TS 06223:1.0

T HR TE 21002 ST

Standard

Communications Earthing and Surge Suppression

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1.0	17/03/2014	First issue as T HR TE 21002 ST (Reconfirmed: 28 May 2019)
1.0	22/02/2023	First issue as TS 06223. Version recommenced in line with new designation. The changes to previous content include the following: • alignment with new electrical low voltage standards • removal of content that is in Australian standards • removal of content that is above the specification of Australian standards where possible • update to current organisational structure.

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Preface

This standard supersedes T HR TE 21002 ST *Communications Earthing and Surge Suppression,* version 1.0 and is a first issue as TS 06223:1.0.

Telecommunications equipment rooms are required to house both the current and future telecommunications requirements of TfNSW telecommunications networks.

This document provides the minimum mandatory requirements for earthing and surge suppression in TfNSW telecommunications equipment rooms. These requirements provide for the safety and security of staff, customers and equipment.

The changes to previous content in T HR TE 21002 ST include the following:

- alignment with new electrical low voltage standards
- removal of content that is in Australian standards
- removal of content that is above the specification of Australian standards where possible
- update to current organisational structure.

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1 Scope

This document specifies communications earthing and surge suppression requirements for all new TfNSW communications equipment rooms and outdoor equipment locations with powered equipment and to existing locations where the earthing system is being upgraded or modified.

The communications earthing and surge suppression requirements address the following:

- protection of people
- protection of equipment
- corrosion control
- surge currents caused by exposure to lightning and electricity supply fault currents
- requirements for the dc supply
- impedance and resistance specifications
- electrical noise.

T HR TE 21003 ST contains additional requirements for telecommunication facilities within high voltage locations on the electric heavy rail network.

The design of these installations should take into account that TfNSW earthing on the site is in accordance with this standard.

2 Application

This standard applies to all TfNSW heavy rail, light rail, metro, ferries and roads telecommunication equipment rooms.

This standard does not apply to rolling stock and heavy rail, light rail and metro signalling equipment rooms and cubicles.

3 Referenced documents

The following documents are cited in the text. For dated references, only the cited edition applies. For undated references, the latest edition of the referenced document applies.

Australian standards

AS 1768 *Lightning protection*

AS/NZS 3000 *Electrical installations (known as the Australian/New Zealand Wiring Rules)*

AS 3015 *Electrical installations – Extra-low voltage d.c. power supplies and service earthing within telecommunications networks*

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AS/NZS 61558.1 *Safety of Power Transformers, Power Supplies, Reactors and Similar Products Part 1: General requirements and tests (IEC 61558-1 Ed 3, MOD)*

AS/CA S009 *Installation requirements for customer cabling (Wiring Rules)*

Note: AS/CA S009 is an Australian Standard that is published and maintained by Communication Alliance Limited.

Transport for NSW standards

SPC 511 *Boundary Fences*

TS 03726 (EP 12 10 00 10 SP) *HV Earthing for Substations and Distribution Systems*

T HR EL 12004 ST *Low Voltage Distribution and Installations Earthing*

T HR EL 17002 SP *Low Voltage Isolating Transformer*

TS 03954 (T HR SS 80002 ST) *Low Voltage Electrical Installations*

T HR TE 21003 ST *Telecommunications for Traction Substations and Sectioning Huts*

T MU MD 21001 ST *Equipment Rooms and Cubicles for Programmable Electronic Systems*

Transport for NSW drawings

EL0284008 *High voltage aerial lines and cables OHEW and UGOH earth electrodes*

4 Terms, definitions and abbreviations

The following terms, definitions and abbreviations apply in this document.

ac alternating current

CEB communications earth bar; a single point of connection to which telecommunications equipment is earthed. The CEB is bonded to the communications earth terminal

CES communications earthing system

CET communications earth terminal; a terminal provided for the purpose of equipotential bonding of the communications earthing system or the telecommunications reference conductor to the main earthing bar, main earthing conductor or sub-main earthing conductor of the electrical installation

CSA cross-sectional area

DB distribution board (240 V / 415 V)

dc direct current

DEW dedicated earth wire

differential earth clamp a device that electrically connects two earthing systems under transient overvoltage conditions, but remains electrically disconnected under normal operating conditions

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DSMSB distribution supply main switch board

EPR earth potential rise; a rise in voltage of an earthing system and the surrounding soil with respect to a distant earth

EPR hazard zone the area around an earthing system bounded by a contour joining all points of EPR equal to the maximum acceptable voltage (hazardous EPR) below which no special precautions need to be taken to protect telecommunication services, cabling providers, staff and customers

GPO general purpose outlet; general purpose 10 A rated socket outlet

hazardous EPR an earth potential rise exceeding 430 V ac

HV high voltage

LV low voltage

MDF main distribution frame

MEN multiple earthed neutral

MSB main switch board

near 1500 V dc track the area inside the railway boundary and, while measured horizontally at right angles, within:

- 20 m of the centre-line of any track with 1500 V dc overhead wiring
- 20 m of any 1500 V dc negative equipment or conductors
- 20 m of any metallic structure spark-gapped to rail.

PEW power earth wire

power earth wire configuration a dc power configuration in which the power cables are used for earthing of equipment as described in Section 9.3.2

TAHE Transport Asset Holding Entity

TAO Technically Assured Organisation (previously known as Authorised Engineering Organisation (AEO))

telecommunications equipment the equipment, including power supplies, cables, radios, switches and other nodes, installed for the purpose of providing communications (including audio, video and data) in a fixed or mobile environment

telecommunications equipment room a room or building with the primary purpose of housing TfNSW telecommunications equipment

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5 EPR hazard zones near HV locations

The provision of telecommunications facilities to HV sites such as substations and sectioning huts in the TfNSW heavy rail network is addressed in T HR TE 21003 ST.

Telecommunications equipment rooms other than those covered by T HR TE 21003 ST shall not be installed within EPR hazard zones. Some existing sites are within such zones or HV installations may be built close to an existing telecommunications equipment room, introducing an EPR hazard zone at the site. In these cases, the design shall be dealt with through the TfNSW concessions process, except where no remote reference exists, that is all incoming telecommunications cabling is non-conductive.

6 Earthing system to be used

The earthing system for telecommunications equipment rooms shall be of the CES configuration (as defined in AS/CA S009) including a CEB and CET as detailed in this section. The earthing system shall comply with AS 3015.

The CET shall be installed in accordance with Figures 4 and 5 in AS/CA S009:2020.

A CEB shall be provided in accordance with Section 7 of this document and AS/CA S009.

7 Communications earth bar

7.1 Configuration of CEB

The CEB shall be a bar, meeting the requirements of AS/NZS 3000 and AS/CA S009, for earthing the relevant equipment in that telecommunications equipment room. In a simple case it may be the MDF earth bar. In radio sites with a feeder gland plate, the CEB shall be installed as close to the gland plate as possible and preferably integral with the gland plate. If the gland plate is separate to the CEB, they shall be interconnected with copper bar or braid no smaller than 20 mm x 3 mm.

An internal earth bus (see Section 7.4) may be used to form a large (distributed) CEB.

7.2 Combination CEB and CET

The CET and CEB may be combined into one physical bar provided the 'enclosed terminal' requirements in AS/NZS 3000 are complied with.

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7.3 CEB connection to CET and earth mat / electrode

The following sections contain the minimum size requirements that shall be used for the earth conductor in accordance with AS 1768.

A lightning risk assessment shall be performed to determine the level of risk and to determine which requirements are applicable in the following sections.

For assets within the electrified rail corridor or near 1500 V dc track, the main earthing conductors shall be copper and have a minimum CSA of 70 mm^2.

See Section 11 for the requirements for the earth mat and earth electrode.

7.3.1 Sites subject to the risk of lightning strikes

Where an antenna feeder gland plate exists, the bonding of the earth electrodes and earth mat to the CEB / internal earth bus shall be via the gland plate. (See Section 7.1 and Section 10.2.4 for further gland plate requirements).

Otherwise, the cables used to interconnect the internal earth bus / CEB to the earth electrodes / mat, shall be green / yellow of minimum cross-sectional area 35 mm^2.

The cables used to interconnect the internal earth bus / CEB to the CET shall be green / yellow of minimum cross-sectional area 16 mm^2.

7.3.2 Sites with negligible risk of lightning strike

The cables used to interconnect the CEB to the earth electrodes / mat, shall be green / yellow of minimum cross-sectional area 16 mm^2.

The cables used to interconnect the CEB to the CET shall be green / yellow of minimum cross-sectional area 16 mm^2.

7.4 Internal earth bus

7.4.1 Purpose of internal earth bus and where required

The TAO may specify that specific telecommunications equipment rooms (for example, train radio huts) shall be equipped with an internal earth bus in accordance with this section. This is particularly the case for locations subject to lightning strikes (for example, from a radio tower / mast); for locations where the standard value of earth resistance in accordance with Section 11.5 cannot be met; or for large telecommunications equipment rooms where the impedance of wire connections from the rack to the CEB can be excessive. Such an internal earth bus shall form a low impedance distributed CEB for the purpose of earthing telecommunications equipment.

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7.4.2 Installation of internal earth bus

Applicable communications buildings or telecommunications equipment rooms, including train radio huts, shall be fitted out with an internal earth bus in the form of a copper bar. The earth bus shall consist of a copper bar fixed to each wall of the equipment room, battery room and the technician's room (where included). Where the building has a wall feeder gland plate, the internal earth bus shall be immediately below this where practicable. (See Section 10.2.4 for earthing of the wall feeder gland plate). In other cases, it shall be at a height to facilitate easy connection of items needing earth connection within the building, typically 300 mm above floor level.

The internal earth bus shall be of minimum dimensions 20 mm wide by 3 mm thick. For rooms larger than a network access equipment room (as defined in T MU MD 21001 ST), it shall be 50 mm wide by 3 mm thick.

The earth bus shall be securely fixed to the building walls and connected to minimise contact resistance and galvanic corrosion effects. A deemed to comply solution for brick or concrete walls would be 6 mm DynaBolts™ (or equivalent masonry anchor) fixed at 500 mm intervals. Where two earth bars are joined the joint may be bolted together with two 6 mm x 12 mm hexagon head brass bolts placed diagonally. The connection between busses shall be tested to ensure connection, meeting the requirements of AS/NZS 3000.

Where portable metal framed or sandwich construction buildings are used to accommodate equipment the internal metalwork and frame shall also be bonded to the internal earth bus.

Where appropriate the earth bus shall extend into each cable tray fitted in the equipment room. The earth bus in each cable tray shall be fixed at 500 mm intervals with 6 mm x 25 mm hexagonal head bolts (preferably stainless steel to minimise galvanic corrosion effects). These bolts shall also be used for terminating cabinet earths.

The internal earth bus shall be bonded to any other earth bar (for example, MDF earth bar) by green / yellow cable of minimum CSA 70 mm² or by direct bolted connection as described in Section 7.4.2 for joints. The connection to any gland plate shall be in accordance with Section 7.1.

Installation of the internal earth bus shall make allowance for the later connection of earth cables. This may be, for example, by the provision of 6 mm earth studs affixed to the bus to which connections may be made using lugs and nuts, designed for the expected cable size and type, or by offsetting the bus from the wall surface to allow the later installation of bolts to which earthing cables may be connected.

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8 Mains supply and earthing arrangements

8.1 Mains supply

This standard does not address details of the 240 V / 415 V design other than as they relate to earthing issues. Figures and text referring to single phase arrangements are not meant to exclude multi-phase arrangements and arrangements for emergency cut-over equipment for dual supplies are not addressed. Such designs shall be in accordance with AS/NZS 3000 and relevant TfNSW electrical standards.

TfNSW may agree in specific cases to provide mains supply to non-TfNSW telecommunications entities. The requirements of this section apply equally to such installations and other sections (for example, Section 12.2 place restrictions on them).

8.2 Mains powered sites external to the electrified rail corridor

8.2.1 General

A MSB and a DB shall be provided for the telecommunications facility, complete with MEN earth – neutral link and a main earth connected to a nearby earth electrode in accordance with AS/NZS 3000 and the supply authority's regulations.

Telecommunications cables connected to the site shall not have components such as pairs, sheath, moisture barrier, which are earthed at both that site and another site. See Section 12.1 for further requirements.

8.2.2 Sites with no communications earth mat or protective earth electrodes

At sites external to the electrified rail corridor which do not include any communications protective earth electrodes or earth mat, the CES, in accordance with Section 6, shall be connected to the earth bar of the DB through a CET.

Figure 1 shows the earthing arrangements external to the rail corridor at sites without a communications earth mat or protective earth electrodes.

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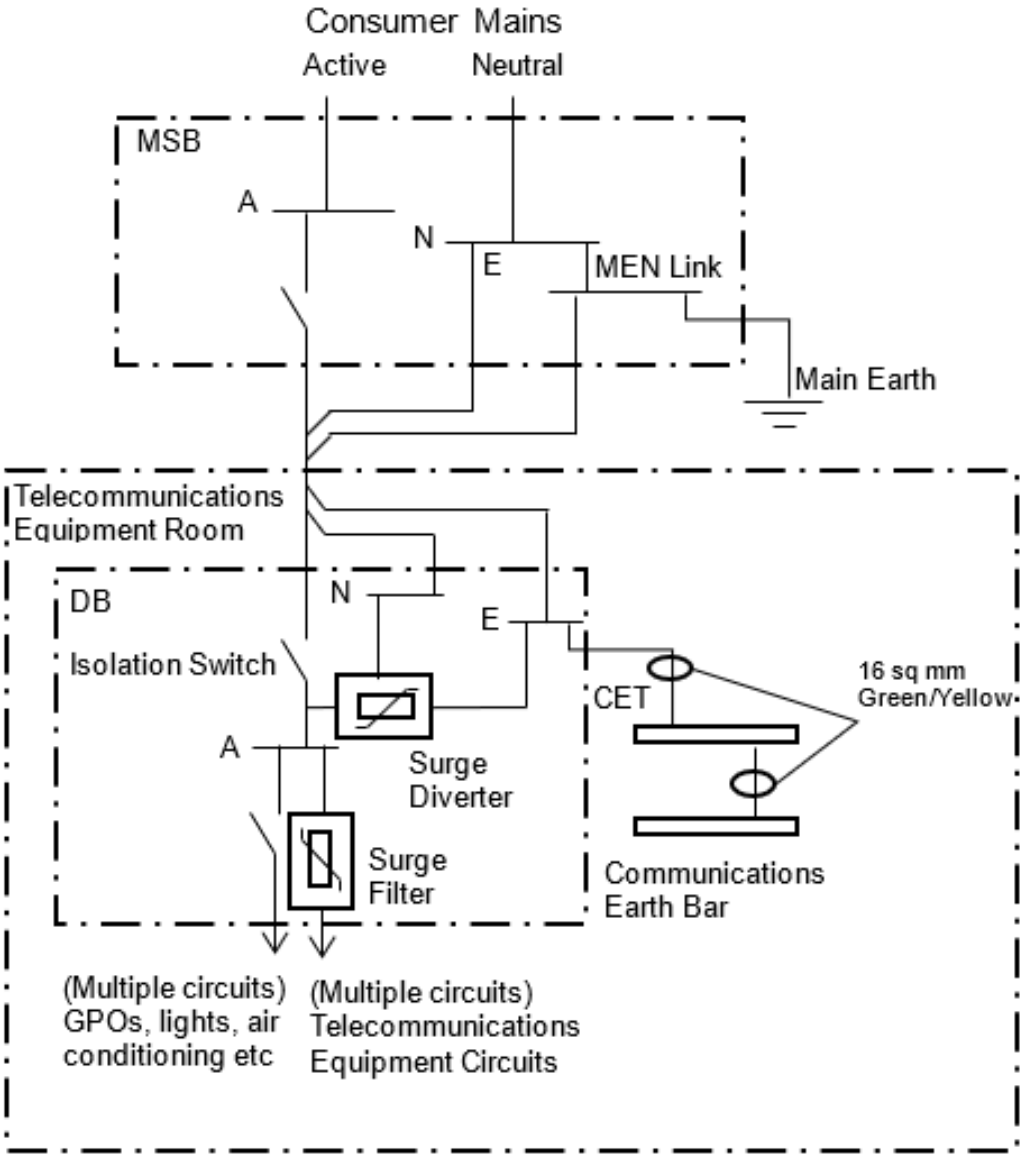

Figure 1 – Earthing arrangements external to the rail corridor at sites without a communications earth mat or protective earth electrode

8.2.3 Sites with communications earth mat or protective earth electrodes

At sites external to the electrified rail corridor, which include communications protective earth electrodes and/or an earth mat, the earth electrodes and earth mat shall be bonded to both the main earth electrode in accordance with Figure 4 Method 3 in AS/CA S009:2020 and to the CEB, thus also bonding the CEB to the LV earth system.

Figure 2 shows the earthing arrangement external to the rail corridor at sites with a communications earth mat or protective earth electrodes.

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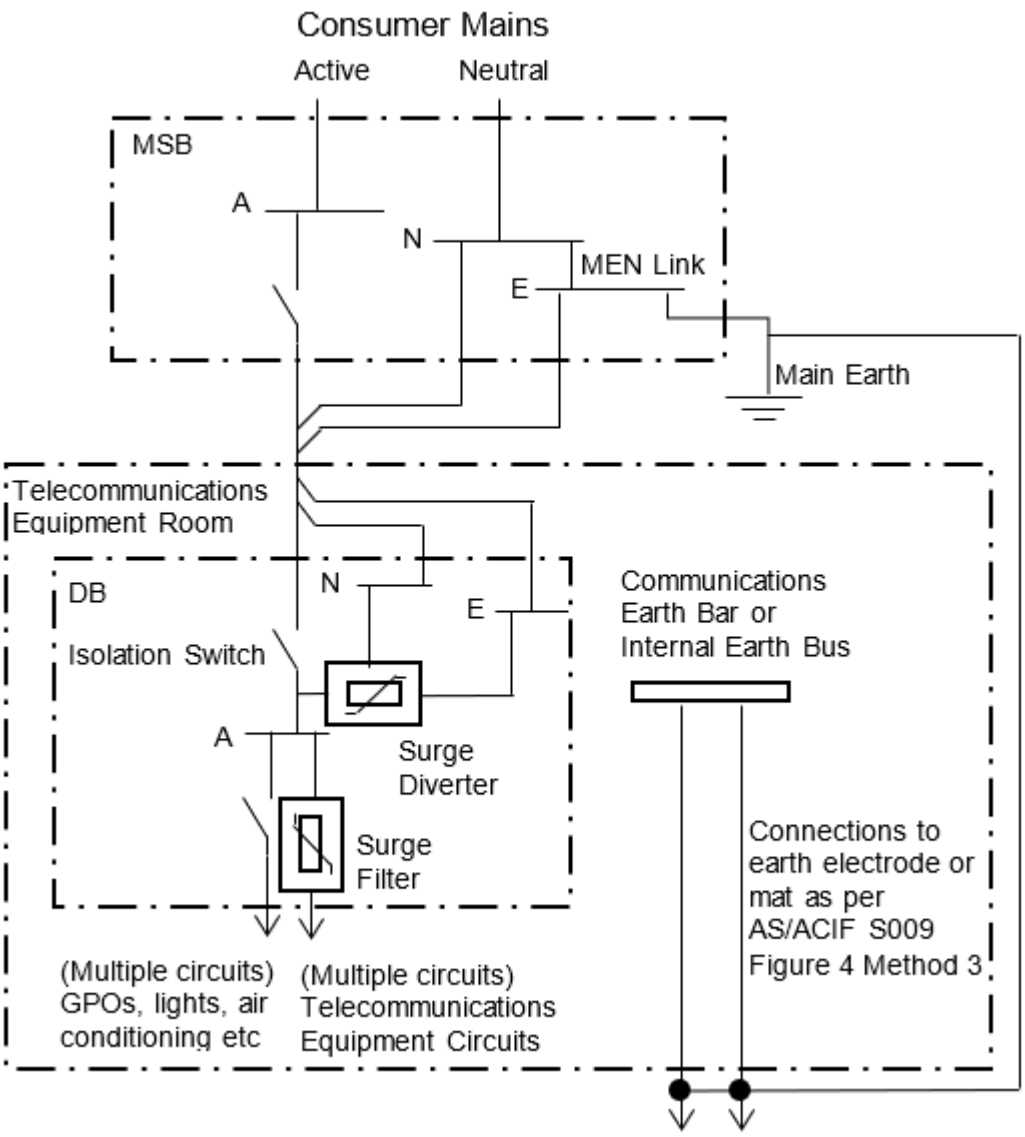

Figure 2 – Earthing arrangements external to the rail corridor at sites with a communications earth mat or protective earth electrodes

8.3 Mains powered sites within electrified rail corridor

8.3.1 DC isolation

Telecommunications equipment installed within the electrified rail corridor shall provide effective separation of the local protective and telecommunications earth from the power distribution authority mains earthing system. All such installations on the heavy rail network shall be in accordance with T HR EL 12004 ST and T HR EL 17002 SP which describe the requirement for an isolating transformer for this purpose.

For any sites within the electrified rail corridor or otherwise exposed to significant dc leakage currents, the site design shall also include measures to avoid any connection of site earth to the

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distribution authority MEN earth via secondary paths such as antenna cables or telecommunications cables originating outside the site.

8.3.2 Mains installation and connections

All installations on the heavy rail network shall be in accordance with T HR EL 12004 ST.

Dedicated isolation transformers shall also be installed where the supply is from the TAHE HV network unless the design demonstrates that electrolysis issues due to the connection of the telecommunications earth electrodes and earth mat to the earth at the DSMSB are acceptable.

The mains installation design shall ensure that no hazardous EPR is introduced to the telecommunications site under foreseeable fault conditions. See Section 5 for related requirements.

A DB shall be provided within the telecommunications equipment room, supplied from the DSMSB. The earth to the DB shall also be reticulated from the DSMSB. The CES, in accordance with Section 6, shall be connected to the earth bar of the DB through a CET to permit isolation during earth testing.

Any additional surge protection earth electrodes or mat shall be connected to the CEB and thence to the CET.

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Figure 3 shows earthing arrangements within the rail corridor.

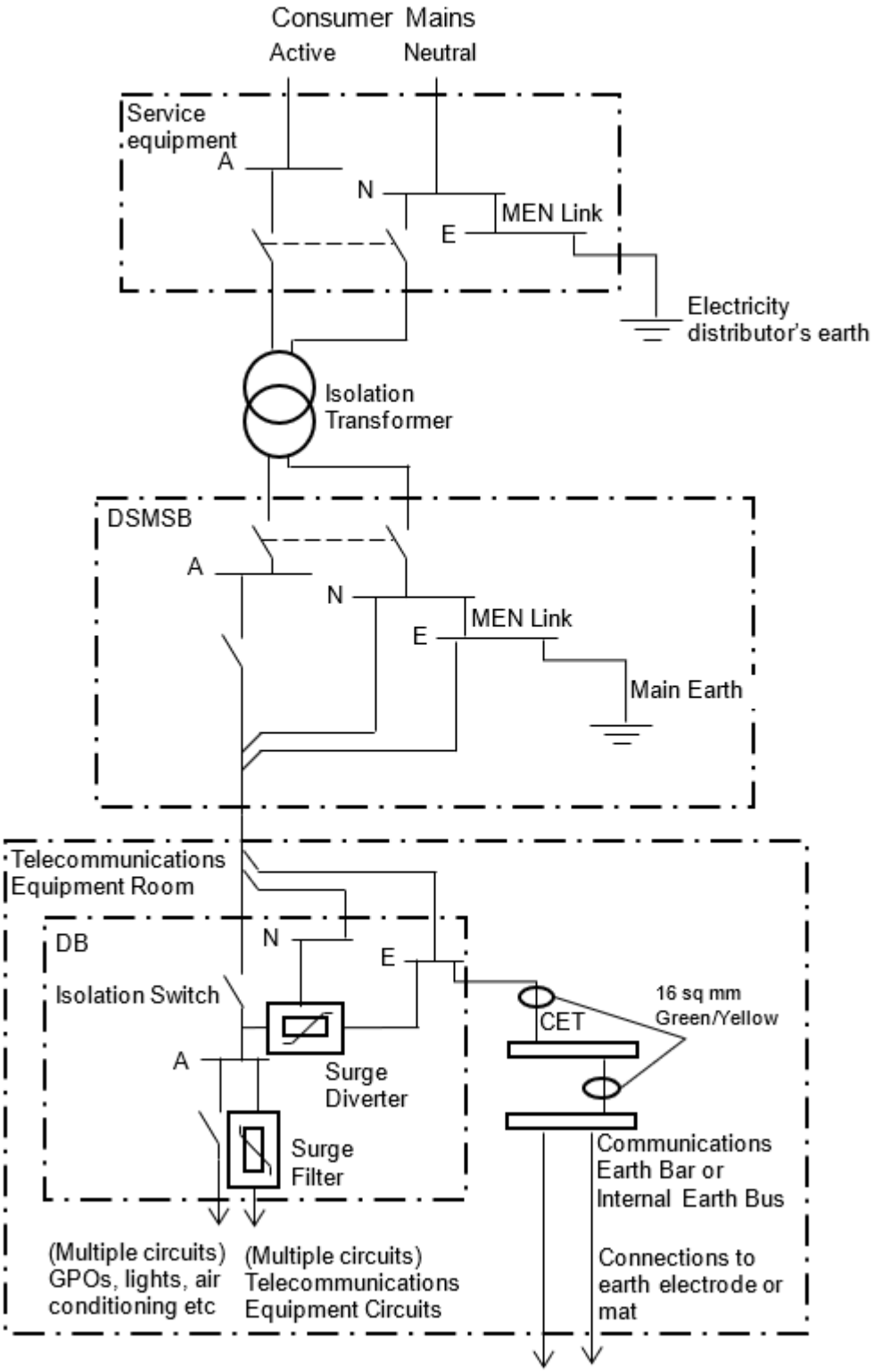

Figure 3 – Earthing arrangements within the rail corridor

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8.3.3 Isolating transformers

Isolating transformers shall be in accordance with T HR EL 12004 ST, T HR EL 17002 SP and AS/NZS 61558.1.

Isolating transformers for telecommunications sites shall be externally mounted.

The circuit breaker or isolating switch for the isolating transformer at the meter board or service equipment board from which the isolating transformer is supplied shall switch the neutral (if applicable) as well as active conductors. In accordance with T HR EL 12004 ST, isolating transformers shall be double insulated with no earth connection made to the case.

8.4 Mains surge protection

Telecommunications equipment shall be protected against surge currents and voltages on the power mains by means of a surge protection scheme incorporating both series surge filter and shunt surge diverter devices in accordance with AS 1768 and TS 03954 (for the heavy rail network).

Although Figure 1, Figure 2 and Figure 3 show the minimal arrangement of separate units, a combined diverter and filter unit is the preferred option. In some locations, the diverter may be in the DSMSB.

For sites that are particularly prone to lightning surges via the mains, the use of appropriate surge protection devices is recommended together with other measures to increase the surge impedance on the mains wiring such as installation inside metal conduit and coils in the cable.

As a minimum requirement, facilities such as lights, air conditioning and GPO’s (not used for powering telecommunications equipment) need not be protected by series filters but shall be protected by shunt diverter devices. However, the preferred option is for full (series and shunt) protection of all circuits.

Two exceptions to the requirements in this section are that circuits powering tower lighting (for example air warning lights) and circuits powering radio equipment owned by third parties shall not be connected to the output side of series filters supplying TfNSW telecommunications equipment. This is because such circuits are susceptible to receiving lightning surges and therefore connecting them to the output side of a filter would negate the function of the filter in protecting telecommunications circuits.

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8.5 Sites without mains power

8.5.1 Sites with locally generated 240 V ac and associated DB

Sites with a 240 V ac DB supplied from a local source (for example, inverter operating from solar powered source) shall be equipped with an electrical protection main earth electrode connected to the earth bar of the ac DB. There shall be a connection, at the DB or inverter unit, from the neutral to earth. The DB may be integral to the inverter unit.

These sites shall also be equipped with a CEB connected to the appropriate level of communications protective earth electrodes and / or earth mat as required. The CEB shall be bonded to the ac DB earth bar via a CET.

Figure 4 shows earthing of sites with inverter powered 240 V ac DB.

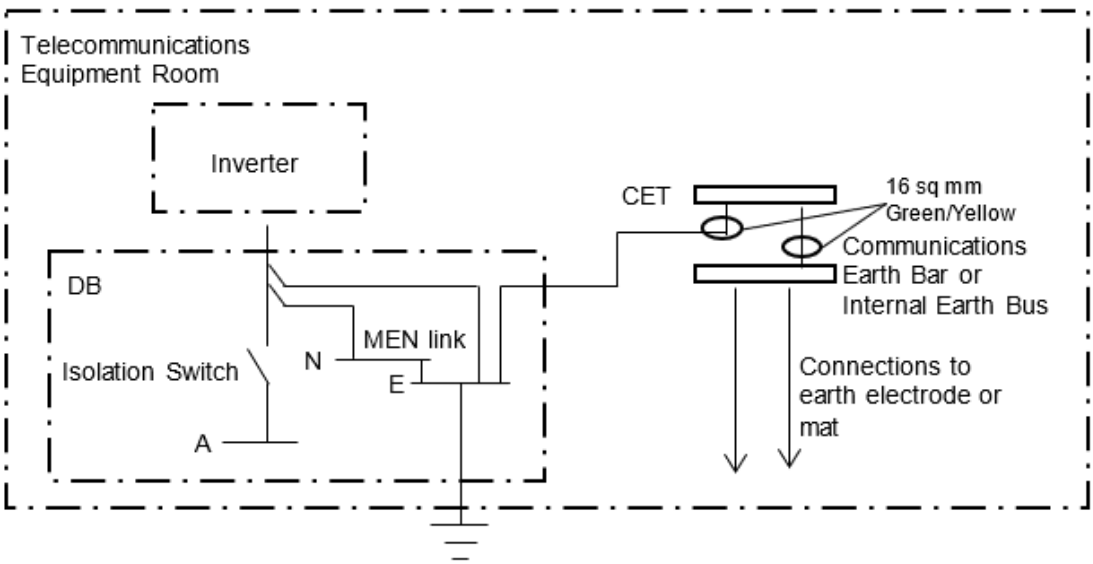

Figure 4 – Earthing of sites with inverter powered 240 V ac DB

8.5.2 Sites without 240 V ac DB

Sites without a 240 V ac DB, for example, sites powered by solar cells with only dc powered equipment, shall be equipped with a CEB connected to the appropriate level of communications protective earth electrodes and / or earth mat.

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Figure 5 shows earthing at site without 240 V ac DB.

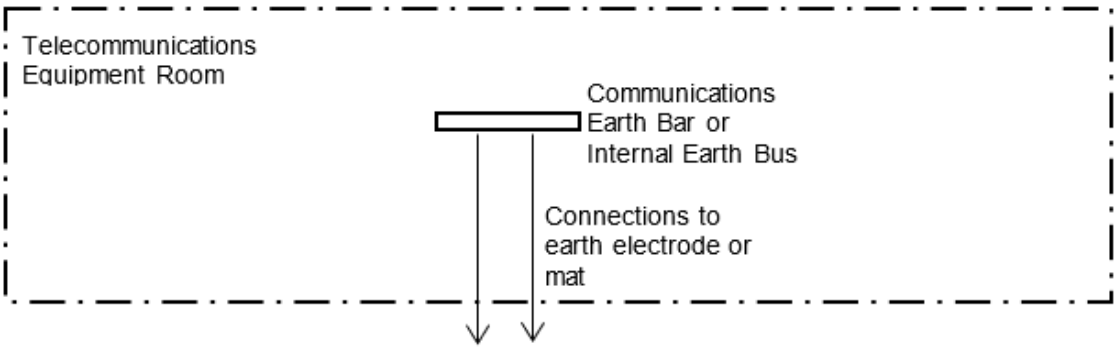

Figure 5 – Earthing at site without 240 V ac DB

9 Earthing of racks, cabinets, runways

9.1 General

Within Section 9 the following applies:

- reference to 'rack' includes “cabinet”
- all green / yellow cables shall have a minimum CSA of 16 mm² unless otherwise specified
- while the figures show a typical connection of the CEB to the earth terminal of the ac DB via a CET, the actual bonding arrangements shall be as detailed in Section 8.

9.2 Fixing of earth wires

Refer to AS/NZS 3000 for the fixing of earth wires.

9.3 Sites without internal earth bus

9.3.1 DC supply –DEW equipment

A rack containing dc powered equipment which is free of any connection (direct or indirect, within the equipment or within the rack wiring) between the incoming dc power supply and the rack, shall be earthed to the CEB with a separate green / yellow earth cable (3rd wire). Such a rack shall be known as a DEW rack.

Where several DEW racks are located near one another, the earth bonding referred to in Section 9 shall be achieved by bonding adjacent racks together with green / yellow earth cables and connecting one of the cluster of racks so formed to the CEB with another green / yellow earth cable.

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Figure 6 shows earthing of DEW equipment racks.

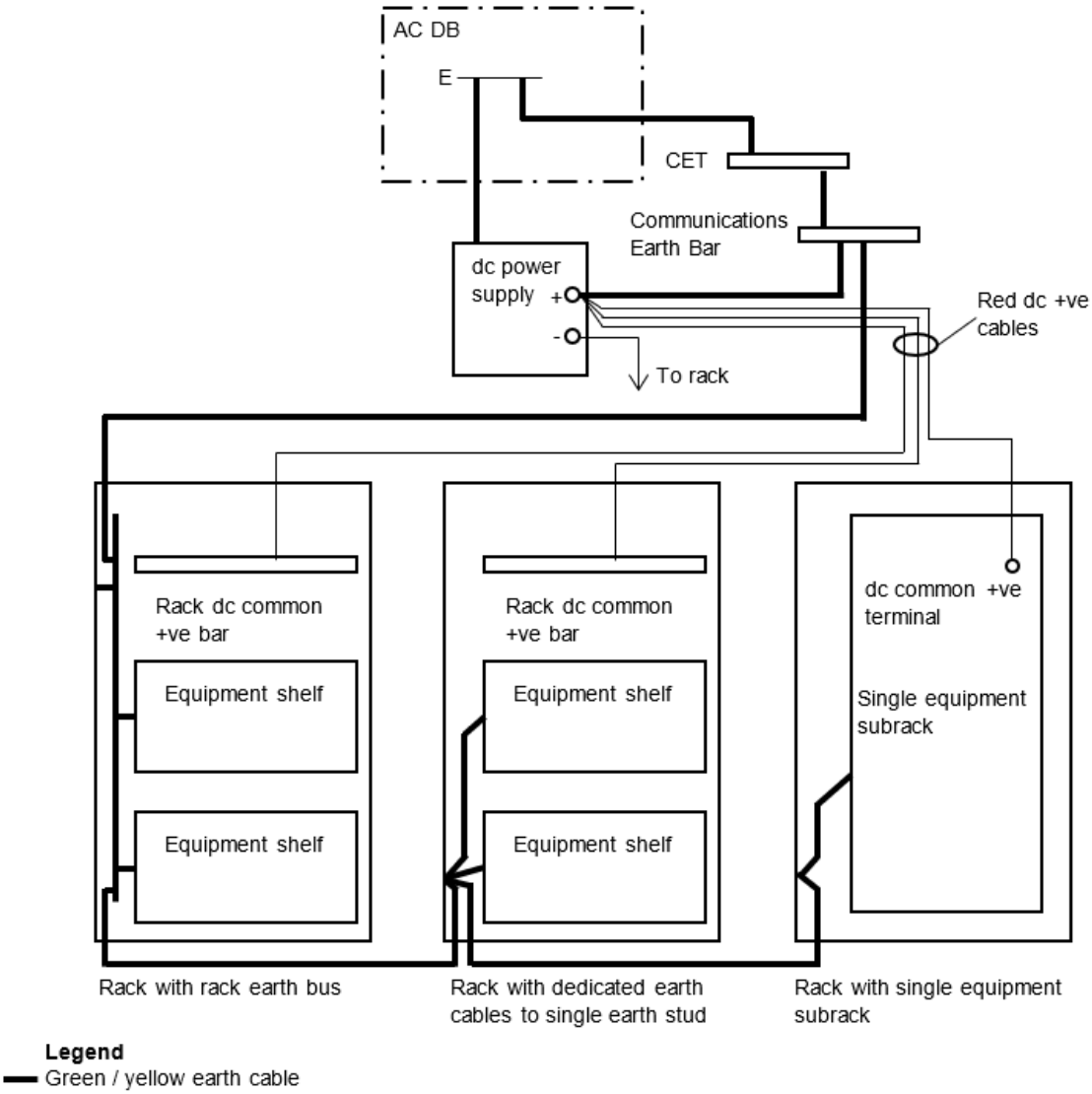

Figure 6 – Earthing of DEW equipment racks

9.3.2 DC supply – Power earth wire equipment

A rack containing dc powered equipment which includes any connection (direct or indirect, within the equipment or within the rack wiring) between the incoming dc power supply and the rack, shall utilise the power supply cable for earthing the rack to the CEB via the power supply and the link from the power supply reference (normally positive) to the CEB. Such a rack shall be known as a PEW rack.

A separate green / yellow earth cable shall not be used to directly bond the rack to the CEB. However, where several PEW racks are near one another, they shall be bonded together by bonding adjacent racks with green / yellow earth cables (but not connecting any of the cluster of racks so formed to the CEB with another green / yellow earth cable).

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Figure 7 shows earthing of power earth wire configuration equipment racks.

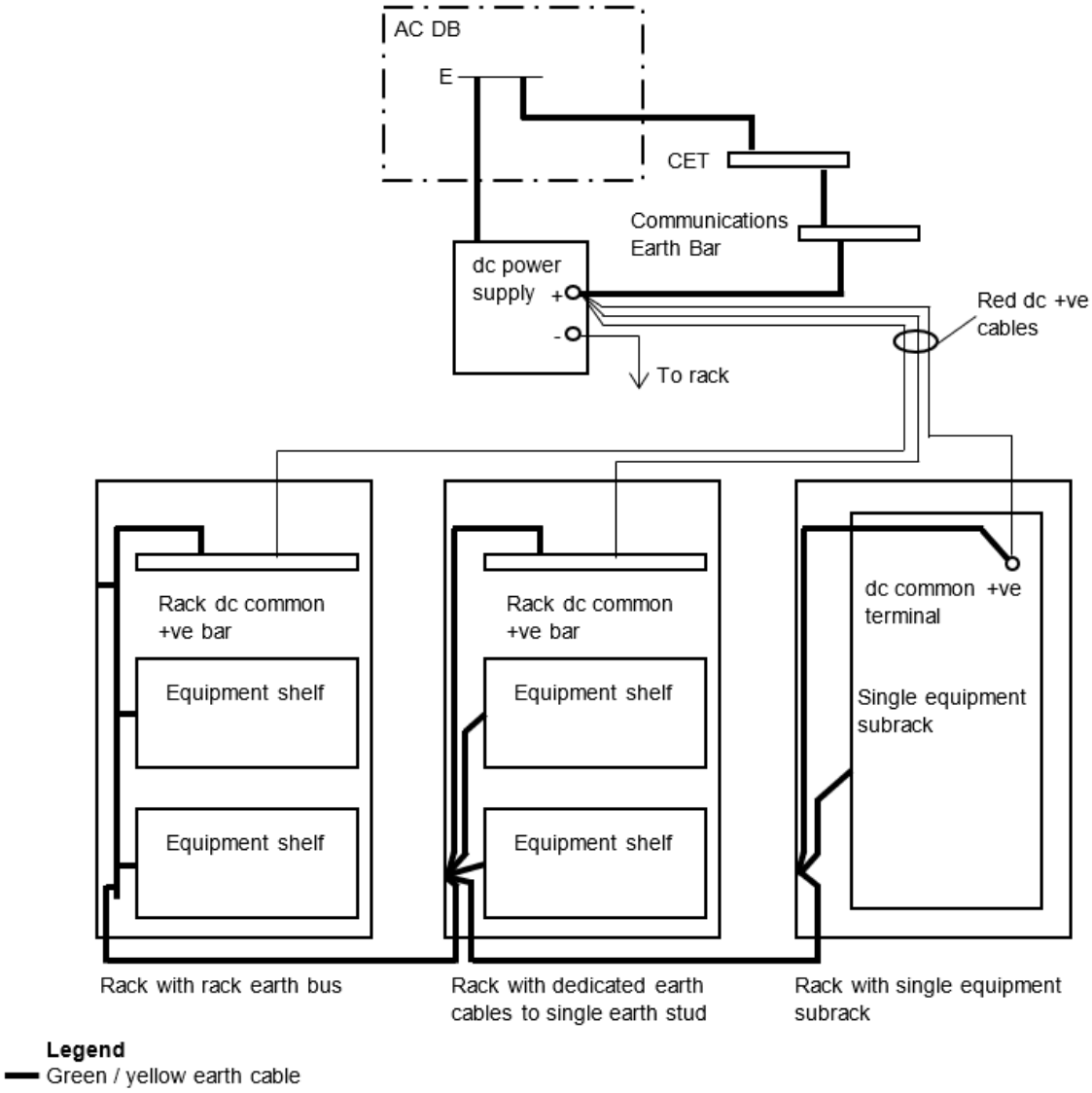

Figure 7 – Earthing of power earth wire configuration (PEW) equipment racks

9.3.3 Equipment suitable for DEW or PEW configuration

If the equipment within a rack which is capable of being wired for DEW configuration could operate just as satisfactorily under PEW configuration, then if that rack is installed in a room amongst PEW configured racks, then it shall be wired for PEW operation.

9.3.4 Double insulated LV ac equipment (including dual mode ac/dc)

A rack containing ac powered equipment which is all double insulated may be treated in accordance with the requirements of other dc powered equipment in the rack. Where no other dc powered equipment exists in the rack, such a rack shall be regarded as a DEW rack for the purposes of earthing and bonding.

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9.3.5 Earthed LV ac powered equipment (including dual mode ac/dc)

A rack containing earthed ac powered equipment shall be earthed to the LV MSB in accordance with AS/NZS 3000 by the same wiring system used for active and neutral (for example, plug and socket). Such a rack shall not contain any PEW dc powered equipment and shall be isolated from racks containing PEW dc powered equipment in accordance with Section 9.6.

If the rack contains dc powered equipment or the equipment is dual mode ac /dc supplied, the rack shall also be earthed to the CEB in accordance with Section 9.3.1. In addition, some ac powered equipment may require earthing to the CEB for surge protection purposes as shown in Figure 8. These requirements take precedence over avoiding earth loops.

Figure 8 shows earthing of racks with dual ac / dc supplies.

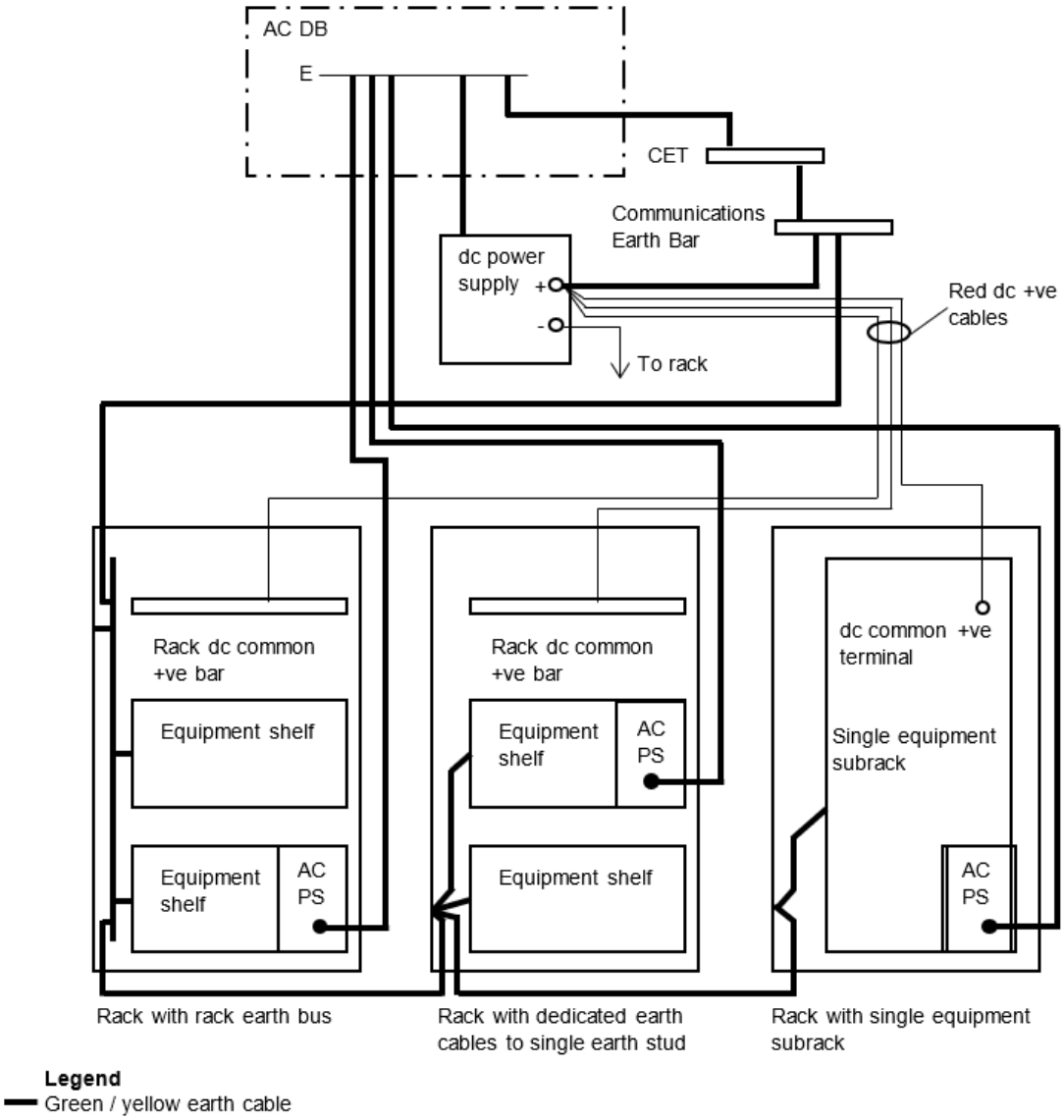

Figure 8 – Earthing of racks with dual ac / dc supplies

9.4 Sites with internal earth bus

An internal earth bus provides both a low ac and dc impedance. Therefore, while as far as possible the requirements of rack earthing for DEW and PEW racks specified in Section 9.3 should be followed, this is less important when an internal earth bus is present.

In the case of DEW racks, individual racks or rack clusters shall be bonded to the closest appropriate point on the internal earth bus in a similar manner to the bonding to the CEB specified in Section 9.3.1.

In the case of PEW racks, the internal earth bus shall be utilised for both dc power reticulation (reference terminal) and low impedance earth reticulation.

If excessive voltage drop or other problems arise, a design shall be established to overcome the issue. This may take the form of separate earth bus legs for the two wiring configurations.

9.5 Rectifier / power supply racks

Rectifier / power supply racks shall conform to the requirements for racks containing ac powered equipment specified in Section 9.3.5.

A green / yellow cable of CSA at least equal to the total for the dc power cables fed by the power supply (one polarity), shall bond the dc reference terminal (normally positive) to the CEB as shown in Figure 6 and Figure 7.

9.6 Racks containing no powered equipment (including MDFs)

A rack containing only passive equipment shall be regarded as a DEW rack for the purposes of earthing and bonding.

MDFs and surge arrestor racks are examples of such racks. For these racks the connection to the CEB or earth bus shall be as short and straight as possible.

Where practicable, MDF verticals shall be individually bonded to the CEB, as shown in Figure 9 and clustered in groups of no more than three verticals. Figure 10 shows this acceptable alternative. 6 mm² green / yellow cable is sufficient for this purpose provided the cable lengths are less than 1.5 metres.

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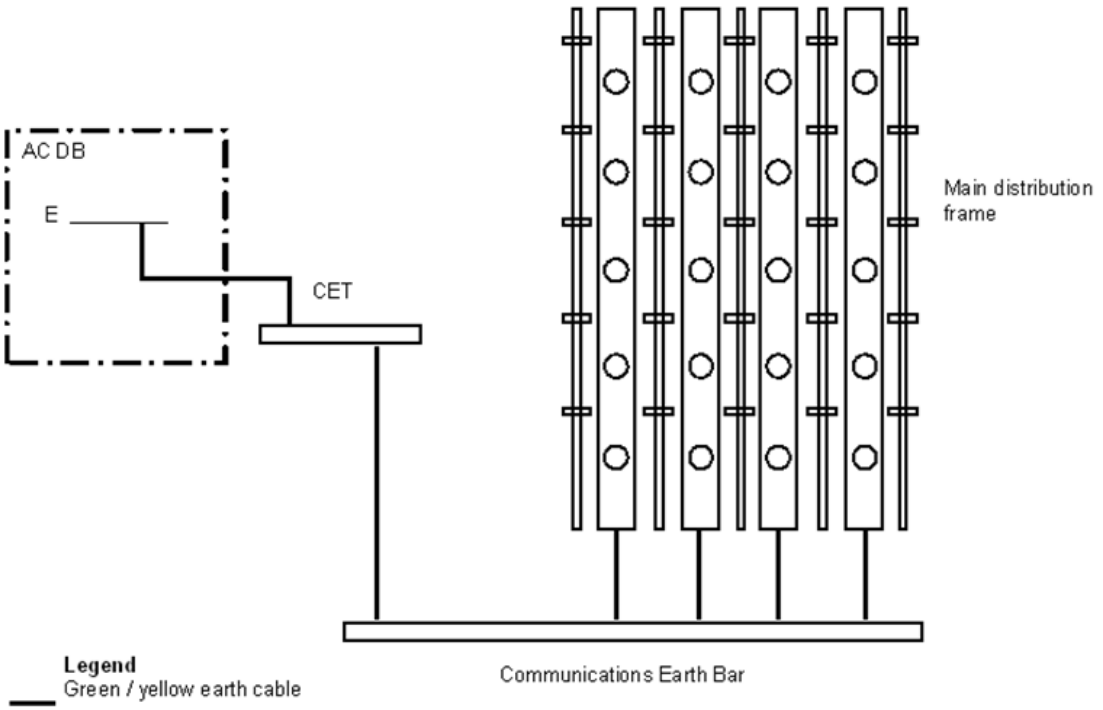

Figure 9 – Earthing of MDF – preferred arrangement

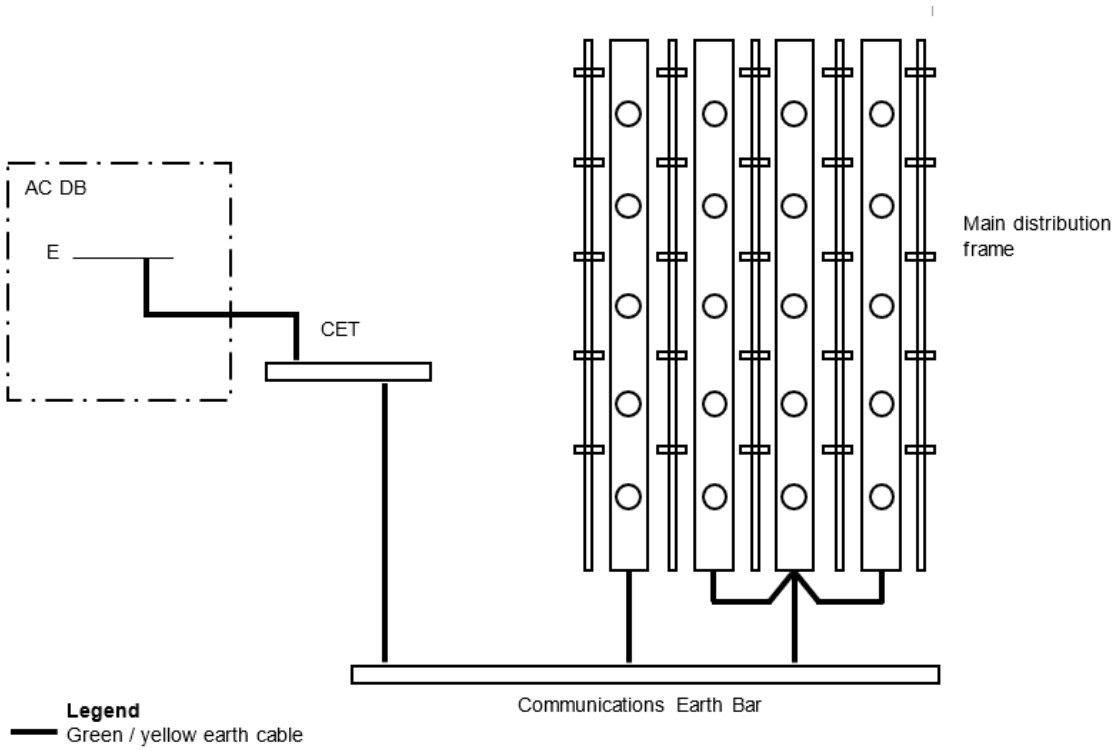

Figure 10 – Earthing of MDF – allowable alternative arrangement

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9.7 Isolation of racks and rack clusters

Other than by the earthing cables referred to in this section, the racks shall be isolated from the building and structural metalwork, conductive floors and cable runways.

Similarly, clusters of PEW racks shall be isolated from clusters of DEW racks and from earthed ac powered racks.

9.8 Internal rack earth wiring

Each rack containing three or more subracks shall be equipped with a rack earth bus to which the earth bonding conductors are attached. Racks with less than three subracks may use dedicated earth cables to connect the items to be earthed to a single rack earth stud.

Green / yellow bonding conductors shall bond the rack earth bus or rack earth stud to each subrack. Such conductors shall have a CSA at least as large as the power conductors supplying that sub-rack from the rack power distribution panel if such exists, or alternatively as large as the power conductors supplying that rack.

For PEW racks only, only one green / yellow bonding conductor shall bond the rack earth bus or rack earth stud to the rack's reference polarity common supply bar if such exists, or alternatively to the reference polarity terminal of the first sub-rack. Such conductors shall have a CSA at least as large as the power conductors supplying that rack.

9.9 Cable runways

Metallic cable runways shall be bonded to the CEB by green / yellow bonding conductors or via the internal earth bus. The connection between metallic cable runway sections shall be tested to ensure continuity.

10 Lightning and surge dissipation

Lightning and surge dissipation shall meet the requirements of AS/CA S009 and AS 1768 and the requirements in the following sections.

10.1 Surge dissipation

To reduce surge impedance all earthing conductors designed to carry surge and lightning currents shall be as straight and short as possible and meet the requirements in AS/CA S009.

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10.2 Lightning protection of radio masts and towers sites with masts or towers

10.2.1 General principals

Lightning protection systems for sites with masts or towers shall be designed to meet the requirements of the specific site and in accordance with AS 1768.

The mast earthing system shall be designed to dissipate lightning currents as efficiently as possible.

An external earth mat in accordance with Section 11.2 shall be used to minimise potential differences in the vicinity of the mast and building.

Lightning protection earthing shall be provided for antenna masts or poles and connected to the site protective earthing system. In the case of tilt poles, additional earth electrodes shall be provided either side of (or if space precludes this, at) the point where the top of the masts comes to the ground and at least one intermediate position to control earth potential rise for staff working on the pole while lowered as shown in Figure 11.

10.2.2 Down conductors

Copper down conductors shall not be fitted on any steel tower or pole to avoid galvanic interaction.

Concrete poles shall be provided with a down conductor of not more than 0.2 ohms from finial to footing. Use of the pole's internal reinforcing steel for this purpose is acceptable if at least three such rods run the full length of the pole and these rods are welded together.

Where this internal conductor does not exist, a concrete pole shall be provided with a down conductor of flat copper strap of not less than 25 mm x 1.5 mm, fixed with stainless or non-metallic fasteners. There shall be no joints in the down conductor run. Copper ions are present in rainwater dripping from any copper down conductor. For this reason, the down conductor shall not be fixed near any ladder or other steel fittings on the pole. The preferred position is on the opposite face.

10.2.3 Finials

A finial (lightning rod) shall be fixed to the top of any pole or mast, protruding above the top of the highest antenna mounted thereon by not less than 1.5 metres. The copper down conductor, where fitted, shall be connected directly to the base of the finial with as little bending as possible, to minimise inductance.

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10.2.4 Antenna feeder cables – above ground building entry

Feeders above ground shall enter the communications building through a metal gland plate no less than 3 mm thick and be solidly earthed to the external ground. The selection of the metal for the gland plate shall take account of possibly dissimilar metals to be connected to it. The earth connection from the gland plate shall consist of two separate copper straps of minimum size 25 mm x 1.5 mm extended vertically on the external wall of the building or less desirably extended immediately on the inside of the entry wall, to be as straight as possible and bonded to the earth mat. Bends shall be avoided as far as practically possible. This is an important part of the earthing design and minimises the voltage on the feeder if the tower is struck by lightning.

All antenna feeder cables and waveguides shall be earthed to the gland plate. Coaxial arresters shall be installed for all coaxial feeders. All flexible earth straps shall be attached to a stainless steel bolt attached to the plate. All penetrations of and connections to the gland plate shall be weatherproofed on the outside of the building.

When installing coaxial arresters, design principles shall be followed with protection against:

- inadvertent touching by personnel
- physical explosion of device under a lightning strike
- moisture entering connectors between coaxial cables and arresters.

10.2.5 Antenna feeder cables – below ground building entry

Where the antenna feeder enters the building underground the feeder and coaxial arresters (for all coaxial feeders) shall be directly earthed to the CEB / internal earth bus, as close as possible to where the feeders enter the building.

10.2.6 Antenna feeder cables – tower or mast bonding

Waveguides and the outer conductor of coaxial cables shall be bonded to the down conductor where such exists or to the steel of the tower / mast at the points whenever the cables change direction including the point next to the antenna and where the cables leave the mast. Weatherproof grounding kits shall be used for this purpose. Where the copper tails are bolted to tower steel the joint shall be fully sealed with an impermeable compound. See Figure 12 for further requirements.

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10.2.7 Typical arrangements

Figure 11 shows the usual arrangement for train radio sites where space is limited, buildings are small and tilting poles are used. Where insufficient space exists for the two radials shown in Figure 11, a single radial in line with the lowered mast may be used.

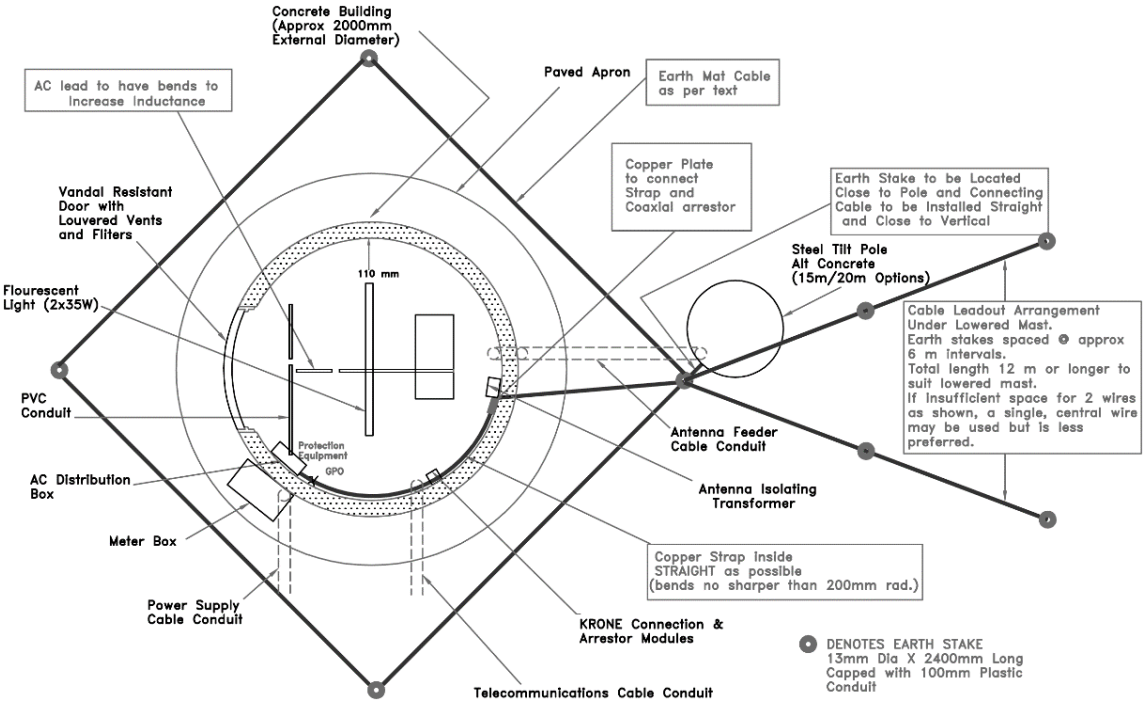

Figure 11 – Train radio site earthing where building is small, space is limited and tilting poles are used

Figure 12 shows the typical arrangements for microwave locations where a large steel lattice tower is part of the installation.

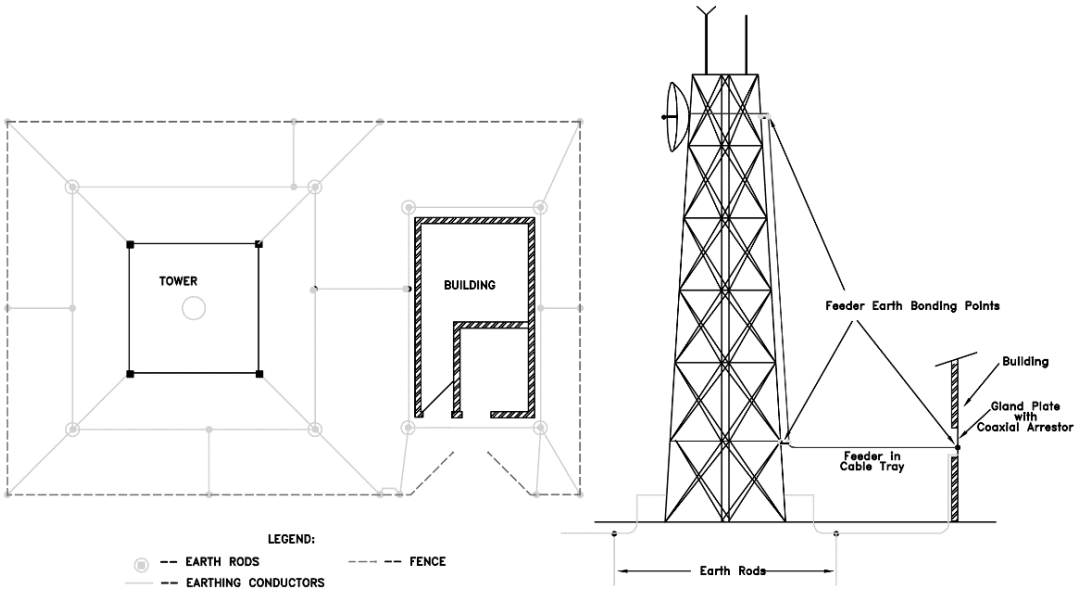

Figure 12 – Earthing at a site with a tower

11 Earth mat and earth electrodes

11.1 Purpose

The earth mat and/or earth electrodes are required as part of the lightning and surge protection system and to achieve the nominated earth resistance (Section 11.5). In addition, an earth mat is used as mitigation against different earth potentials within the compound.

Earth mats and earth electrodes shall meet the requirements of AS/NZS 3000 and AS 1768 as well as the requirements in the following sections.

In the electrified rail area and near to 1500 V dc track, the earth mat/electrode shall only be copper or copper plated. For electrode, pit and installation details in these situations refer to TS 03726. Consideration shall be given to minimise the footprint of earthing systems near to 1500 V dc track due to the risk of electrolysis.

11.2 Earth mat

An earth mat shall be provided at any site with a mast or tower. An earth mat may also be provided at other sites to achieve the required earth resistance.

The earth mat shall consist of a series of interconnecting bare copper conductors forming a rectangle around the building and radials from the tower / mast. The trench shall be no closer than 1 m from buried metallic services or 200 mm from non-metallic services.

In the heavy rail network, it shall also be no closer than 4 m from the signals main earth mat.

The bare copper conductor used for the earth mat shall be no smaller than 70 mm² (19/2.14) or equivalent copper strap.

The earth mat shall be directly bonded to the antenna feeder gland plate (where such exists) in accordance with Section 10.2.4 or, where no gland plate exists, to the internal earth bus / CEB by green / yellow insulated copper cable in accordance with Section 7.3.

The earth mat shall also be bonded to each tower leg, to each corner and centre post of the compound fence if provided and each gatepost.

The connections to the tower fastenings, corner posts and gateposts, and so on as applicable shall be by green / yellow insulated copper cable no smaller than 70 mm².

Copper earthing strap or cable shall not be placed in direct contact with steel masts or fittings to avoid electrolytic corrosion. Stainless steel fittings shall be employed at joints except in the case of coaxial cable bonding.

Use of the reinforcing steel in building or tower foundations to augment the ground system is permissible provided that a stainless steel fitting separates such steel from any copper.

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All other metal structures in the compound, other than specifically separate earth systems such as the signals main earth system, shall also be bonded to the earth mat. These include handrails, pipes and so on.

Within the electrified corridor, where a LV earth electrode exists at the location, the earth mat shall be indirectly bonded to it via the CEB, CET and earth bars within LV switchboards. Outside the electrified corridor, where a LV earth electrode exists at the location, the earth mat shall be directly bonded to it in accordance with Figure 4 Method 3 in AS/CA S009:2020 and as shown in Figure 2 in this document.

The direct connection to the LV earth, if applicable, shall be by green / yellow insulated copper cable no smaller than the main earth conductor.

11.3 Earth electrode

Earth electrodes shall consist of standard copper bonded steel or stainless steel rods of not less than 2.4 m length with a minimum diameter of 13 mm. To obtain the best effect electrodes should not be spaced closer than a distance of at least twice their length. Slip-on joiners may be employed if soil conditions permit the driving of more than one length of rod.

Where the earth electrode is installed in a borehole due to rocky terrain, the top of the rod should be approximately 200 mm below the ground surface. The bore hole shall be backfilled with an approved earth enhancement material to the manufacturer’s instructions. Any earth enhancement material used shall not leach into or otherwise pollute the water table or soil. The earth enhancement material shall retain its earth resistance without maintenance irrespective of soil water levels. A capped plastic conduit lid shall then be fitted over the earth electrode to provide a point of inspection and protection of the earth electrodes as shown in Figure 13.

Where an earth mat is installed, a minimum of four earth electrodes, bonded to the earth mat, shall be placed at the corners of the building. In the case of radio sites additional earth electrodes shall be bonded to the earth mat radials to achieve the required earth resistance as shown in Figure 11, making allowance for the site situation.

For sites in the rail corridor see the drawing EL0284008.

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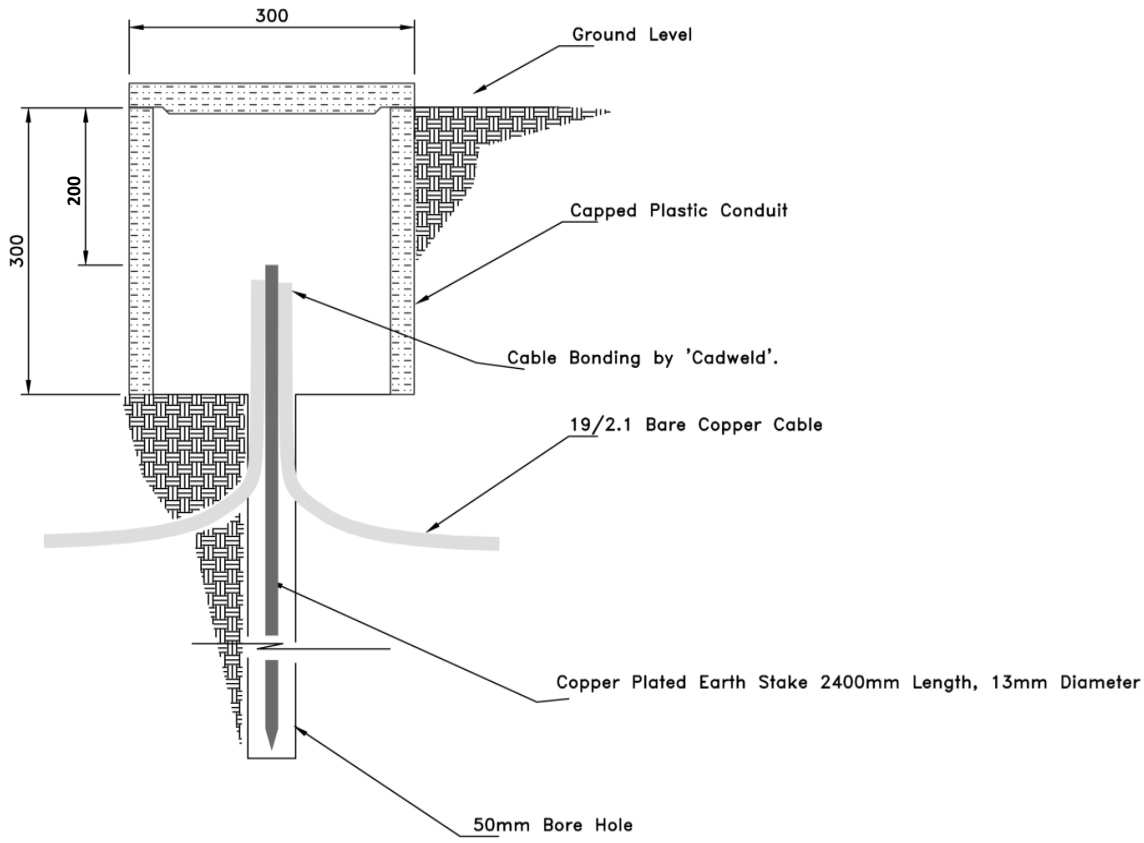

Figure 13 – Earth electrode installation in borehole

11.4 Earth cable bonding in the electrified rail area

Earth cable bonding shall be carried out in accordance with TS 03726.

Above ground cable connections to tower footings, fence posts and gateposts shall be by heavy-duty tin plated copper lugs. In the case of tower footings, the connection shall be of no lesser security than a crimped, closed lug, lock-nutted onto a stud of minimum size 12 mm. Otherwise, copper earthing strap or cable shall not be placed in direct contact with steel masts or fittings to avoid electrolytic corrosion. Stainless fittings shall be employed at joints.

11.5 Earth resistance

The earth resistance shall be measured and meet the requirements shown in AS 3015. Earth resistances greater than 2.5 times those listed in AS 3015 shall be dealt with through the TfNSW concessions process.

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12 Communications cables

12.1 Earth bonding of cable sheaths

The sheath, screen, moisture barrier, armour and so on (as applicable) of TfNSW communications cables shall be earthed to the CEB (via the internal earth bus where appropriate) only at one end of the cable or not at all.

MDFs and so on shall be located to facilitate external cables being earthed, where appropriate, to the CEB / internal earth bus as close as possible to the point of entry to the building.

A gas-filled surge suppression device may be used in situations where direct earth bonding of cable sheath, screen, moisture barrier, armour and so on is not practical.

12.2 Non-TfNSW communications cables in the rail corridor

Non-TfNSW entities shall not earth the sheath, screen, moisture barrier, armour and any other element of their communications cable(s) at the installation within the rail corridor.

13 Signals earth

A signals earth may also be installed or planned at the site in which case an integrated earthing system shall be designed by the TAO and approved by both the Director Signals and Control Systems Engineering and the Director Telecom Engineering.

The signals earth, where it exists within the same building as the communications earth, shall be bonded to it via a differential earth clamp.

14 Earth isolation in the electrified rail corridor

Continuous metallic structures (fences, pipes and so on) required to be bonded to the earth mat under Section 11 in the electrified rail corridor shall have isolation sections to prevent electrolysis and other stray-current issues.

In particular the following applies:

- Where the railway boundary fence forms one side of the compound fence, isolation panels shall be installed in it each side of the compound in accordance with SPC 511
- Any metallic pipe or conduit which is bonded to the earthing system shall have insulation sections installed where the pipe exits the compound as shown in Figure 14.

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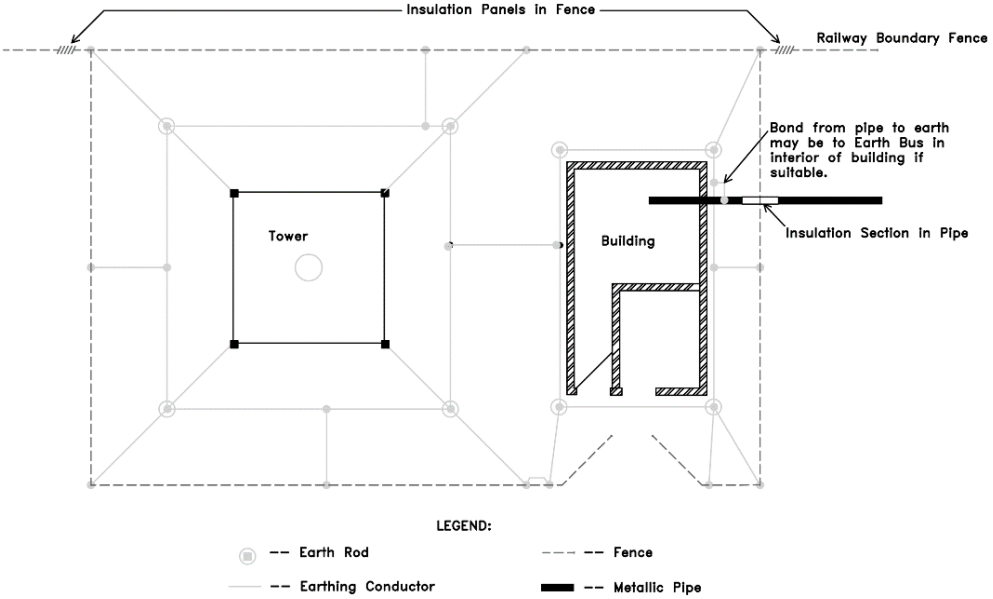

Figure 14 – Earth Isolation