

GENERAL SPECIFICATION

ELECTRICAL

GS EP ELE 051

Design and installation of lightning protection
--

04	10/2012	IEC reference update
03	10/2009	Addition of typical installation standard
02	10/2005	Addition of "EP" root to GS identification
01	12/2003	General revision - Change of Group name and logo
00	03/2001	First issue
Rev.	Date	Purpose of the revision

Owning entity: DEV/TEC	Managing entity: DEV/TEC/ELE
------------------------	------------------------------

General Specification		GS EP ELE 051
Design and installation of lightning protection		
Rev.: 04	Effective date: 10/2012	Page: 2 of 21

Contents

1. Scope	3
2. Reference documents.....	3
3. Protective devices.....	4
3.1 General.....	4
3.2 Preliminary evaluation.....	4
3.3 Equipotentialization	4
3.4 Gridlike spatial shields	5
3.5 Surge Protective Device (SPD)	5
3.6 Fibre optic cables between structures.....	7
3.7 Earthing	7
3.8 Air-termination system	8
3.9 Aerials on offshore platforms.....	8
4. Quality control methods.....	8
4.1 Equipotentialization	8
4.2 Surge protective devices.....	8
4.3 Earth electrodes.....	9
4.4 Air-termination system	9
5. Other references	9
Appendix 1	10

General Specification		GS EP ELE 051
Design and installation of lightning protection		
Rev.: 04	Effective date: 10/2012	Page: 3 of 21

1. Scope

This specification defines the minimum requirements for design, construction, and inspection of lightning protection systems in the Company installation located either onshore or offshore.

2. Reference documents

The reference documents listed below form an integral part of this General Specification.

Design and engineering shall conform as a minimum requirement to current edition of the following in order of preference:

- Applicable laws and regulations of the country in which system will be operated. In cases where no “local” regulations exist, French laws and regulations shall be used
- Company Particular Specifications and data sheet (if any)
- Company General Specifications
- Applicable International Electro-technical Commission IEC Standards
- Applicable CENELEC Standards
- Applicable recognised standards and codes (e.g. UTE-NFC, BSI, VDE, etc.) where IEC publications have not yet been issued:

External Documents

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published at the effective date of this document.

Reference	Title
IEC 60092-401-A2	Electrical installations in ships - Part 401: Installation and test of completed installation - Amendment 2
IEC 60099-1	Surge arresters - Part 1: Non-Linear resistor type gapped surge arresters for A.C. systems
IEC 61643 (Parts 11; 12)	Low-voltage surge protective devices - Parts 11; 12
IEC 62305 (Parts 1; 2; 3; 4)	Protection against lightning - Parts 1; 2; 3; 4

Total General Specifications

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published in the applicable yearly collection.

Reference	Title
GS EP ELE 031	Design of earthing and bonding systems

General Specification		GS EP ELE 051
Design and installation of lightning protection		
Rev.: 04	Effective date: 10/2012	Page: 4 of 21

3. Protective devices

3.1 General

Preliminary evaluation for protection lightning shall be done for onshore application at basic engineering stage by an independent third party specialised in lightning protection and never by an equipment Supplier. For both offshore and onshore application, the risk analysis shall be done at detailed phase engineering. Third Party selection shall be submitted to Company approval. The engineering Contractor shall assist the Third Party in providing all necessary information required for the performance of the studies.

The Third Party shall verify all the detailed engineering drawings and documents issued by the EPC Contractor. The Third Party shall perform a final inspection at site before precommissioning stage.

This study shall define the Lightning Protection Zones (LPZ) as per IEC.

A checklist including the most sensitive equipment to the lightning effects shall be provided.

Protection against indirect effects, which produce overvoltages shall be provided by equipotential bonding and surge protective devices. Equipotentialization is a very important measure to reduce hazard of lightning effects in the space to be protected.

Protection against direct lightning strikes shall be provided by air-termination systems. Air-termination setting up shall not be systematic. A preliminary evaluation shall be carried out, which shall show the direct lightning risks for structures and buildings. Devices for surge protection against indirect and direct effects of lightning or other transient overvoltages shall be in accordance with [IEC 61643-11](#).

3.2 Preliminary evaluation

3.2.1 Protection levels for Lightning Protection Systems (LPS)

For every structure considered, the Third Party designer shall decide whether or not a LPS is needed. If required, the minimum efficiency shall be $E = 0.98$ in accordance with [IEC 62305-1](#).

3.2.2 Lightning protection zones

The volume to be protected shall be divided into LPZ to define volumes of different Lightning ElectroMagnetic Impulse (LEMP) severity, and to designate locations for bonding points on the zone boundaries.

Zones shall be characterised by significant changes of the electromagnetic conditions at their boundaries as per [IEC 62305-4](#) paragraph 4.

In general, the higher the number of the zones, the lower the electromagnetic environment parameters (i.e. LPZ 0, LPZ 1, LPZ 2).

3.3 Equipotentialization

Equipotentialization and strengthening of the bonding as per [IEC 62305-4](#) shall be applied at first to carry out the lightning protection.

Bonding network shall be meshed configuration (M) instead of star configuration (S).

General Specification		GS EP ELE 051
Design and installation of lightning protection		
Rev.: 04	Effective date: 10/2012	Page: 5 of 21

Management of different Lightning ElectroMagnetic Protection impulse for new buildings and extensive changes in construction or use of building shall respect the Table 2 as per [IEC 62305-4](#) paragraph 9.

3.4 Gridlike spatial shields

In practice, large volume shields of structures or rooms are built by natural components such as metal supports, metal frames or metal reinforcement rods.

These components build up a gridlike large volume shield.

The conducting elements penetrating a shield shall be bonded to the shield as close as possible.

3.5 Surge Protective Device (SPD)

3.5.1 General

Surge protective devices (SPDs) are used to protect, under specified conditions, electrical systems and equipment against various overvoltages and impulse currents, such as lightning and switching surges.

SPDs shall be selected according to their environmental conditions and the acceptable failure rate of the equipment and the SPDs.

Effectiveness of SPD's doesn't depend only on their intrinsic characteristics. So they shall be selected and installed in accordance with [IEC 62305-4](#) and [IEC 61643-12](#).

Surge Protective Devices (SPDs) shall conform to [IEC 61643-11](#) and shall be installed according to the Lightning Protection Zones concept given by [IEC 62305-4](#).

For SPDs installed within a complex system, it shall be divided into simple basic arrangements, observing the rules described in the [IEC 62305-4](#).

The specific characteristics of the individual SPD's and the hazard at the respective place of installation shall be considered for effective coordination.

3.5.2 Coordination

The realisation of the energy coordination of all SPD's installed in a system, including the equipment to be protected, is decisive for the efficiency of the protection.

Basic parameters for the coordination of individual SPD's shall be declared by the Manufacturer of SPD's.

The coordination shall be proved by the following:

- Coordination test certificate
- Calculation
- Application of intercoordinated SPD's families
- Coordination method according to Let-Through Energy (LTE).

General Specification		GS EP ELE 051
Design and installation of lightning protection		
Rev.: 04	Effective date: 10/2012	Page: 6 of 21

3.5.3 Design of protection against voltage surges

All surge arresters must be selected in accordance to the [IEC 60099-1](#).

3.5.3.1 High-voltage power lines

- Entirely underground main supply (infrequent):
Surge protective devices are not required, except in special cases.
- Overhead/underground main supply (with the installation to be protected connected underground):
A set of surge protective devices equipped by variable resistance shall be provided at the feeder pole.
Beyond 30 metres downstream of the surge protective devices, protection is no longer provided; further protection may be needed if sensitive equipment is present.

3.5.3.2 Transformers

As appropriate, three variable resistance surge arresters shall be installed on the up line side of the transformer.

Furthermore, star-connected transformers with neutral(s) insulated from earth or earthed through high impedance shall incorporate a spark gap, a surge arrester or a surge absorber on the neutral conductor.

3.5.3.3 Low-voltage power lines

Protection for overhead line shall be provided by installing a variable resistance surge arrester between each phase conductor and the earth electrode to be installed at the base of the pole or at the feeder point.

Where the distance between the base of the pole and the feeder point exceeds 30 m, surge protective devices shall be installed at both ends.

If the neutral conductor is not directly earthed a surge arrester shall be fitted between neutral and earth.

3.5.3.4 Cables connecting sensitive buildings to be protected

This section concerns power cables, outdoor lighting cables and all cables susceptible to voltages induced by atmospheric phenomena.

Protection is provided by fitting a low-voltage variable resistance surge arrester to each conductor of the cable or circuit to be protected.

The surge arresters are located at the point of entry of the cable into the building to be protected and the connections between them and the earthing system shall be as short as possible.

These surge arresters are usually installed in dedicated cabinets and shall be next to the incoming cables in the building.

General Specification		GS EP ELE 051
Design and installation of lightning protection		
Rev.: 04	Effective date: 10/2012	Page: 7 of 21

3.5.3.5 Protection of Instrument and communication cables

The following protecting measures shall be applied:

- Segregation of the cables from unprotected cables either by running them separately or by using metal ducting connected to the earthing circuits. Common routing in plastic ducting in buried systems is prohibited
- Laying accompanying earth conductors over cables buried in trenches
- Fitting surge protective devices between conductors and earth at the point of entry of the cable(s) into the buildings to be protected.

3.5.3.6 Sensitive equipment

A residual voltage surge remains downstream of the surge arresters, which may cause damage to sensitive electronic equipment.

Surge diverters shall be installed to protect such equipment when the objective of these is to reduce the residual voltage surge to levels acceptable to the electronic equipment.

Surge diverters shall be installed in series with the installations to be supplied and their rating depends on the size of the installation. They supply only the sensitive equipment to be protected and no other equipment.

Connections from surge diverters shall be routed separately, on dedicated routes far away from other cable runs (to avoid induced interference).

3.6 Fibre optic cables between structures

Fully insulated fibre optic cables (i.e. those without metallic armour, moisture barrier foil or steel internal draw wire) shall be used safely between structures and no further protection measures are needed. This is the preferred method of data interconnections for complete freedom from lightning interference.

3.7 Earthing

The purpose of the earthing system is to dissipate as much as possible the lightning current into the soil without producing dangerous potential differences in the earthing system.

Earthing system shall be meshed with interconnexion of all network as per three dimensional system (see Appendix 1).

The earthing and bonding system shall be unique and suitable for all purposes (i.e. lightning protection, power, instrument and telecommunication systems) and in accordance with **GS EP ELE 031**.

The Earthing system impedance shall be as low as possible (high frequency waves). So the length of each earth electrode shall be as short as possible or in a parallel device as indicated figure 6 [IEC 60305-4](#).

It shall therefore mainly consist of a large number of conductors buried in trenches and laid out in a meshed arrangement.

General Specification		GS EP ELE 051
Design and installation of lightning protection		
Rev.: 04	Effective date: 10/2012	Page: 8 of 21

3.8 Air-termination system

Their general principles of installation described in [IEC 62305-3](#) shall be applied only in case of necessity of structure protection against lightning.

The lightning rods shall be positioned according to the hypothetical sphere method as per [IEC 62305-3](#).

To obtain the most effective protection possible (sphere radius $R = 20$ m for large constructions), guard cables shall be installed.

3.9 Aerials on offshore platforms

An air-termination is necessary only when aerials are installed at the top of the mast. In this case, the rod shall be located at least 2 m above the highest aerial.

The down conductor shall run inside the mast using a copper strip with a minimum cross-sectional area of 30 x 2 mm, and connected to the mast base by a stainless steel lug welded to the structure of the platform when the platform structure is used as an equipotential bonding system.

4. Quality control methods

A full lightning protection installation requires complete documentation including accurate drawings. Once the documentation has been approved, installation shall be checked during the work and on completion. Inspection shall cover:

4.1 Equipotentialization

- Continuity of earthing
- Verification of interconnections between earthing circuits
- Electrical continuity, welding together of all civil engineering steelwork elements
- Measurement of continuity between the different earth electrodes
- Connection of stays to the earthing system
- Correct installation of down conductors (proximity to metal parts, absence of sharp edges, etc.)
- Quality of welds and solder joints
- Location of trenches
- Cleaning of the bottom trenches before laying earth conductors
- Position of earth conductors.

4.2 Surge protective devices

- Surge protective devices position and assemblies
- Coordination between surge protective devices.

Design and installation of lightning protection

Rev.: 04

Effective date: 10/2012

Page: 9 of 21

4.3 Earth electrodes

Measurement of the resistance of the following:

- Air-terminations earth pits
- Each independent earth pit
- General earthing.

4.4 Air-termination system

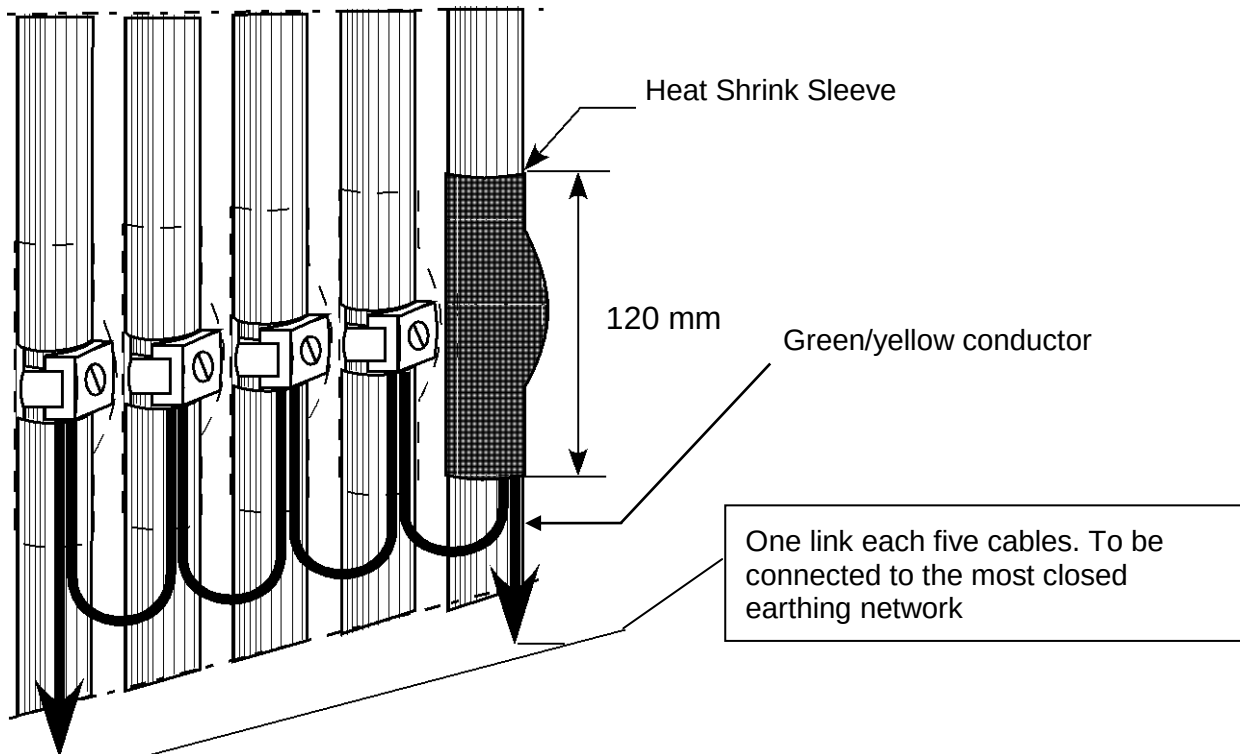
- Lengths, cross-sections and locations of steelwork for connecting the reinforcing rods of reinforced concrete to the exterior earthing loop and to the interior earthing circuits
- Nature of earthing rods
- Location and height of lightning rods
- Connection of lightning rods, number of down conductors
- Verification of interconnections between earthing circuit.

5. Other references

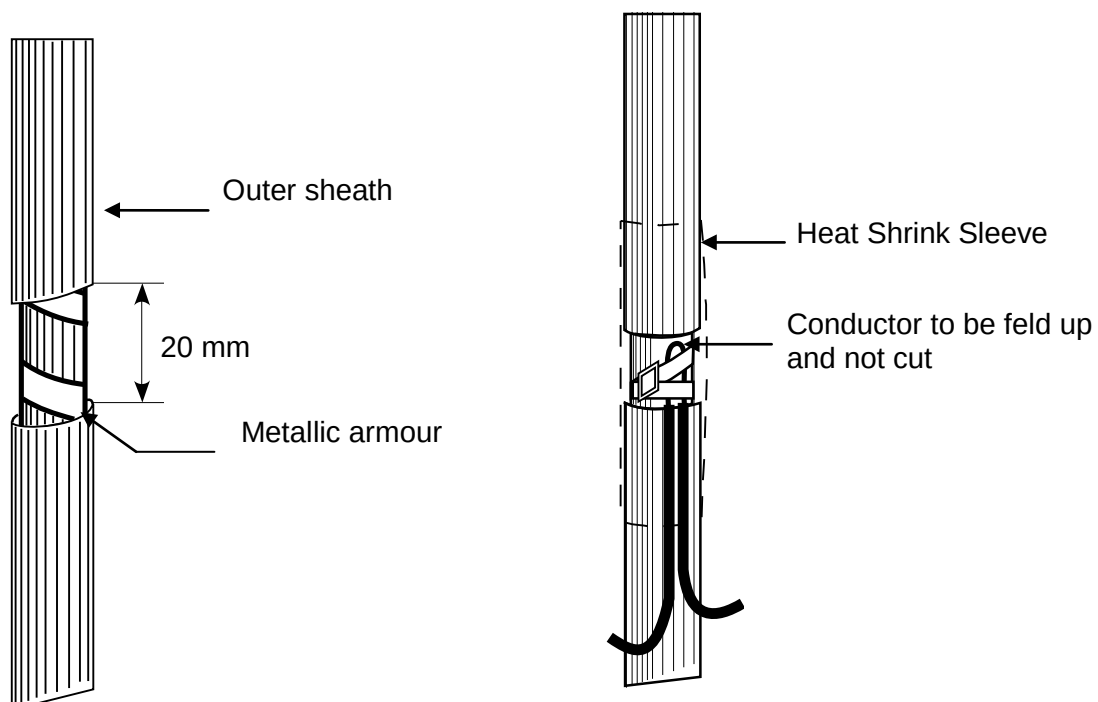
Following document is applicable: [IEC 60092-401-A2](#).

Appendix 1

Bonding by stainless steel screw clamp (from 35 mm²)



Bonding by stainless steel clamp (up to 35 mm²)

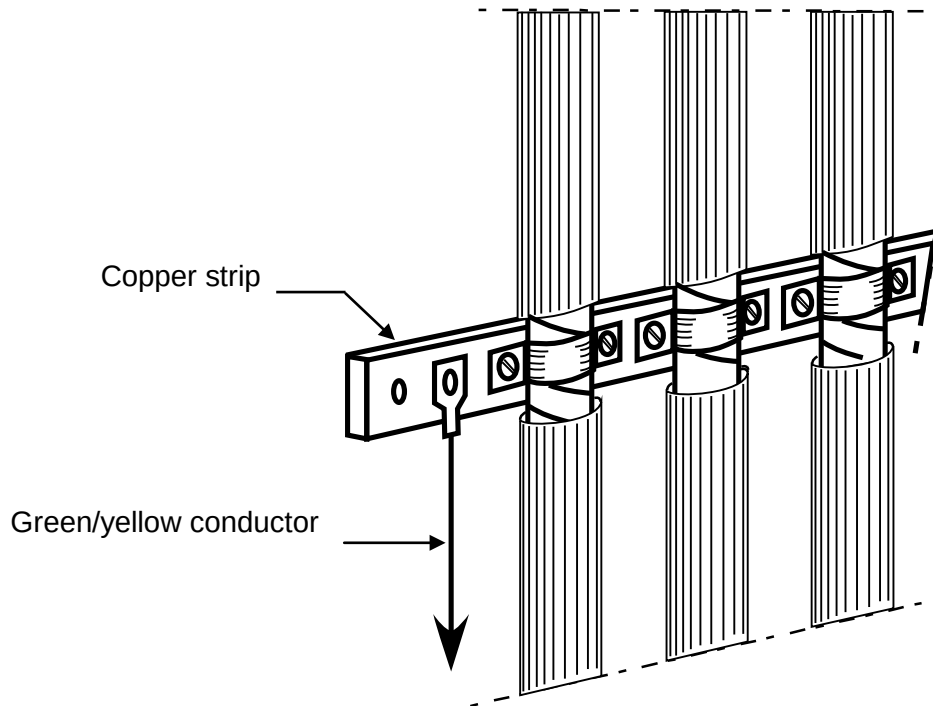


Design and installation of lightning protection

Rev.: 04

Effective date: 10/2012

Page: 11 of 21

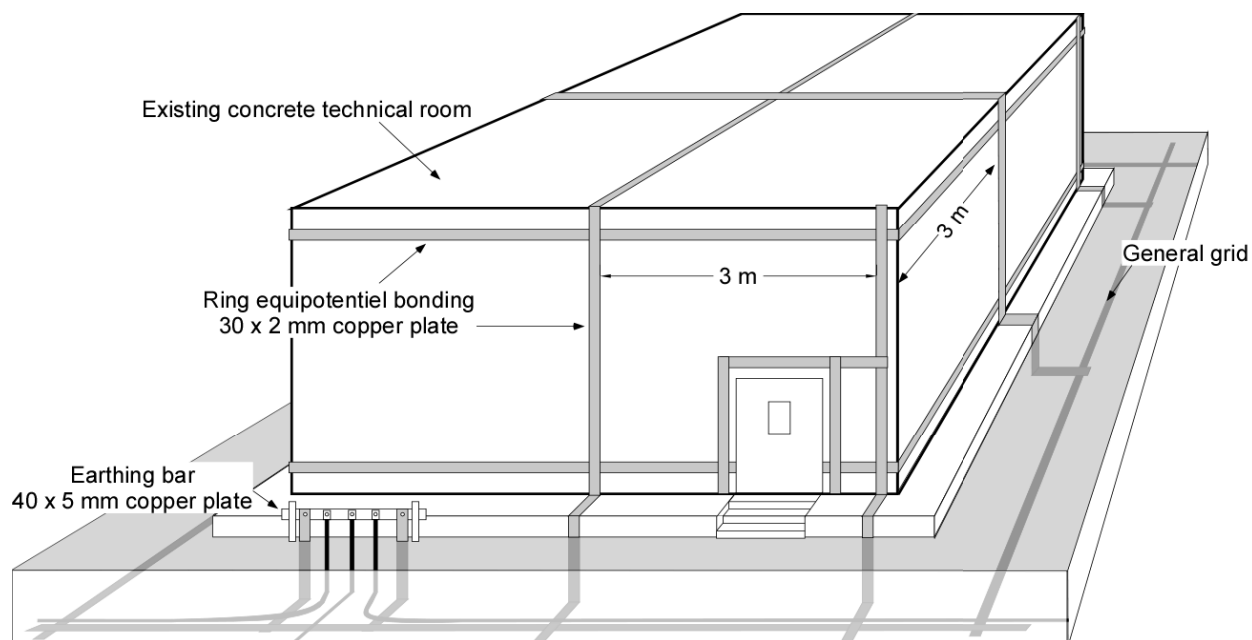
Appendix 1
Armoured cable bonding to earth bar


Design and installation of lightning protection

Rev.: 04

Effective date: 10/2012

Page: 12 of 21

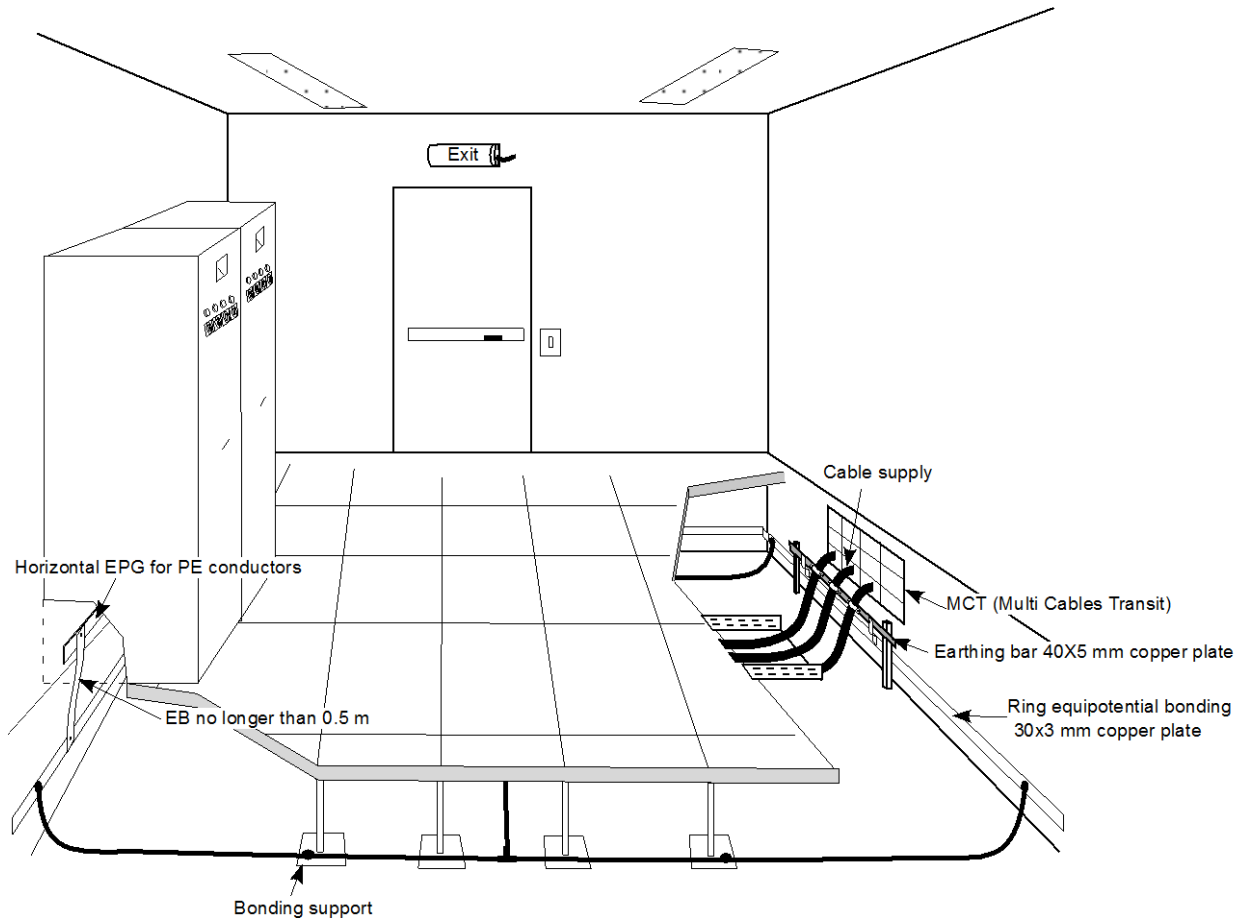
Appendix 1
Earthing arrangement for outdoor technical room


Design and installation of lightning protection

Rev.: 04

Effective date: 10/2012

Page: 13 of 21

Appendix 1
Earthing arrangements in technical room


Design and installation of lightning protection

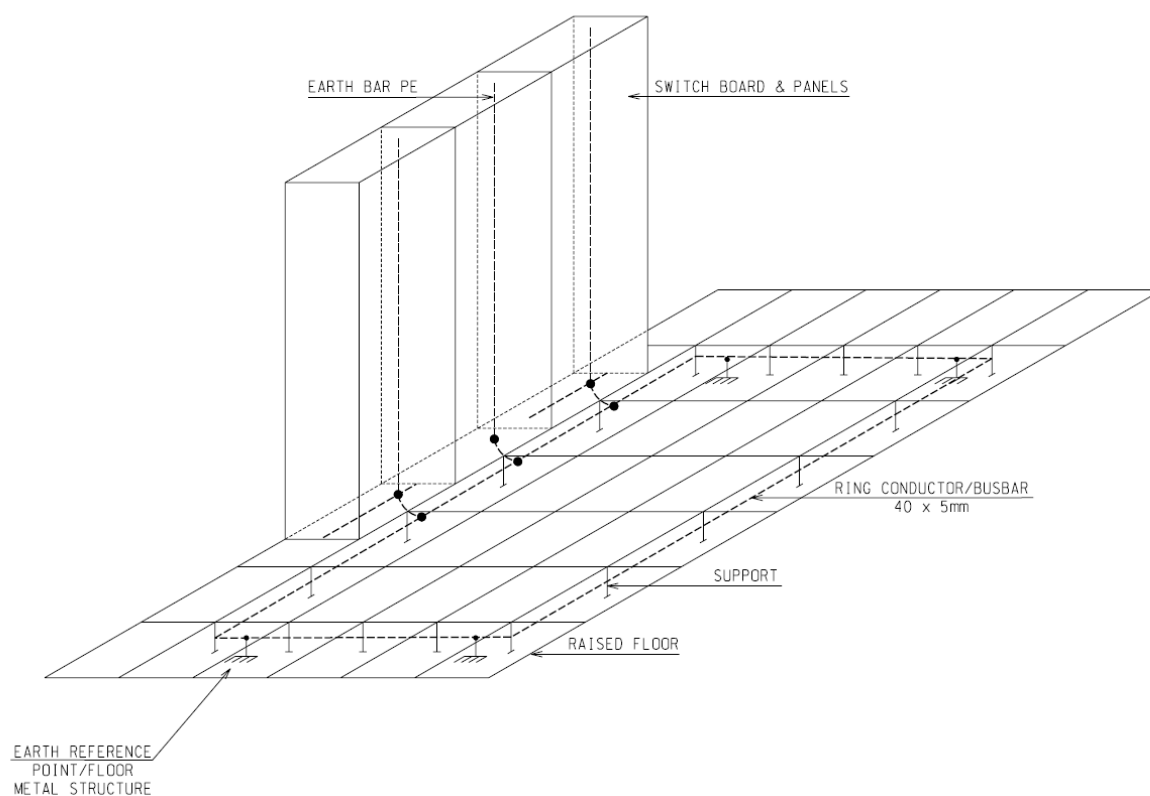
Rev.: 04

Effective date: 10/2012

Page: 14 of 21

Appendix 1

Electrical room - Earthing system

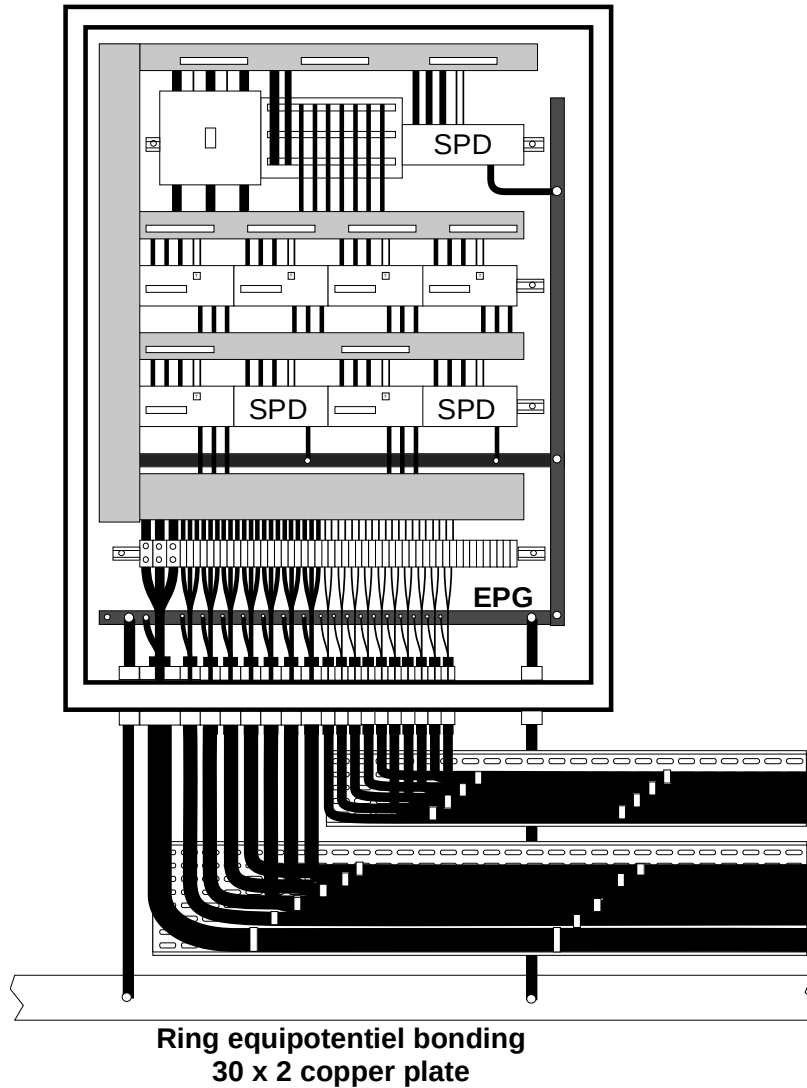


Design and installation of lightning protection

Rev.: 04

Effective date: 10/2012

Page: 15 of 21

Appendix 1
Switchboard arrangement


Design and installation of lightning protection

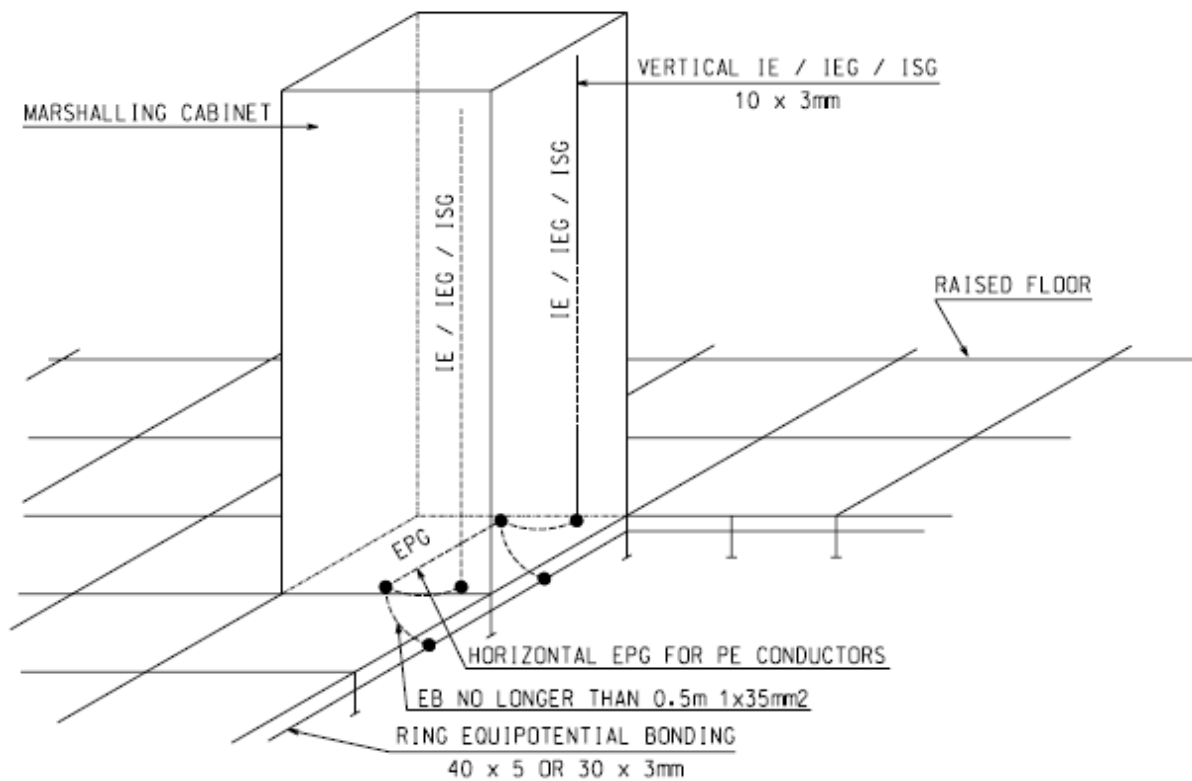
Rev.: 04

Effective date: 10/2012

Page: 16 of 21

Appendix 1

Marshalling Cabinet

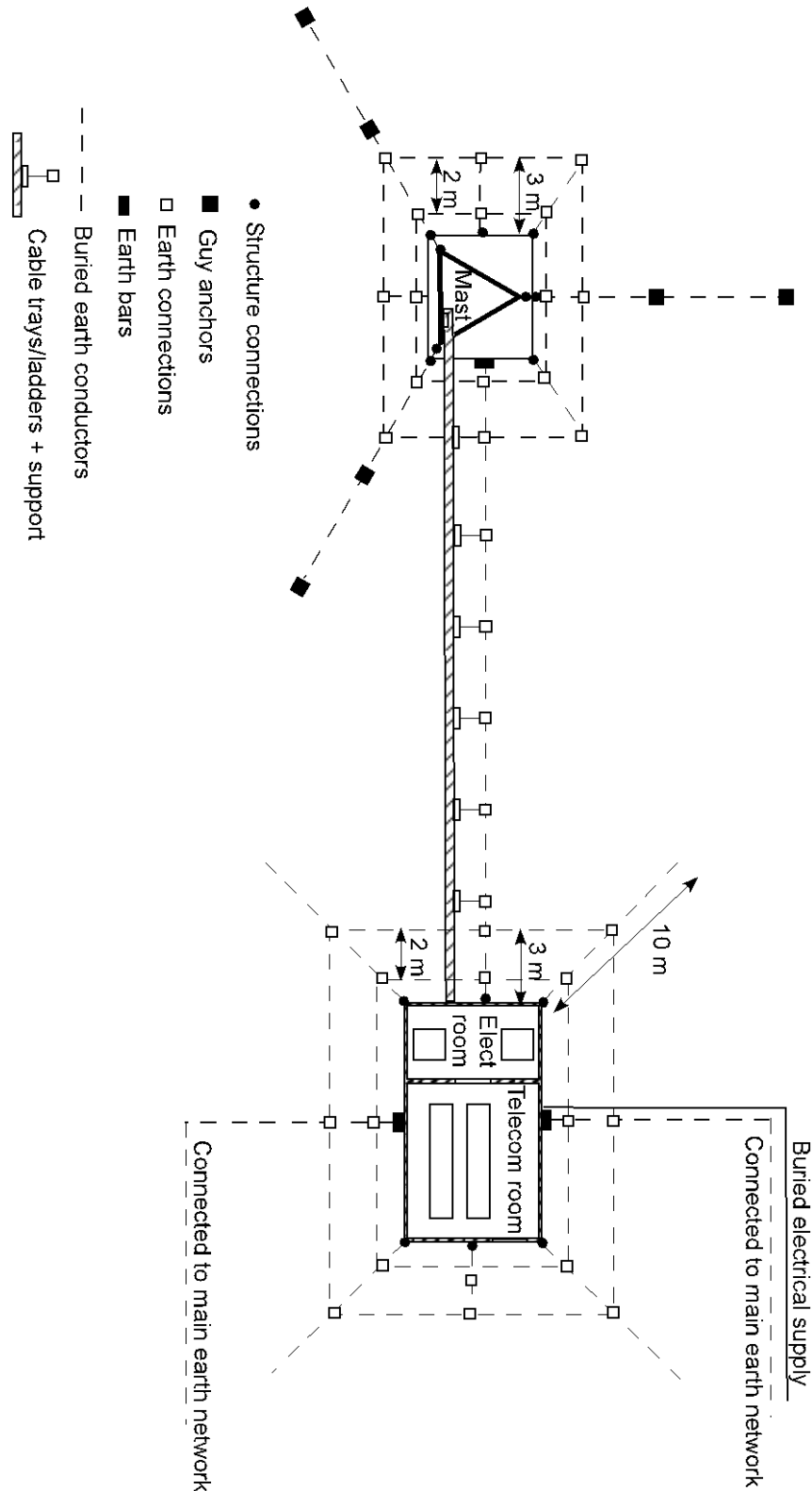


Design and installation of lightning protection

Rev.: 04

Effective date: 10/2012

Page: 17 of 21

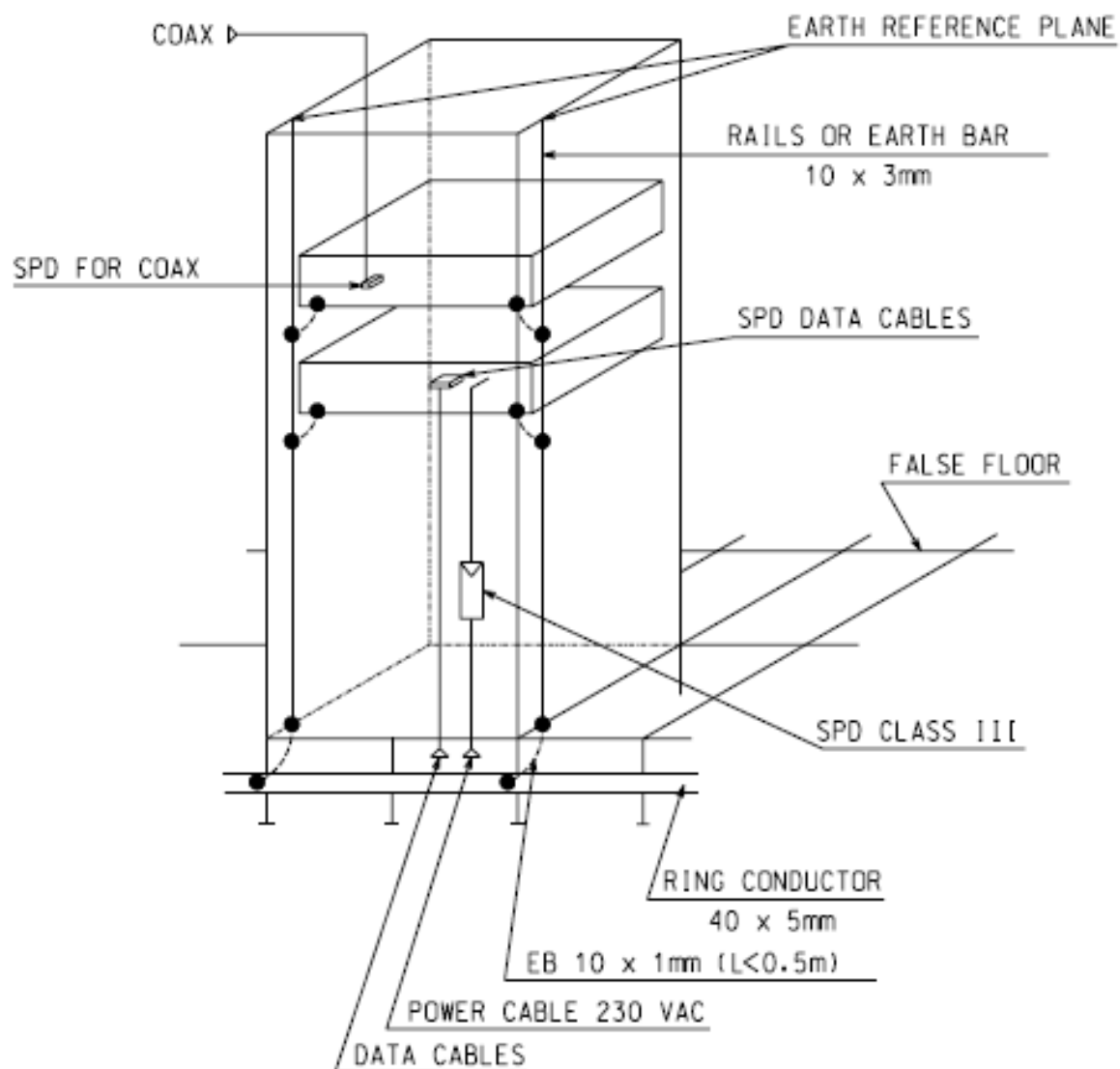
Appendix 1
Lightning earth for telecom installation


Design and installation of lightning protection

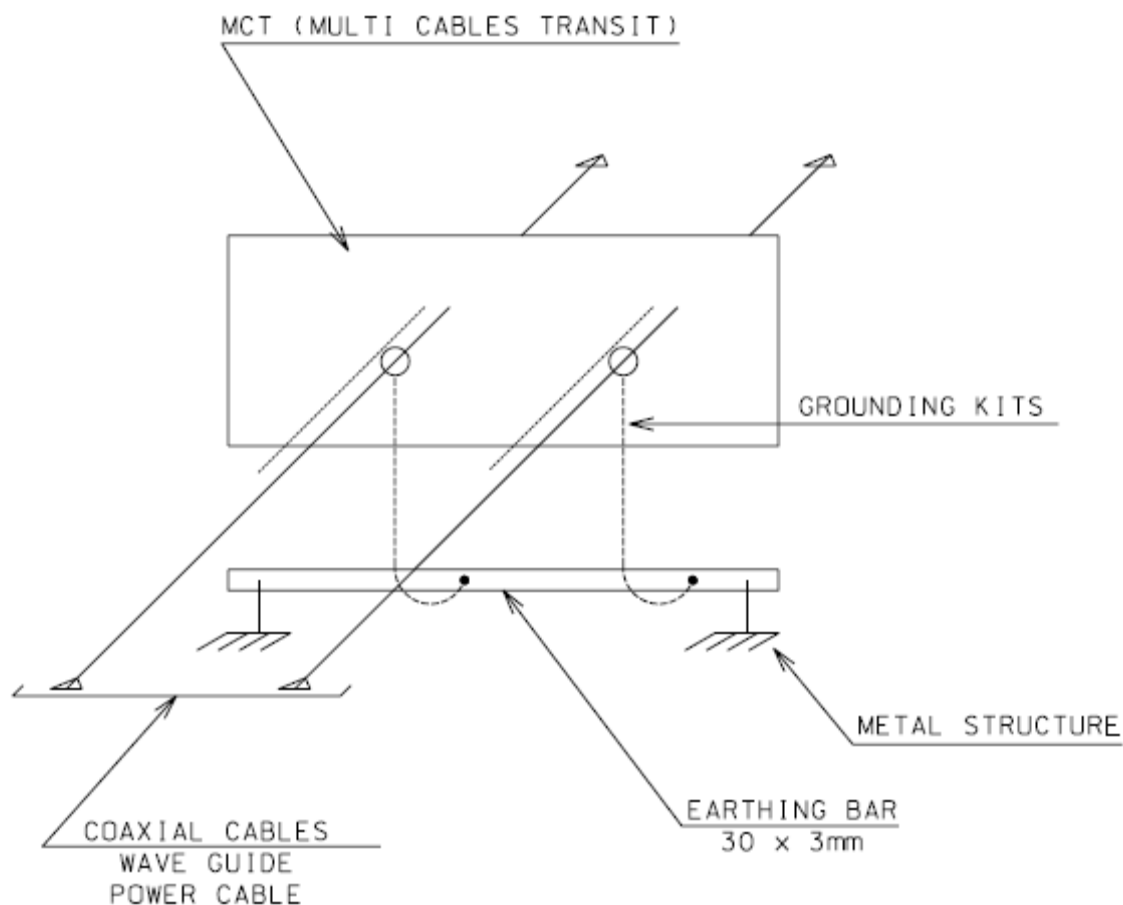
Rev.: 04

Effective date: 10/2012

Page: 18 of 21

Appendix 1
EMC telecom cabinet


Cable penetrations for coaxial cable



Design and installation of lightning protection

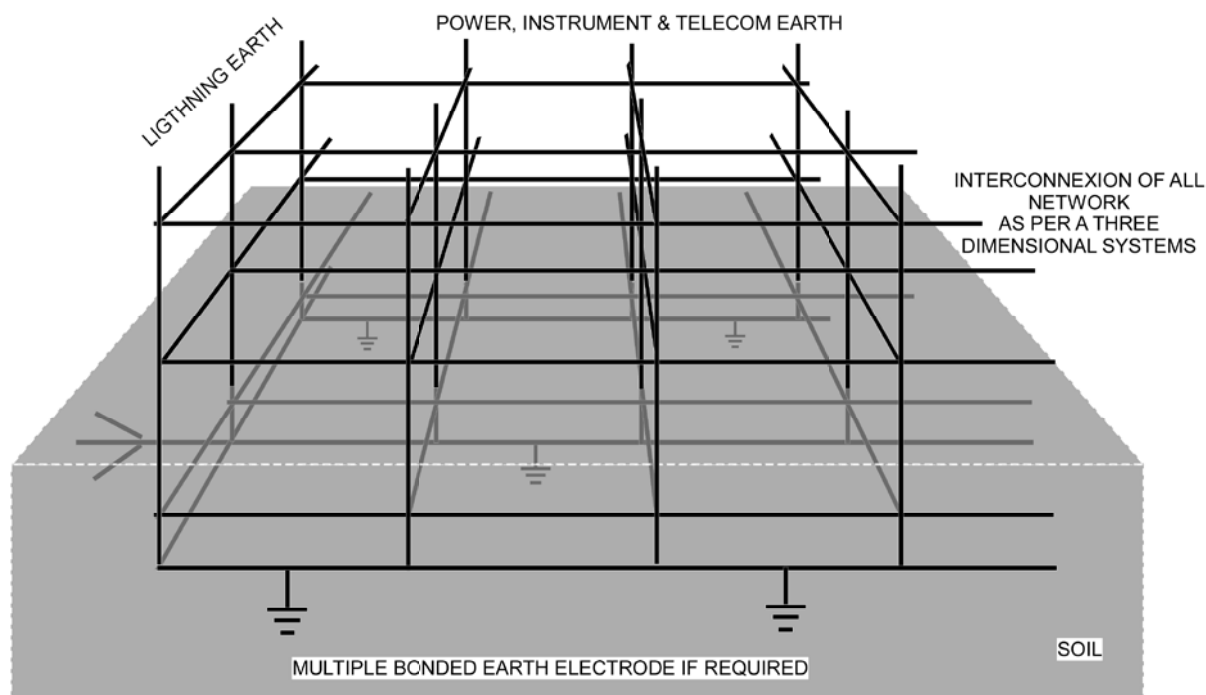
Rev.: 04

Effective date: 10/2012

Page: 20 of 21

Appendix 1

Three dimensional systems

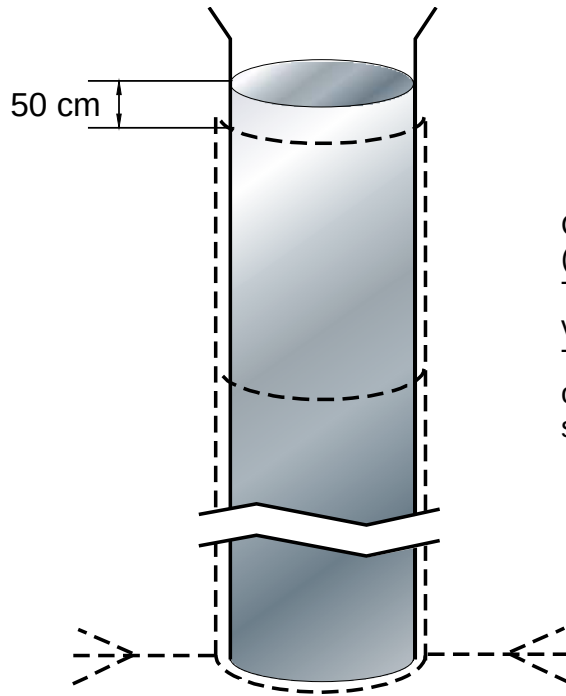


Design and installation of lightning protection

Rev.: 04

Effective date: 10/2012

Page: 21 of 21

Appendix 1
Non-Metallic Chimney


One lightning rod per 2 m of perimeter
(two rods minimum)
The distance between lightning rods and
vents shall be at least 15 m
Two down conductors if $h > 30$ m, with
one positioned on the prevailing upwind
side