earth – Do Not Remove”

10. Lightning Flash Counters

- Outdoor weatherproof
- Triggered whenever it encounters 1.5kA impulse current in 1.5 microseconds duration
- Record up to 9,999 lightning strikes

10. Lightning Flash Counters

- Installed at the most direct down conductor above the testing joint or any location indicated in the Drawing or 2500mm above ground level



11. Test, Test Instruments And Test Certificates

Test and Calibration of Measuring and Test Instruments

- Accuracy within 5%. For analogue 2%
- Test and Calibration Reports valid 2 years

Test and Test Certificate

- Tested in accordance with MS IEC 62305

11. Test, Test Instruments And Test Certificates

Test and Calibration of Measuring and Test Instruments

- Accuracy within 5%. For analogue 2%
- Test and Calibration Reports valid 2 years

Test and Test Certificate

- Tested in accordance with MS IEC 62305
- Continuity of air termination
- Continuity of air termination system and down conductor
- Continuity of earth termination system

11. Test, Test Instruments And Test Certificates

Test and Test Certificate

- Continuity of earth termination system and the main earthing bar for the electrical installation
- Earth electrode resistance
- Earth termination resistance

12. Service and Maintenance

- Replacing or making good all lightning flash counters
- Replacing and making good all losse joints and terminations, all mechanical support linkage, earth electrode chambers and covers etc
- Making good any damage to roads, buildings, drains, cables, pipes, concrete areas, paved areas etc.
- All other works deemed necessary by the S.O Rep

12. Shop Drawings

- The dimensioned general arrangements, layouts, positions and routes of air termination system, down conductors, earth terminations etc
- Elevations views of the LPS
- The dimensioned general arrangements, layouts, positions and routes of bonding conductors
- The dimensioned general arrangements, layouts, positions, and routes of earth terminations and their earth electrodes
- All other drawings as deemed necessary by the S.O's Rep

12. As Built Document and Tools

- As Installed drawings
- Manual
- Certificate
- Catalogue
- Inventories
- Part lists

As Installed drawings:

- Site plan
- Layout plan
- Elevation view of the LPS

12. As Built Document and Tools

As Installed drawings:

- Layout plans of conductor routes and earthing points with reference to easily recognisable buildngs and structures
- All other drawings as deemed necessary by the S.O's Rep

Manuals and documents for lightning flash counters and other important equipment:

- Brief description of the installation/system
- Installation manual
- Operation manual

12. As Built Document and Tools

Manuals and documents for lightning flash counters and other important equipment:

- Service and Maintenance Manual
- Parts List
- Product Data and Catalogue
- Product Test Certificate