IT'S HOW WE CONNECT

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POWER & EARTHING AT SHARED SITES

A.C SERVICES

007338 - Power & Engineering Services

CORPORATE STANDARD

SUB-DOMAIN: A.C POWER

FUNCTION: The 007338 suite of standards is required to ensure that Power & Network Facilities capacity and capability is delivered efficiently and consistently throughout the business no matter where it is required. A cross-company consultative process is used to formulate and maintain these standards. Compliance with these standards will ensure: (i) efficient use of resources, (ii) alignment with Telstra's strategic objectives, and (iii) efficient ongoing management, planning, maintenance and operation of the Network nationally.

INTENDED AUDIENCE: This Power & Engineering Services document is to be used by network planners, designers and operators to plan, dimension, deploy, manage and operate Power & Building Services infrastructure in order to meet Telstra's Business Objectives.

SUMMARY: The focus of this paper is focused on a.c and d.c power and earthing interfaces and bonding requirements. This document is not intended to be a reference for lightning protection.

VERSION LABEL: Final

SECURITY CLASSIFICATION: Telstra Unrestricted

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1. PURPOSE

To advise fixed network, transmission and mobiles planners, designers and contractors of requirements for power and earthing at shared Telstra radio sites.

The site may accommodate multiple buildings or a shared building with Telstra and Access Seekers sharing a common earthed metal communications tower, mast or pole.

Normally the site will be supplied by the local electricity distributor with a single service.

This document uses colour.

2. SCOPE

2.1. GENERAL

This standard was developed to outline the power and earthing requirements at radio communication sites shared by Telstra and other mobile access seekers such as Optus and Vodaphone.

The focus of this paper is on external a.c and d.c power and earthing interfaces and bonding requirements only.

This document is not intended to be a reference for lightning protection.

This document is not intended to specify TEBA requirements. Such requirements are fully specified in C8-6.

If the intended location for an access seeker's deployment is within a Telstra Equipment Area (non-preferred arrangement - Clause 7.2.2 refers), compliance with all Telstra standards relevant to that Equipment Area may also be required to achieve compliance with this standard. Such standards include but are not limited to:

- 005747-B062 - "Planning Principles for Network Equipment Area Common Infrastructure - Deployment Standard"
- 007338 C12-10 "Power and Environment Principles for New Technology Deployments"
- 007338 C12-5 "Mobile Network Power & Environment"
- 007338 C3-8 "Suite Based Cooling Criteria"
- 007338 C6-2 "Internal Service Earthing System"
- 007338 C6-3 "Telecommunications Power System Earthing"

2.2. RETROSPECTIVITY

The requirements in this Standard apply from the date of issue. No retrospective action should be taken unless specifically mentioned in the text of this standard.

2.3. CUSTOMER AND BUSINESS IMPACT

The application of this standard will assist Telstra to meet its obligations with regard to site access by access seekers such as other carriers without compromising electrical safety or Network performance of either Telstra's or the access seeker's networks.

3. RELATIONSHIP WITH AS/NZS 3000 AND AS/NZS 3015

Australian Standard AS/NZS 3000 sets out the (minimum) requirements for all electrical wiring. In addition, Australian Standard AS/NZS 3015 sets out the (minimum) requirements for telecommunications ELV (extra low voltage) d.c power supplies, which are located in restricted access locations such as Telstra's network buildings (e.g. telephone exchanges, mains or solar powered microwave and optical fibre regenerators).

The function of this paper and other similar internal documents is to outline the standards which Telstra will adopt, to at least meet, and where deemed appropriate, exceed the minimum requirements outlined in AS/NZS 3000 and AS/NZS 3015. Hence, in addition to the requirements detailed in this standard, the relevant requirements of both AS/NZS 3000 and AS/NZS 3015 shall also be met in order to achieve compliance with this standard.

In the event of a conflict between AS/NZS 3000 or AS/NZS 3015 and an internal (Telstra) standard, the relevant Australian Standard shall apply. Any such conflict (or apparent conflict) shall be reported to the Technical Editor for this paper (refer page 1) before any variation to the requirements of this paper are undertaken or initiated.

Refer to C1-3 for further details.

4. KEY STAKEHOLDERS

The following stakeholders (listed alphabetically) have reviewed and agreed to the content of this document before issue:

NAME	TITLE
Craig Armstrong	Manager Facilities Access, Telstra Property
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Mike Wall	Facilities Planning Manager – Network Facilities Ops, Telstra

Table 1: Key Stakeholders for Latest Major Issue

5. BACKGROUND

5.1.1. CIRCULATING NEUTRAL CURRENTS

The initial issue of this standard highlighted a shortfall in the Australian Standards at the time, which did not cover the possibility of neutral currents flowing through a shared common metal structure such as a communications tower. This issue was recognised in AS/NZS 3000:2000 and further expanded upon in the 2007 edition which specifically notes the issue of circulating currents at telecommunications sites using multiple MENs.

Clause 5.5.3.1 retains the option of either:

(a.) Connecting the earthing system of the 'outbuilding' to the electrical installation in which the MEN is located or ;

(b.) Establishing a separate MEN installation in the outbuilding and treating the outbuilding as a separate electrical installation.

However, item (vi) of AS/NZS 3000 Clause 5.5.3.1 (b) states:

(vi.) The combined protective earthing and neutral (PEN) conductor supplying the distribution board in the outbuilding should not be connected in parallel, by means of earthing or equipotential bonding conductors, with conductive pipes or structural metal within the electrical installation.

NOTE: Particular care is required where conductive pipes and such items as telecommunication cable sheaths, covered walkways, etc may be continuous between separate buildings and thus establish a parallel earth/neutral path.

The purpose of this standard is to manage the risk of circulating currents noted in AS/NZS 3000 "Australian Wiring Rules" whilst minimising rework to existing sites.

Because of the bond via the Service Bar and the tower, it is not possible to treat installations in each carriers' shelter as separate installations as is required by option (b) above. See Figure 1which illustrates possible parallel earth/neutral paths in a system with more that one supply and more than one MEN.

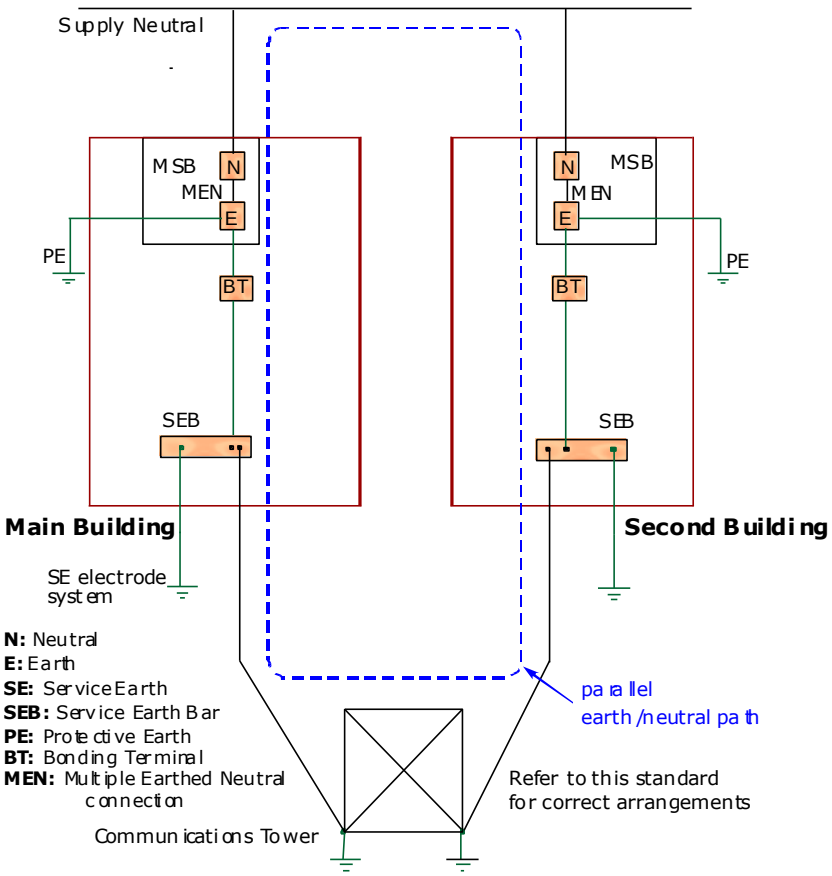


Figure 1: Possible parallel earth/neutral currents flowing in a system with two Supplies and two MEN links

5.1.2. SEGREGATION OF A.C AND D.C ELECTRICAL SYSTEMS

With the exception of Data Centres (out of scope of this standard), all Telstra operational equipment areas are designed for the accommodation of 48V d.c powered equipment only. This requirement is documented in Telstra Corporate standards 007338 C2-8 "Standard End-To-End Power Environment" and 007338 C12-10 "Power and Environment Principles for New Technology Deployments" and it is not possible to alter this at an existing equipment area.

Further, larger equipment area may comprise more than one 48V d.c electrical installation where more than one Telepower system is used. In such situations where separate Telepower systems have been deployed to different standards or are operated differently, each power system must be constructed as a separate electrical installation under the terms of AS/NZS 3000 "Australian Wiring Rules". This will also require appropriate segregation under all circumstances (including during installation and operational support activities).

An additional level of segregation is also required between all 48V d.c electrical installations and the building's 400/230V a.c distribution (as as permitted by AS/NZS 3015 "ELVDC Power Supplies for Telecommunications").

Full and complete segregation between 'lethal' 400/230V a.c installations and 'non-lethal' -48V d.c installations to mitigate electrical safety risks to personnel working at site. This is due to the different distribution and earthing techniques in the two systems as well as differences in licensing requirements to work on the installations.

5.1.3. D.C FAULT CURRENTS

As a result of the presence of battery capacity connected directly across the 48V supply of Telepower systems, the maximum prospective fault current of such systems is very high.

Australian Standard AS/NZS 3015 "ELVDC Power Supplies for Telecommunications" specifies distribution and earthing requirements such that this high fault current is constrained to within the distribution system of the individual Telepower system and does not enter the building's Service Earthing system.

This arrangement permits the use of smaller conductors in the building's service earthing system (as are specified in AS/NZS 3015) but does require that each Telepower system is fully isolated from all other Telepower systems.

Design Note: *This requirement for isolation of Telepower systems is to ensure that ground faults (which use the service earthing conductor as their return path) are contained within the Telepower system's distribution and that the building's service earthing conductors are not subject to these high fault currents.*

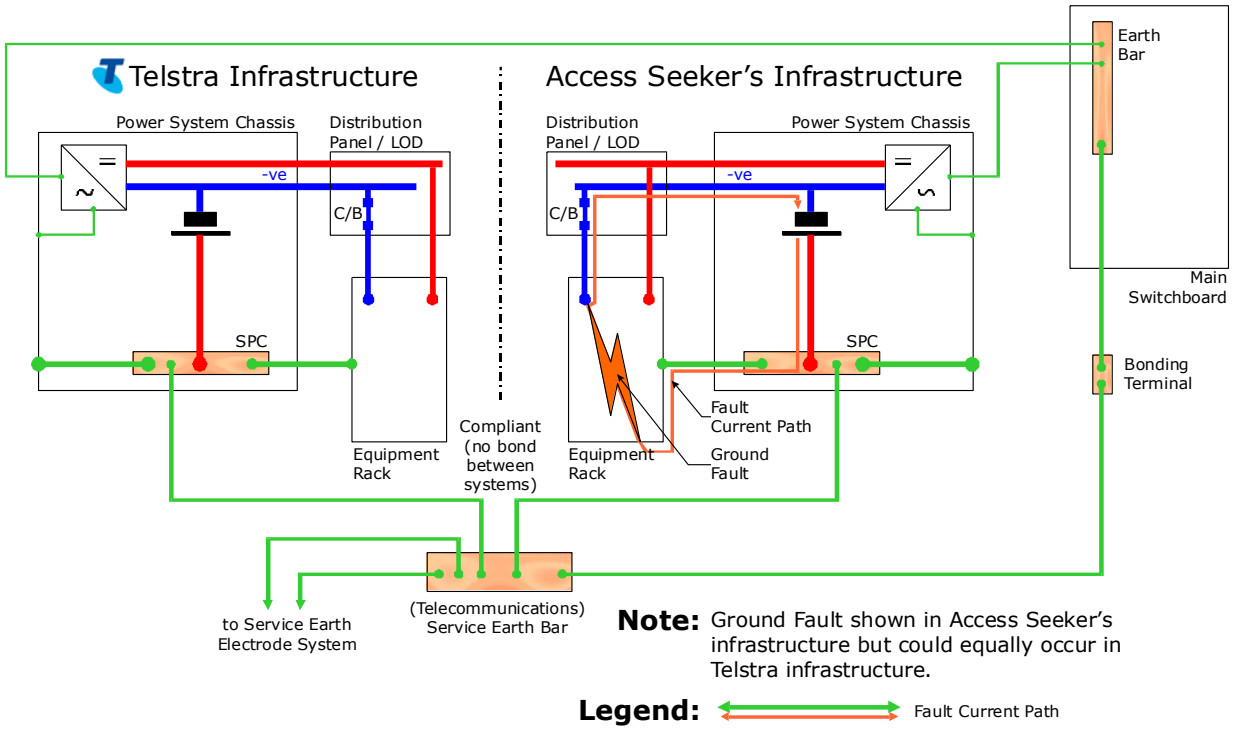


Figure 2: Conceptual Example of a Fault Current Path contained within the Power System Distribution in an AS/NZS 3015 Compliant System (no conductors at risk)

Failure to maintain complete isolation between individual Telepower systems will result in high fault currents in the building's service earthing system and hence the risk that the building service earthing conductors will be destroyed.

Further, due to the parallel path via LV Protective Earth (which is bonded to each Telepower system (in accordance with AS/NZS 3000), there is also a risk that this earth may also be damaged if the fault loop impedances of the LV Protective Earth and the Telecommunications Service Earth are not correctly coordinated. In practice, this is not possible to achieve due to the frequent changes to 48V distribution and service earthing systems.

Design Note: *An additional path for fault current where Service Earths from multiple power systems are bonded together may also include through a shared common metal structure such as a communications tower (depending on Network equipment type and installation practices). However, it is considered that the*

impedance of such a path will be significantly higher than the internal fault currents paths and hence should not be subject to damage under distribution fault conditions.

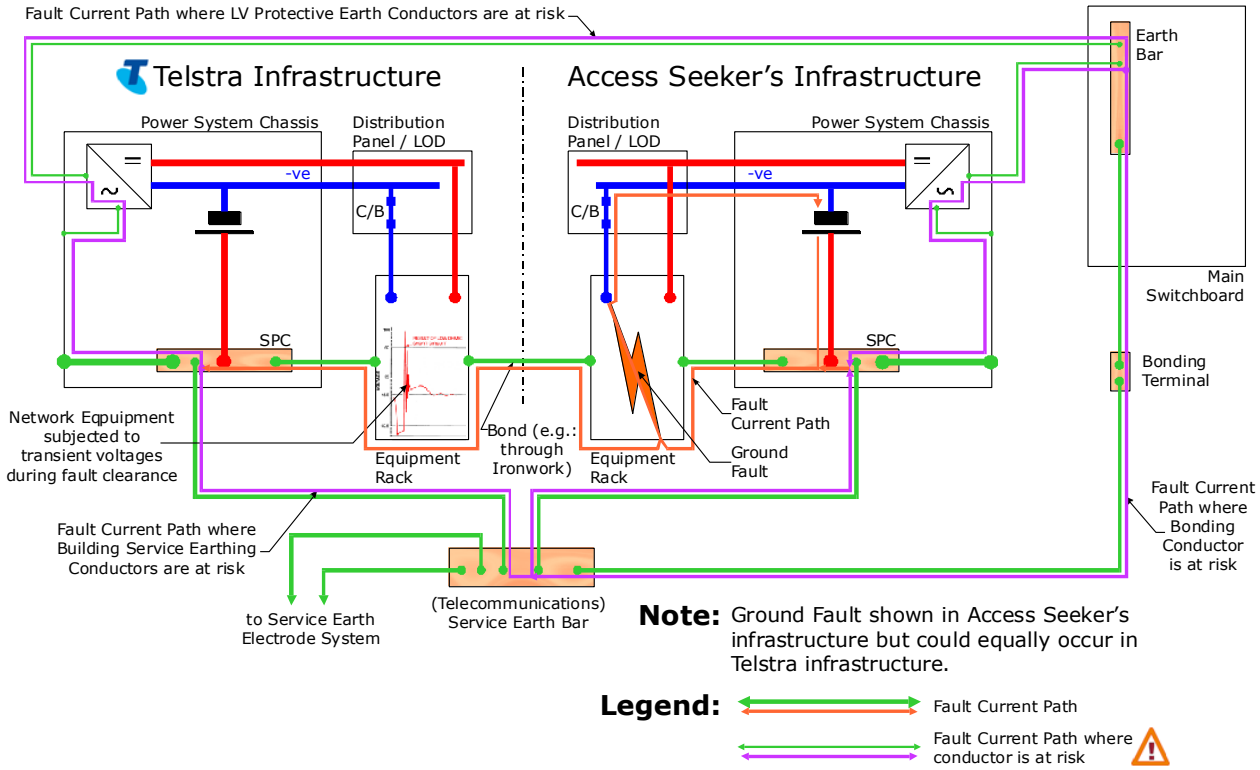


Figure 3: Conceptual Example of Fault Current Paths where multiple Fault Paths exist due to Bonding of Service Earths within the Power Systems' Distribution System

As can be seen from Figure 3 above, there are multiple fault loop paths at risk and this risk is higher in smaller sites where the Service Earth Bar and MSB are located near the Telepower systems.

In addition, under the arrangement where multiple fault paths exist due to bonding of Service Earths within the Power Systems' Distribution System; when the fault is cleared (by the Distribution Panel / LOD circuitbreaker), Network equipment not directly affected by the fault will also be subjected to a voltage transient event. This voltage and during of this event will depend on Distribution system inductance but can be as high as 100V and of duration of at least 20msec.

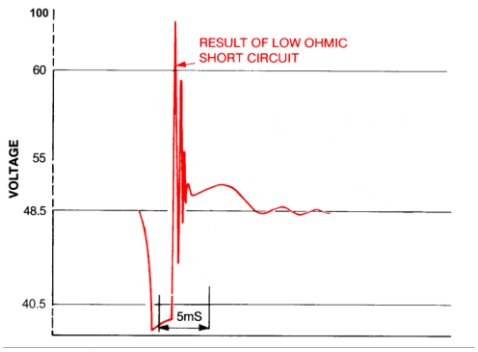


Figure 4: Example of a Voltage Transient at a Network Equipment Rack as a Result of a Low Ohmic Fault

Full and complete isolation of the Distribution (including Service Earthing) for each Power System will mitigate the risk of damage to other earthing conductors in the building as well minimise risk of Network failure due to voltage transients during the fault.

6. RETROSPECTIVITY

6.1. A.C MEN ARRANGEMENTS

Where local regulations require the modification of an installation, these regulations shall take precedence over the exemptions offered in this clause. Further, where such modifications are required, the modification shall comply with the requirements of this standard (excluding this clause).

This standard shall not be applied retrospectively unless issues relating to circulating neutral currents have been identified at a site (or it is necessary to modify one or more electrical installations at site to comply with local wiring regulations).

However, the requirement to implement single MEN at an **existing** site is optional if the project / site meets **all** of the following parameters:

i. The relevant regulator does not mandate to use of single MEN at a site where multiple MENs exist.

ii. There is no evidence of circulating Neutral currents at the site.

iii. The project does not include external modification to existing switchboard (i.e. replacement of MSB / upgrade or extension of MSB).

iv. The project does not involve modification to any consumer mains at the site.

v. The project does not involve modification to any BT at the site.

vi. The project does not involve modification to any SEB at the site with the exception of connection of new equipotential bonding conductors between new Network equipment / power system and the SEB.

Note: *This includes activities involving extension of an SEB to facilitate connection of equipotential bonding cables as specified in vi above.*

6.2. TELEPOWER SYSTEM SEGREGATION

Location of new Telepower systems shall meet the requirements of Clause 7.2.2. However, modification of ***existing installed and operating*** Telepower systems is permitted only within the following criteria:

i. The power system modification is limited to rectifier and/or distribution work only.

ii. Batteries may be replaced provided that the installed battery capacity (Ah) of the Telepower System is not increased.

iii. In all other respects, the requirements of this standard are met.

Design Note: *This requirement may cause the need for some remediation of the installation in order to meet the requirements of this clause.*

Only compliance with Clause 7.2.2 will fully mitigate the risks associated with collocated Telepower systems. However, compliance with the requirements of this clause will ensure that the risk does not increase.

7. A.C SUPPLY AND MEN

7.1. SEPARATE BUILDINGS

7.1.1. ONE SUPPLY AND ONE MEN PER SITE

Where the site is shared by multiple buildings, which are likely to share a metallic infrastructure such as a tower, AS/NZS3000:2007 section 5.5.3.1 (a) shall be followed with one electricity service to the site and one MEN**.**

Subject to local power authority regulations, the access seeker's building could be powered via the Supply Authority's meter panel. See Figure 5 for details.

Due to AS/NZS 3015 Service Earthing Requirements and lightning protection requirements, it is not possible to apply option (b) of AS/NZS 3000:2007 section 5.5.3.1.

7.1.2. SUPPLY TO THE ACCESS SEEKER'S BUILDING

The protection device for the supply to the Other Users building shall be readily accessible and appropriately discriminated from the upstream protection device in accordance with current practices, to reduce the likelihood of the supply fuse blowing prematurely. The supply cable shall be rated accordingly.

The MDB in the new building shall have an isolating device for that portion of the installation (AS/NZS 3000:2007 clause 2.3.3.3 (b) or the equivalent clause in the latest issue of AS/NZS 3000).

7.1.3. PROTECTIVE EARTH TO ACCESS SEEKER'S BUILDING

The Access Seekers building shall be earthed in accordance with Clause 7.1 of this standard.

Signs inside and out of the Access Seekers building MDB shall indicate that a MEN connection shall not be made here. This is also be required in Telstra's' building where the MEN connection is made in the MSB/meter panel.

7.1.4. SERVICE EARTH CONDUCTOR TO ACCESS SEEKER'S BUILDING

Where the Access Seeker's building requires a connection to Telstra's' Service Earth, this is provided in the form of a Service Earth Conductor dimensioned in accordance with C6-2 / AS/NZS 3015. A service earth tap-off can then be installed from this conductor as per C6-2 / AS/NZS 3015.

The Access Seeker's building requires a connection to the Telstra Service Earth. This is provided in the form of a 35mm² green/yellow cable insulated service earth bonding conductor via the shared tower as shown in Figure 2. This will limit the potential difference between the service earths. Refer to with C6-2 for details on the Service Earth Conductor. The SEB shall be installed to satisfy the requirements of AS/NZS 3015:2004 Section 4 or the equivalent clause in the latest issue of AS/NZS 3015.

As the site has a single MEN link at the MSB, no equipotential bond shall be provided between the protective and service earths in the Access Seeker's building.

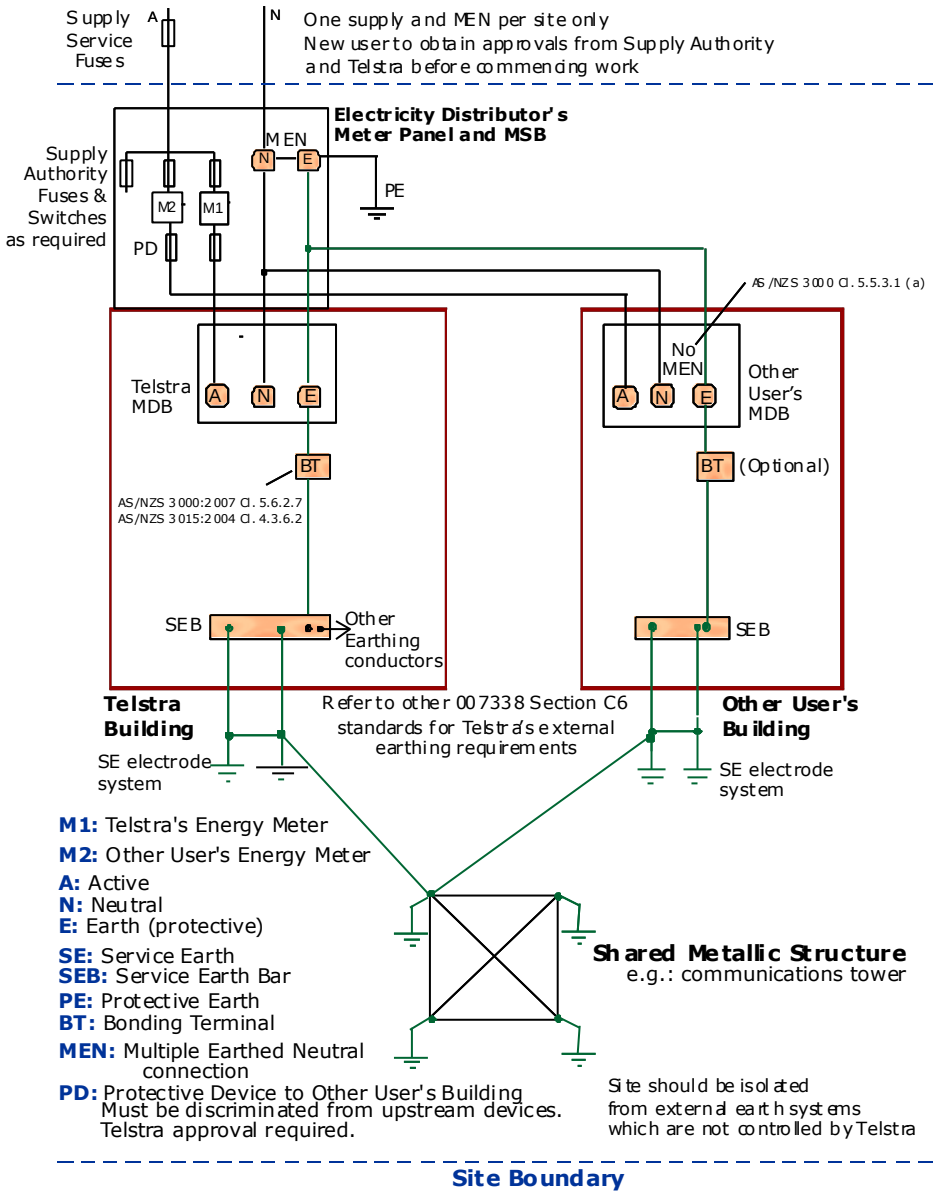


Figure 5: Power & Earthing at a Shared Site (Separate Buildings, Shared Tower, and Single Electricity Service)

7.2. ACCESS SEEKER SHARING THE TELSTRA BUILDING

7.2.1. AC SUPPLY AND SERVICE EARTHING

Figure 3 shows the power and earthing arrangement when another user shares the Telstra building by collocating their equipment within the Telstra building. In this case, the Access Seeker should retain a separately metered supply where commercially appropriate. The communications tower, SE electrode system and the SEB are shared.

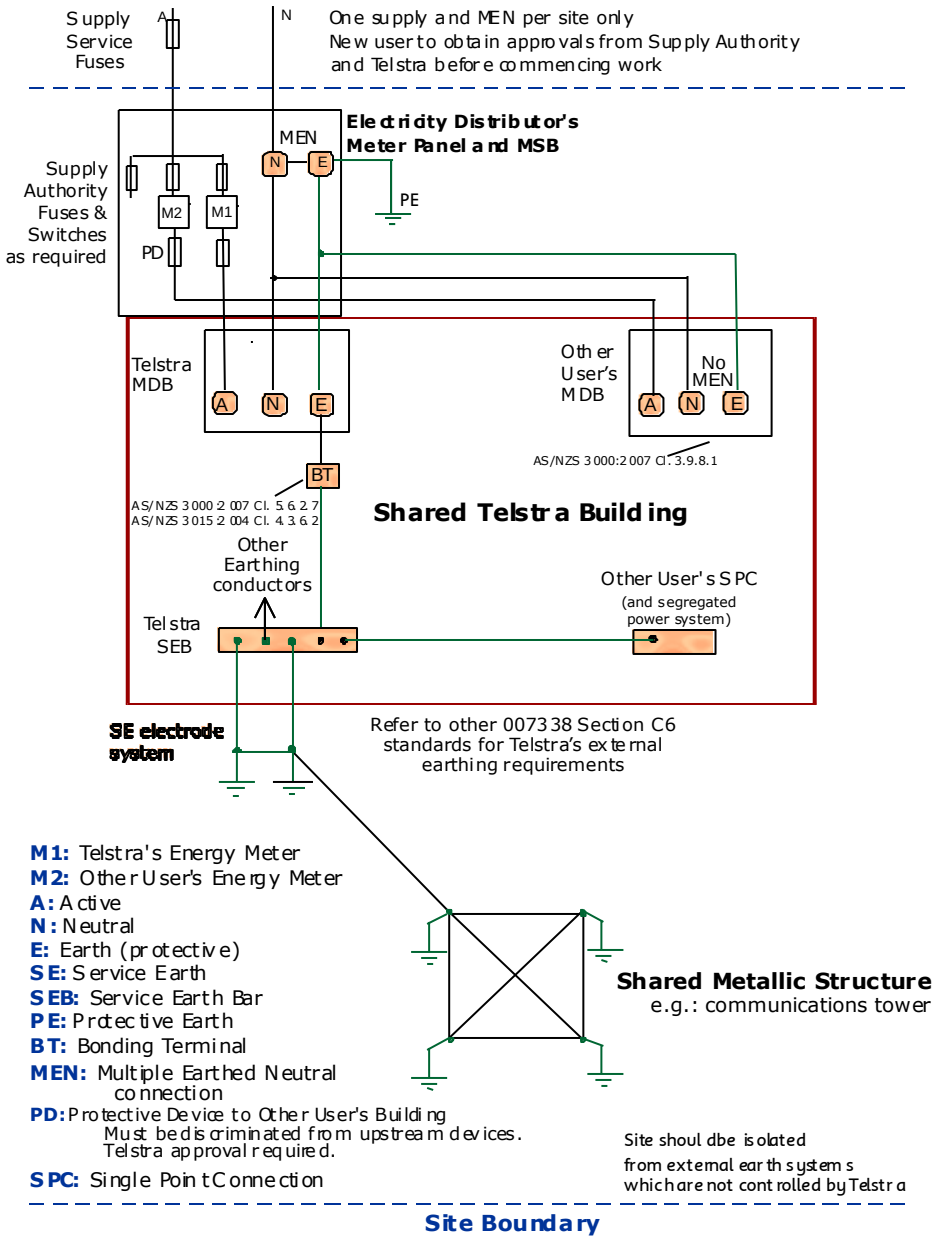


Figure 6: Power & Earthing at a Shared Site (Shared Building, Shared Tower, and Single Electricity Service)

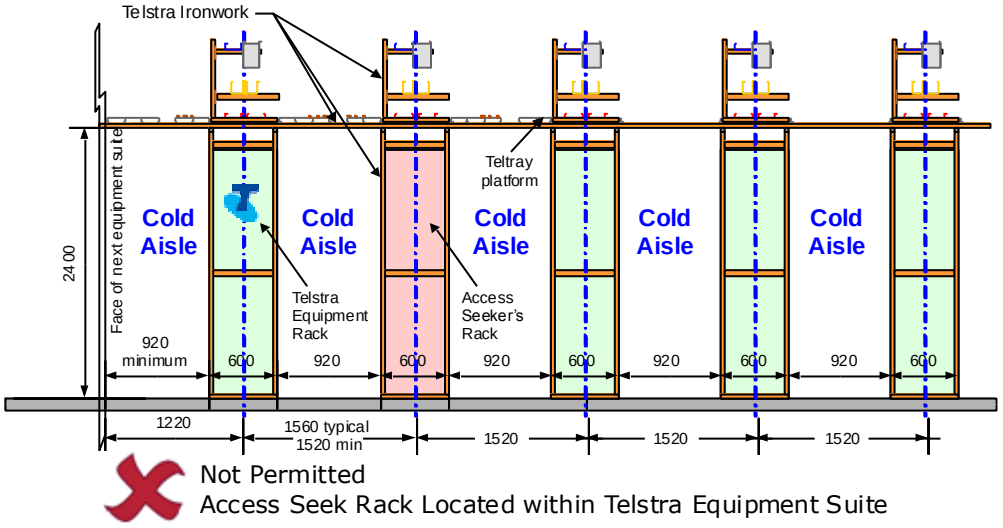
7.2.2. LOCATION OF ACCESS SEEKER'S INFRASTRUCTURE

The arrangements specified in Clause 7.2.1 rely on complete electrical isolation between all Telstra 48V infrastructure and the access seeker's 48V infrastructure with the exception of connection to the site Service Earth Bar and via the LV Protective Earth.

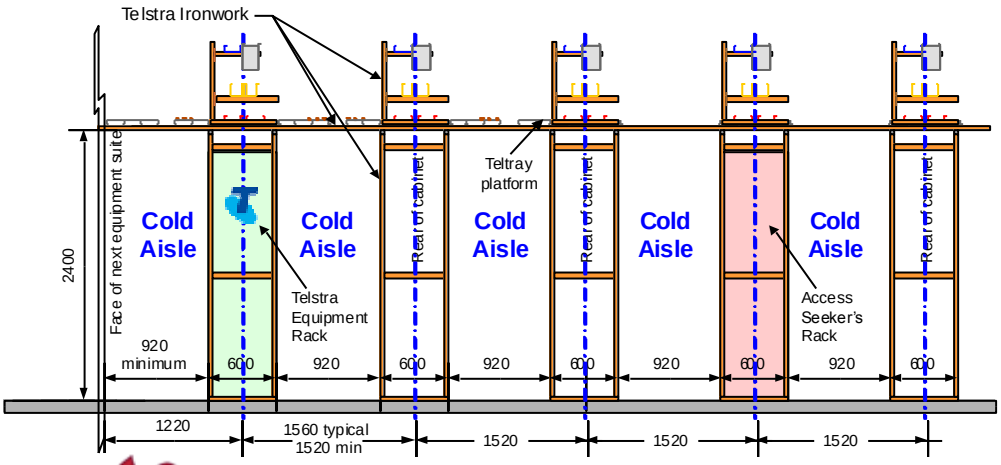
For this reason, the only permitted locations within a Telstra building for access seeker's equipment (including their 48V d.c Telepower power system) are as follows listed by order of preference:

PREFERENCE	ARRANGEMENT
1st	Locate the access seeker's infrastructure in a room separate from the Telstra 48V equipment area. This could be an old Power & Battery room or an old Test Room etc.
2nd	In the same room as the Telstra 48V equipment area but separated from the Telstra equipment by a distance not less than 2m from the nearest Telstra infrastructure (including ironwork, cable trays etc). For example, if Telstra equipment is located at one end of the room, a new area for the access seekers could be established at the other end. ***Design Note:*** *Maintaining a gap of 2m provides additional safety in that in the event of lightning strike on or near the tower, variation in earthing arrangements may lead to dangerous potential differences between Telstra's and access seeker's service earth. Maintaining a separation of 2m ensures that it is extremely unlikely that personnel can be touching both earths simultaneously during such an event.*

Table 2: Access Seeker Infrastructure Location Options



Not Permitted
Access Seek Rack Located within Telstra Equipment Suite



Not Permitted
Adequate Clearance from Telstra Racks but under Telstra Ironwork

Non-permitted arrangement include by are not limited to those shown.

Figure 7: Examples of Non-Permitted Arrangements

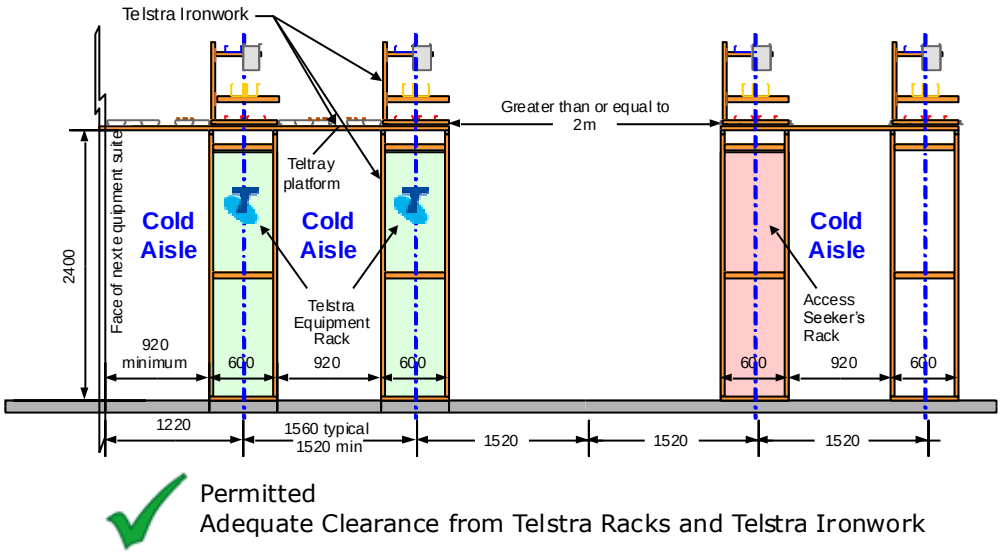


Figure 8: Example of Permitted Arrangement Showing Adequate Clearance

Infrastructure Note: *Figure 7 and Figure 8 show current generation Telstra suites of H2 cooling class. However, the same principles can also be applied to all other suite types including but not limited to legacy 300W/m² cooling suites, TEBA suites and Wireless Engineering radio suites.*

Any arrangement as described above would need to meet both Telstra's and the access seeker's business needs with regard to growth at the site.

7.3. SOURCE OF SUPPLY TO ACCESS SEEKERS

Preferred – from MSB/Meter Panel (as in Figure 5 and Figure 6)

Benefits and Issues:

- Avoids the need to access Telstra's' building.
- Prevents the supply of essential power to the Access Seekers building.
- Subject to local Supply Authority requirements.

Non-preferred – from Telstra MDB (MSB)

Benefits and Issues:

- No requirement for major changes for additional user if the existing MSB can be utilised.
- Depending on the design of the electrical system, the supply to the outbuilding may be an essential supply (i.e. generator backed). This may be advantageous in some instances, but generally not.
- Separate Supply Authority metering to the 'Access Seeker's Building would not be possible as the meter would be in series with Telstra's' meter. An alternative arrangement would be required (e.g. Telstra read meter or estimation).
- Subject to both local Supply Authority and Fire Authority requirements. If power is supplied after Telstra's' Main switch, the Access Seeker's building can be isolated from Telstra's building.

8. SERVICE EARTH ELECTRODE SYSTEM

The service earth electrode system associated with an Access Seeker's building shall comply with AS/NZS 3000 and AS/NZS 3015. In addition, it must be of the same steel based material as that of the Telstra earth system which usually consists of 50mm x 3mm Galvanised Iron Strap and Stainless Steel clad rods.

Galvanic corrosion of the Telstra steel based electrode system will occur if copper electrodes or bare copper wire are used at the site. Insulated copper conductors may be used for the interconnection and bonding of service earth electrodes and earth systems.

9. EXEMPTIONS TO THIS STANDARD

The front page outlines the importance of compliance with the requirements of this standard. However, the complexity of the network means that 007338 standards may not always cover all scenarios. Exemption requests are an important mechanism for documenting non standard installations, identifying gaps in standards and triggering reviews of standards. For this reason, any variation from this Standard must be documented and accompanied by an approved Exemption Request.

Exemptions Requests and associated justification material must be submitted via the following web form:

http://www.in.telstra.com.au/ism/007338/exemptionrequest.asp

To ensure the best opportunity to receive an Approval to your Exemption Request, please ensure you provide full details of scope of the request and all business benefits associated with it in the Justification Document.

10. ACKNOWLEDGEMENTS

The following contributors (listed alphabetically) are acknowledged for their assistance in the preparation of this document.

NAME	ORGANISATION
Nil	

Table 3: Acknowledgements

11. REFERENCES

11.1. 007338

All 007338 active Standards are available online to Account-01 users from Telstra's Intranet at URL:
http://func.collab.in.telstra.com.au/rep/func/0000547/Published%20Standards1/Forms/All%20Active%20Standards.aspx

DOCUMENT NUMBER	TITLE
C2-8	Standard End-To-End Power Environment
C3-8	Suite Based Cooling Criteria
C6-2	Internal Service Earthing System
C6-3	Telecommunications Power System Earthing

DOCUMENT NUMBER	TITLE
C8-6	TEBA Equipment Power and Earthing
C12-10	Power and Environment Principles for New Technology Deployments
C12-5	Mobile Network Power & Environment

11.2. OTHER INTERNAL

DOCUMENT NUMBER	TITLE
005747-B062	"Planning Principles for Network Equipment Area Common Infrastructure - Deployment Standard" http://func.collab.in.telstra.com.au/rep/func/0000052/005747%20Published%20Standards/005747-B062.pdf

11.3. EXTERNAL

DOCUMENT NUMBER	TITLE
AS/NZS 3000	Australian wiring rules
AS/NZS 3015	Electrical Installations – Extra low voltage d.c. power supplies and service earthing within public telecommunications networks

12. DEFINITIONS

TERM	DEFINITION
Access Seeker	Third party seeking to deploy their infrastructure at a Telstra site either in a separate shelter or within the Telstra building
AS/NZS	Australian Standard
BT	Bonding Terminal
MDB	Main Distribution Board. A switchboard from which a portion of the installation can be controlled.
MEN	Multiple Earth Neutral connection
MSB	Main Switchboard. A switchboard from which the whole installation can be controlled.
PD	Protective Device
PE	Protective Earth
SE	Service Earth
SEB	Service Earth Bar
Shall	A mandatory requirement

TERM	DEFINITION
Should	Recommended non-mandatory requirement
Site	Entire area encompassing the buildings and tower
Telepower System	Power system providing no-break -48V d.c power. Comprised of rectifiers, batteries and distribution facilities.
Tower	Communications antenna support structure – tower, mast or pole

For a full list of Network infrastructure based acronyms, please visit: http://www.in.telstra.com.au/ism/planningprinciples/glossary.asp (Telstra Intranet Link Only).

For access to Telstra's 'Jargon Buster' tool containing acronyms used across all Telstra Business Units, please visit: http://home.in.telstra.com.au/Glossary/Pages/Results.aspx?clickTrack=Homesite quicklinks (Telstra Intranet Link Only).

13. ATTACHMENTS

DOCUMENT NUMBER	TITLE
Nil	

14. DOCUMENT CONTROL SHEET

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ISSUE NO.	DATE	APPROVED	NATURE OF AMENDMENT
1	June 22, 1995	Glenn Lee TM – Power & Network Stds	
2	February 26, 1996	Glenn Lee TM – Power & Network Stds	Clause 1, co-located equipment aligned with AS/NZS 3015; Clause 4.1.5, 70mm² green/yellow cable in lieu 120mm², Clause 4.1.6, retrospectivity added.
3	December 13, 1996	Glenn Lee TM – Power & Network Stds	Clause 4.1.4, rename service earth conductor; General clarifications.
4	March 31, 2004	Gary Racine GM, NRP, W&W, TTIP	Figure 2 revised and new Figure 3 added.
5.0	February 16, 2009	Zach Kernich NM, Stds & Compliance, FP	Rules for existing sites added
6.0	September 11, 2015	George Bradilovic GM - Network Fac. Ops., Telstra Property, TOps	Rules added for provision of shared space within Telstra buildings. Background added to re fault current management. Additional background added covering segregation requirements.
6.1	October 26, 2015	Chris Baran-Kamp 007338 Technical Editor	Minor Revision to clarify scope of document and its relationship to other Telstra standards