Eskom	Standard	Technology

Title: **RADIO STATION EARTHING AND BONDING**

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COE Acceptance

Phineas Tlhatlhetji

Senior Manager – Substation Engineering

Date: 07/05/2018

DBOUS Acceptance

Amelia Mtshali

Senior Manager – Design Base and OU Support

Date: 07/05/2018

This document is **STABILISED**. The technical content in this document is not expected to change because the document covers: *(Tick applicable motivation)*

1	A specific plant, project or solution	
2	A mature and stable technical area/technology	
3	Established and accepted practices.	✓

PCM Reference: **Substation Design**

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Compiled by

E Waddington
Technologist – ET, National Planning, Facilities.

Date: 23-01-2013

Approved by

Riaz Vajeth

SCOT SC Chairperson

Date: 19/2/2013

Functional Responsibility (LES)

Dan Dukhan

Chief Engineer- Lines Engineering

Date: 23/01/2013

Authorized by

Prince Moyo

Power Delivery Engineering GM

Date: 20/2/2013

Contents

Foreword

This document is prepared by the Technology - Facilities work group.

Introduction

This document specifies the necessary earthing and bonding of a typical radio / microwave station. The earthing and bonding arrangement described constitutes an integral, primary lightning protection system for the radio / microwave station and its installed equipment.

Some radio / microwave stations will present slightly different geometry's to that described here. In such cases, the earthing and bonding arrangement adopted should follow this standard as closely as possible. This standard will be periodically revised as appropriate.

The standard does not cover the secondary and tertiary protection of the equipment. The secondary protection is concerned with the stopping and shunting to the primary protection system, at the building access point, of lightning currents induced in the conductors such as power cables for tower/mast lighting and feeder cables. Therefore, no specification of circuit arrestors or spark gaps has been given. The tertiary protection involves the inclusion of protective devices inside the equipment and this is generally left to the equipment manufacturers.

1. Scope

To provide the Telecommunications Department with a standard earthing and bonding guide for radio stations. This will not only ensure uniformity but also clarify some of the matters over which general consensus have never been reached in the past.

1.1 Purpose

The following standard is to provide uniformity and best practicing earthing and bonding requirements at Eskom Telecommunication's radio sites.

1.2 Applicability

This standard is applicable to Eskom Holdings Limited, its divisions Eskom Telecommunications.

2. Normative References

The following documents contain provisions that, through reference in the text, constitute requirements of this standard. At the time of publication, the edition indicated was valid. All controlled documents are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent edition of the documents listed below. Information on currently valid national and international standards and specifications can be obtained from the Information Centre and Eskom Documentation Centre at Megawatt Park.

SANS 10199: "The Design and Installation of an Earth Electrode"

3. Definitions and Abbreviations

3.1 Definitions

3.1.1 Air Termination: The conductive rod (lightning spike) installed to provide a point of lightning strike or departure.

3.1.2 Antenna: The signal radiating / receiving point of communications equipment.

3.1.3 Auxiliary Supply: The external AC supply to the station.

3.1.4 Bonding: The joining of two or more materials in such a way that they are electrically connected. (Either by exothermic weld or by nut and bolt.)

3.1.5 Earth: The conductive mass of the earth, whose electrical path to carry the lightning current from the point of strike to the ground

3.1.6 Earth Termination: A conductive part, or group of conductive parts, of an earthing system in contact with and providing an electrical connection with the earth.

3.1.7 Ground: See Earth.

3.1.8 Ground Ring: A group of conductive parts buried in the earth to provide an electrical connection with it and so connected as to enclose the facility being protected

3.1.9 Radio Station: Term being used to also mean radio / microwave terminal or radio / microwave repeater. This is a telecommunications facility forming part of a radio / microwave communication link or network. Also referred to as a High Site.

3.1.10 Radials: Conductive strips buried in the soil and radiating from a point at which a low impedance path to earth has to be provided.

3.1.11 Tower/Mast Structures: Tower - metallic lattice or concrete, Mast - metallic lattice stayed, Construction on which antennas are mounted at a High Site.

3.2 Abréviations

N/A

4. Radio Station

A typical radio station will basically have antennas mounted on a tower from which signal feeder cables run to the equipment building. See basic layout in Figure 1. The following can be identified as the areas, which need to be protected in a radio station: antennas, tower structures, the building structures which house the equipment, the equipment inside the building, the auxiliary supply and lastly the fence with all the other miscellaneous items within it.

5. Air Termination

5.1 Where the tower structure requires protection with an air termination, then a single spike of galvanised steel, at least two (2) meters high and 150mm² cross-section should be bolted to the uppermost point of one of the structures legs.

5.2 All tower structures that have working platforms at the top of the structure must have a spike installed with dimensions as in section 5.1, unless an antenna installed at the highest point and the lightning spike has been removed. See 5.3 below.

6. Tower Earth Termination

The earthing of the tower structure and that of the equipment building is shown in Figures 2a and 2b. The following should be done:

6.1 Lay a 150mm² cross-section copper bar ground ring to a depth of no less than 500mm around the tower.

6.2 All tower legs should be bonded to the externally buried ground ring surrounding the tower with copper strips of cross section 150mm². Bonding should be made below ground level by means of braising the 150mm² copper strap directly onto the lower end of the cage bolts of each leg using Sebra alloy braising rods.

6.3 Two radials of copper strip 150mm² cross-section, buried to a depth of not less than 500mm, should be bonded at one end to the tower ground ring furthest from the building and to the fence posts at the other end.(see Figure 2a & 2b) When braising copper to copper then copper-flow braising rods should be used.

7. Bonding of Antennas, Feeders and Equipment

7.1 Bond the metallic antennas to the metallic support structure.

7.2 Feeder and equipment will be bonded to cat ladder bonding plates by connecting the lugged ends of the earthing cables with M8 brass bolts, nuts and washers. The cat ladder bonding plates will in turn be clamped to the flat bar of the cat ladder. These cat ladder-bonding plates must be clamped onto the same side of the cat ladder as the feeder run. See Figure 5. **Note that the copper earth strip running the length of the tower is no longer required.**

a. A cat ladder bonding plate will be fitted 500mm below the top of the tower and will be used as the first bonding point.

b. Further cat ladder bonding plates can be fitted for equipment installed lower down the tower but always 500mm below the equipment to be bonded.

c. A cat ladder bonding plate will be fitted at the bottom of the tower and used for bonding cables / wave-guides.

8. Equipment Building Earth

The equipment building's external earthing is shown in Figures 2a and 2b. The following must be noted:

8.1 Provide an external buried ground ring for the equipment building using a copper strip of cross-section 150mm². The ring should be buried to a depth of not less than 500mm and 100mm from the building foundation. Bond the ground ring to the tower structures as explained in section 6.

8.2 Two radials shall be run from the ground ring to the corner posts of the fence. See Figure 2a.

8.3 If the building does not fall in the cone of protection of the tower structure (45°-protection angle), then a separate air termination must be provided for it.

8.4 All the cables, both signal and power, must enter the building from the same side and at the same point. The container or building should be earthed at one point (single point earthing). All lightning protection should take place at the same point.

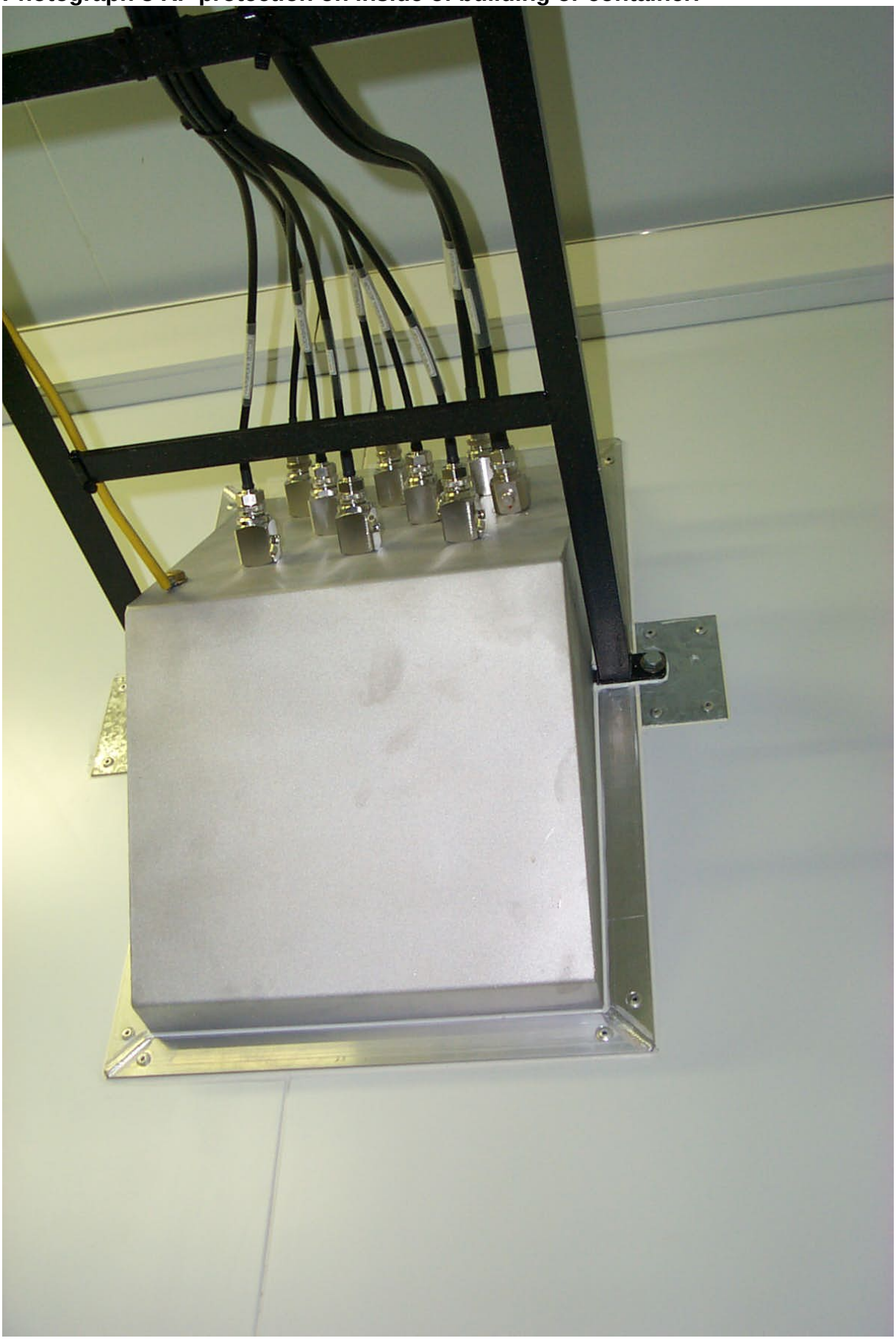
On containers the copper T piece should be bolted to the aluminium strip. Copper slip should be used to provide a good connection. See photograph 1 below.

Photograph 1 Copper T-piece connection.

Any metallic objects, pipe works, metal trunking etc. (buried or otherwise), which unavoidably run through the building, must be bonded to the building earth ring at both the point of entry into and exit from the building.

Photograph 2 Broad aluminium strip is used to bond RF & AC earthing points.

Photograph 3 RF protection on inside of building or container.



9. Bonding of the Equipment and Racks

The earthing and bonding of the inside of the equipment building is shown in Figures 2a and 2b. The following should be noted:

9.1 Provide an earth bus inside of the building in the cable tray for the equipment and run it as close to the equipment to be earthed as possible using 25mm X 3mm flat copper bar.

9.2 Effect the earthing terminal connections of the equipment frameworks, racks and other metallic objects inside the building with as short and straight conductors as possible of cross-section not less than 16mm².

9.3 Bond the inside equipment earth bar to the external building ground ring.

9.4 Bond all the miscellaneous metallic objects inside the building, such as IDF, doors, (including the roof if metallic), etc., to the earth bar.

10. Bonding of Metallic objects outside the building

10.1 All metallic objects within the station fence should be bonded to the ground equipotential ring.

10.2 Bond the station fence to the tower ground ring as explained in section 6. Also bond the two gateposts of the station fence together using bonding strap of 150mm² cross-sections.

10.3 All earthing / bonding strips crossing each other or in close proximity must be bonded together.

11. Bonding of the Auxiliary Supply

11.1 The auxiliary supply cables must be routed in such a way that they enter the building from the same side as the other cables. See Figure 3.

11.2 The armouring of the supply cables must be bonded to the grounded metal at the point of entry to the building.

11.3 Run an earth strip of cross section 150mm² parallel to the AC supply cable. Bond it to the building earth ring at one end and to the secondary neutral ground at the other end. Ensure that the primary surge arrestor ground is interconnected to the secondary neutral ground. See Figure 4.

11.4 In the case where the radio / microwave station is supplied by a feeder from a substation in the vicinity, then the earthing strip running parallel with the supply cables mentioned in section 11.3, must be bonded to the substation earth mat.

12. Compliance

12.1 Bonding of the 150mm² copper earth strap is to be braised using Sebra alloy or copper flow braising rods. Cad welding is unacceptable.

12.2 Bonding to the fence posts is to be made below ground.

12.3 The installed earth needs to be inspected by an Eskom representative and signed off to ensure that there are no poorly braised or high resistance connections before the earth mat is covered.

12.4 Photographs should be taken of earth connections for record keeping purposes.

13. Copper Theft

13.1 The copper trenching should be backfilled by mixing the backfill material with 10% cement and then compacting the material back into the trench.

13.2 A concrete apron should be cast around the building and fence.

Photograph 4

13.3 All exposed copper should be painted with aluminium paint so as to disguise the evidence of copper.

14. Attachments

N/A

15. Related Documents

N/A

16. Authorisation

This document has been seen and accepted by:	
Name	**Designation**
Corrie Vermeulen	Eskom Telecommunication Manager
Joe Manyisa	Middle Manager Operations - NMC
Jaap Maritz	Middle Manager Operations - Mpumalanga & Limpopo
Ben van Nieuwenhuizen	Middle Manager Operations - Coastal Region
Mlungisi Mkhwanazi	Middle Manager Project Management Office
Cornelius Naidoo	Technology and Engineering Manager
Willie van der Vyver	Middle Manager - Projects
Keith Cornwall	Middle Manager Operations - Central
Alan Driver	Senior Consultant - National Planning
Mark Ganesan	Middle Manager Operations - Safety & Environment

17. Revisions

Date	Rev.	Remarks
18 June 2009	Rev 1	*n/a* .
25 February 2010	Rev 2	*n/a*

18. Development team

Eric Waddington and Facilities work group

19. Annexes A – List of Figures

Figure 1: Typical Radio/Microwave Station Layout.

Figure 2a: Organisation of Tower/Mast and Building Earthing – Plan.

Figure 2b: Organisation of Tower/Mast and Building – Elevation.

Figure 3: Arrangement of Cable Entry into Equipment Building.

Figure 4: Earthing of the Auxiliary Power Supply.

Figure 5: Outdoor Equipment Cat Ladder Bonding Plate.

Annex A: List of figures

Figure 1: Typical Radio/Microwave Station Layout.

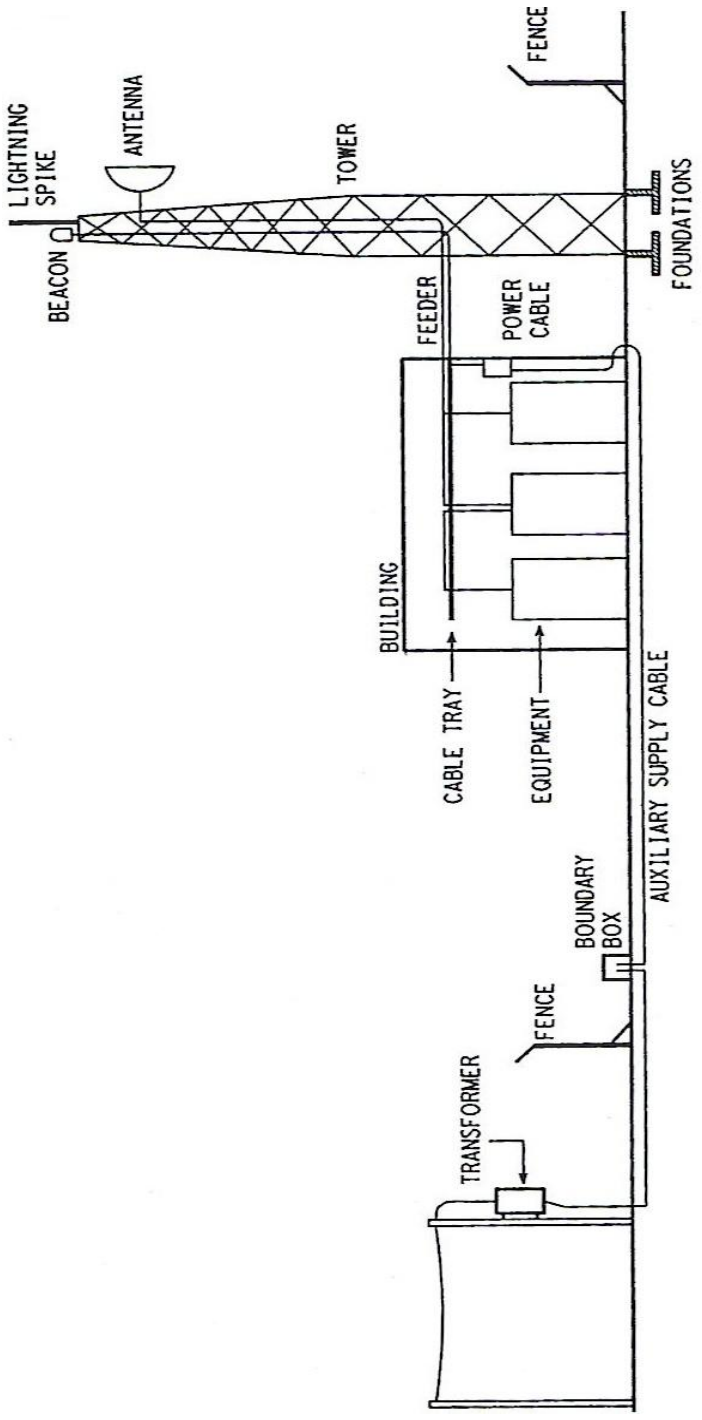


Figure 2a: Organisation of Tower/Mast and Building Earthing – Plan

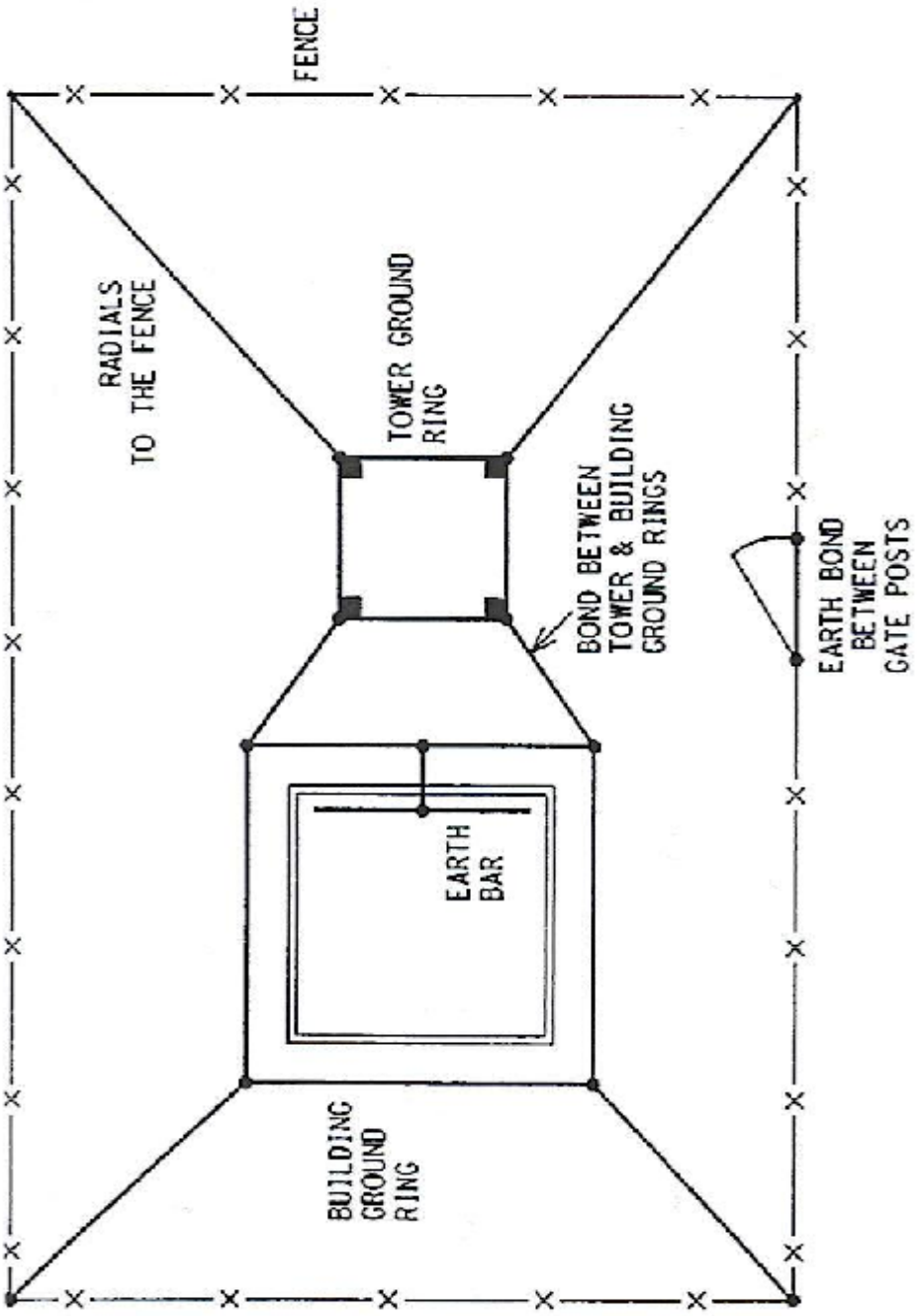


Figure 2b: Organisation of Tower/Mast and Building – Elevation

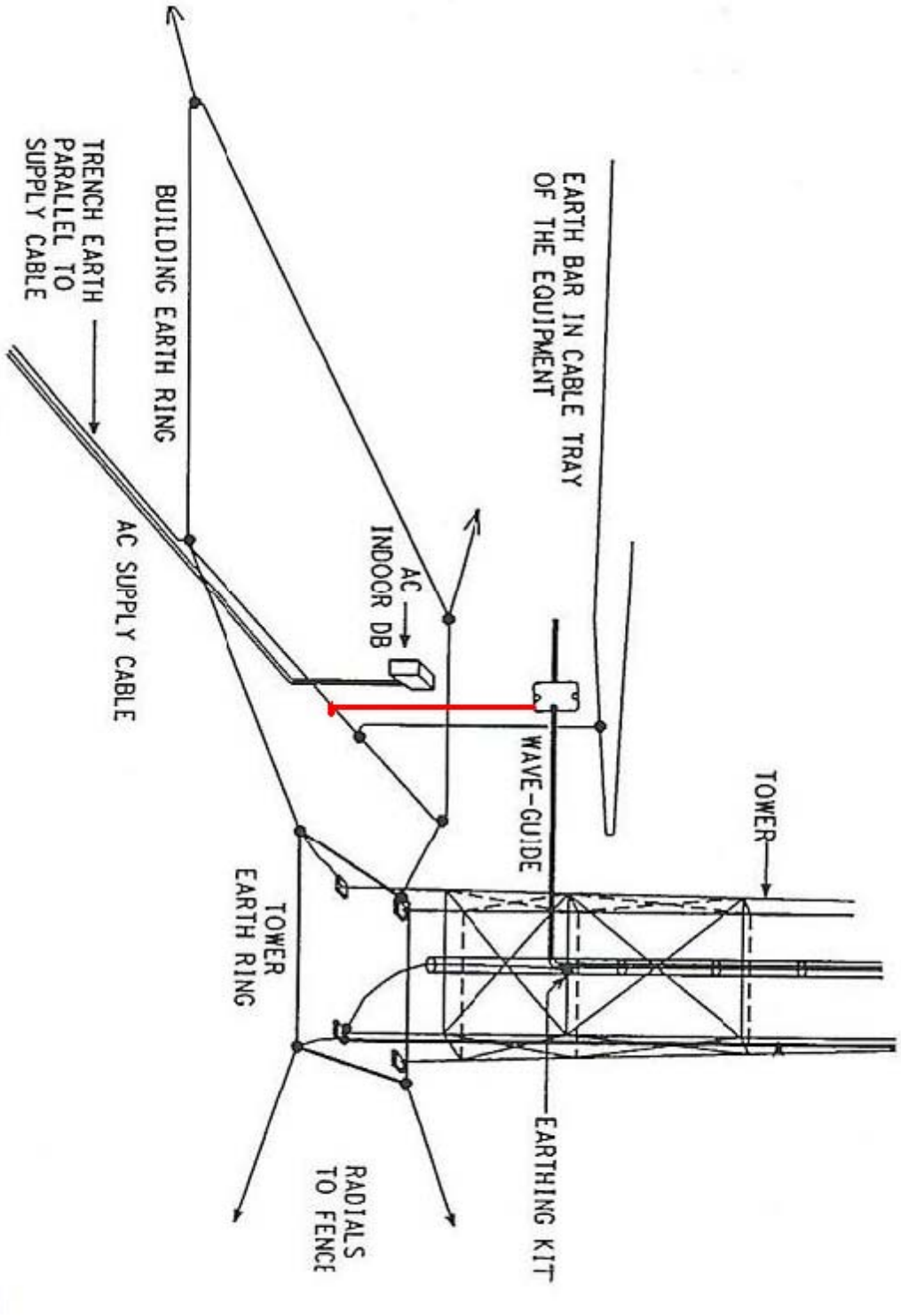


Figure 3: Arrangement of Cable Entry into Equipment Building.

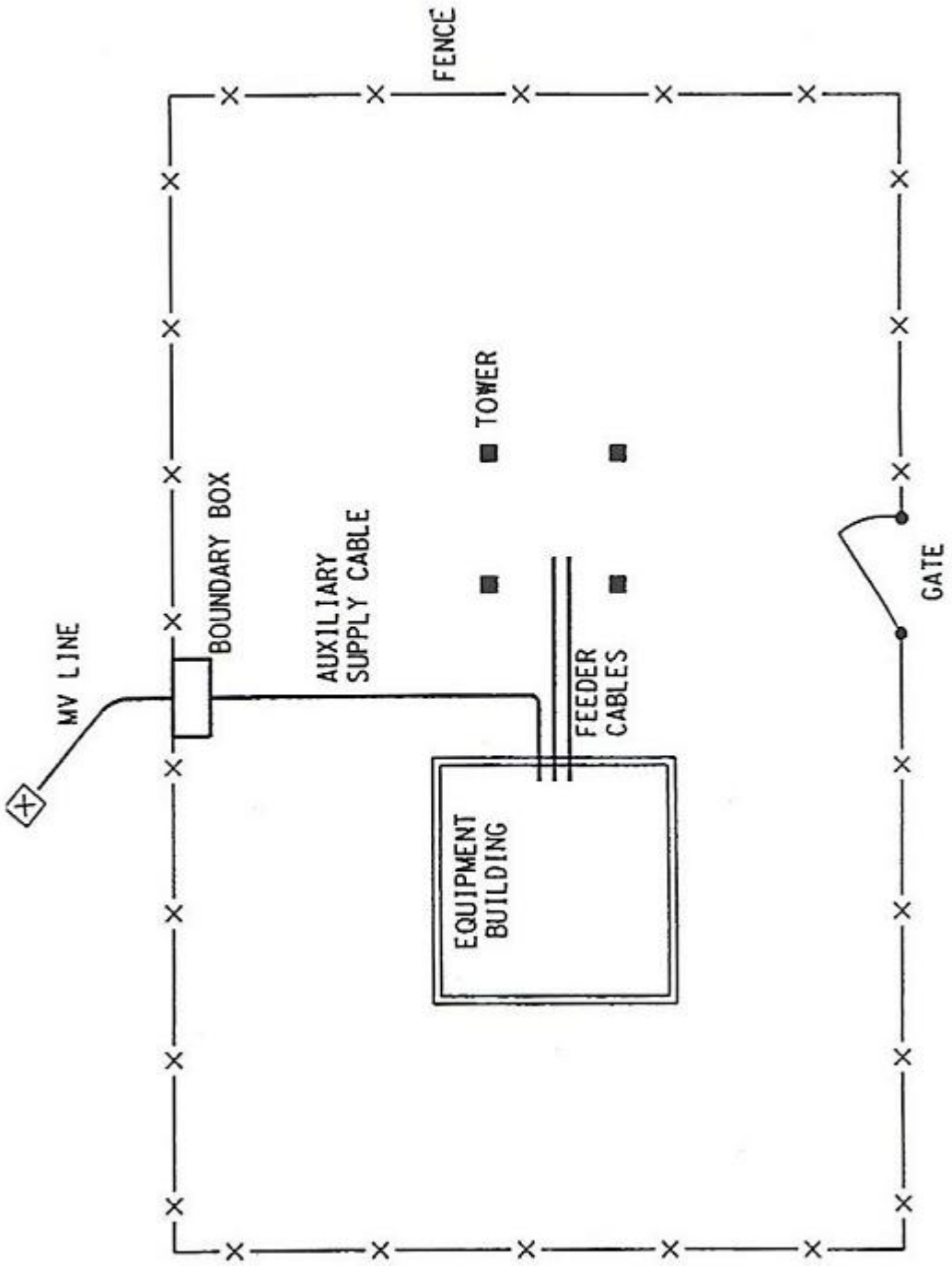


Figure 4: Earthing of the Auxiliary Power Supply.

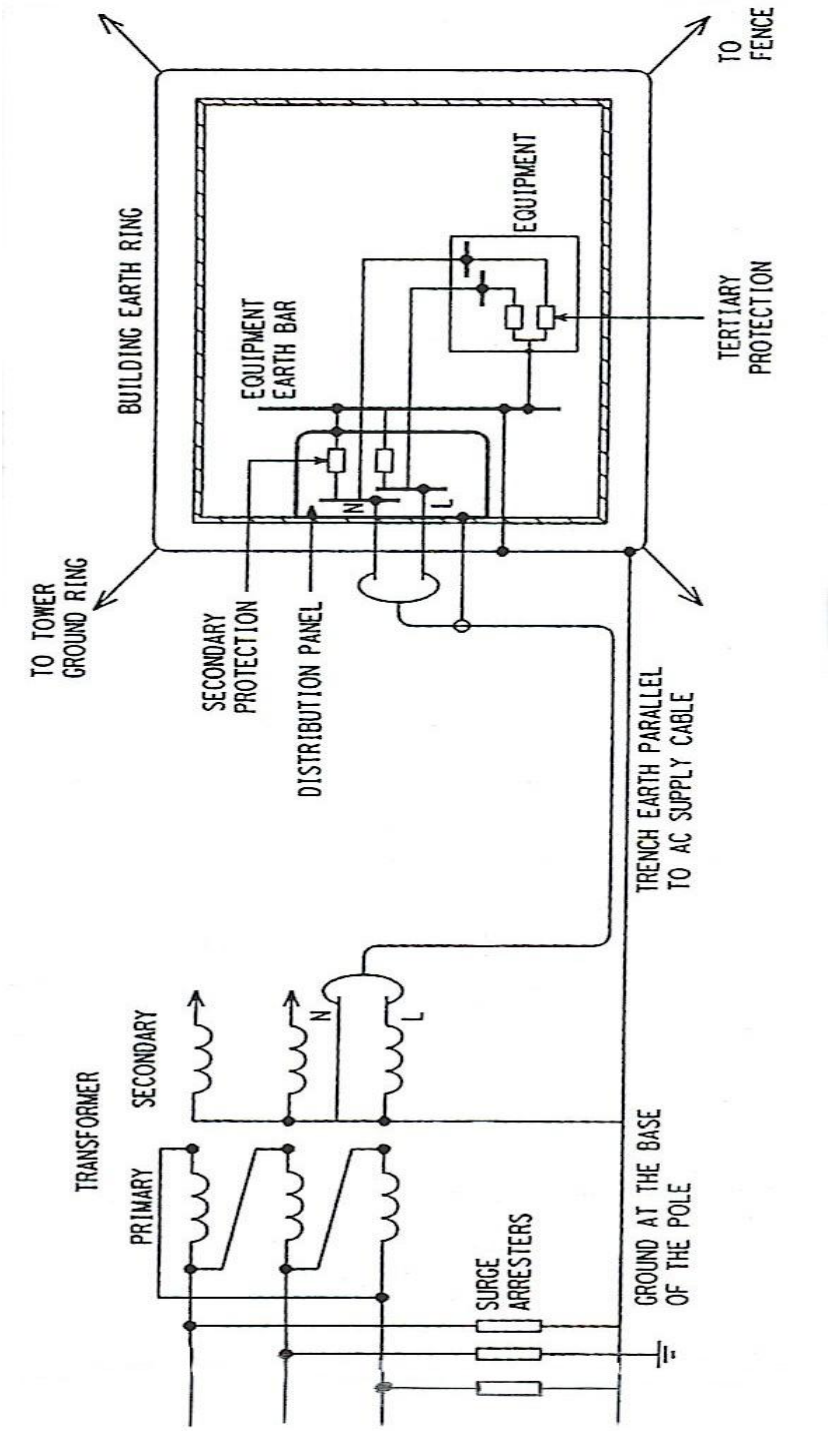


Figure 5: Outdoor Equipment Cat Ladder Bonding Plate.