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Australia



Electrical installations — Extra-low voltage power supplies and service earthing within telecommunications networks



AS 3015:2022

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- Australian Building Codes Board
- Australian Energy Council
- Australian Industry Group
- Communications, Electrical and Plumbing Union — Electrical Division
- Consumers' Federation of Australia
- Electrical Regulatory Authorities Council
- Electrical Workers Registration Board
- ElectroComms & Energy Utilities Industry Skills Council
- Energy Networks Australia
- Engineers Australia
- Institute of Electrical Inspectors
- Master Electricians Australia
- National Electrical and Communications Association
- National Electrical Switchboard Manufacturers Association

Additional Interests

- Downer EDI Engineering Pty Ltd
- Eaton Electrical (Australia) Pty Ltd
- NBN Co
- nVent ERICO
- Optus
- Telstra
- TPG Telecom

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Electrical installations — Extra-low voltage power supplies and service earthing within telecommunications networks

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Preface

This Standard was prepared by the Australian members of the Joint Standards Australia/Standards New Zealand Committee EL-001, Wiring Rules, to supersede AS/NZS 3015:2004, *Electrical installations — Extra low-voltage d.c. power supplies and service earthing within public telecommunications networks*.

After consultation with stakeholders in both countries, Standards Australia and Standards New Zealand decided to develop this document as an Australian Standard rather than an Australian/New Zealand Standard.

The objective of this document is to establish safety requirements, consistent with maintaining continuity of essential supply, for the installation of extra-low voltage (ELV) power supplies in restricted access locations (RAL) of telecommunications networks.

The major changes in this edition are as follows:

- (a) AS/NZS 3015:2004 applied only to public telecommunications networks. This edition now applies to all telecommunications carriers.
- (b) Other organizations and entities may opt to use this document.
- (c) The demarcation points between Standards relating to telecommunications infrastructure have been defined.
- (d) Requirements for outdoor cabinets and enclosures, and pole-mounted infrastructure have been included.
- (e) Electrical energy source classifications have been defined.
- (f) Requirements for the co-location of ELV and low voltage (LV) power have been included.
- (g) Guidance on emergency powering of outdoor cabinets has been included.
- (h) The batteries and battery hazards section includes new battery energy storage technologies and the addition of lithium-ion (Li-ion) batteries.
- (i) Requirements for special earthing for buildings and shelters, outdoor cabinets, pole-mounted equipment and rooftops have been included.
- (j) Updates to figures for overall site earthing, radio site earthing, outdoor cabinets, pole-mounted equipment and co-located site earthing.
- (k) Requirements on indoor earthing have been included.
- (l) Maximum values of earth resistance have been revised.
- (m) [Appendix C](#) has been updated.
- (n) [Appendices D, E and F](#) have been added.
- (o) Hybrid fibre-coaxial (HFC) is deemed to be ES1 or ES2, and included in the scope of this document.

The terms “normative” and “informative” are used in Standards to define the application of the appendices to which they apply. A “normative” appendix is an integral part of a Standard, whereas an “informative” appendix is only for information and guidance.

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Introduction

Most telecommunications network equipment is powered from extra-low voltage (ELV) supplies that are 12, 24 or 48 V d.c. but may also include a.c. telecommunications network equipment that is powered from ES1 or ES2 power supplies. This voltage is the nominal voltage between positive and negative regardless of which pole, if either, is earthed. Consequently, these supplies and their power distribution systems fall into the category of ELV as defined in this document.

The power supplies form an integral part of the telecommunications facility and their proper function is vital to the continuation of such a facility, especially to essential services such as railways, the police, fire brigade and ambulance services. The practices that are included in this document have been developed over many years of safe operation in telecommunications networks. This document applies to telecommunication carriers or other organizations and entities that opt to use this document. Use of this document is recommended for all other entities that install or operate telecommunications equipment.

Australian Standard®

Electrical installations — Extra-low voltage power supplies and service earthing within telecommunications networks

Section 1 Scope and general

1.1 Scope

This document sets out requirements for telecommunications ELV power systems and earthing in the provision of telecommunications networks where —

- (a) the telecommunications carrier or entity owns the ELV power supply;
- (b) the ELV power supply is located in a restricted access location; and
- (c) the ELV power supply is located in premises and on land that are owned, leased or otherwise occupied in whole or in part by the telecommunications carrier or entity.

This document defines the demarcation points between Standards when used in telecommunications infrastructure.

This document also specifies the minimum requirements for personal safety, equipment safety and safety from fire while maintaining the viability of the telecommunications network.

This document is applicable to the following:

- (i) Critical power systems including —
 - (A) telecommunication facilities;
 - (B) wireless/radio sites;
 - (C) small cells;
 - (D) outdoor cabinets and enclosures;
 - (E) hybrid fibre-coaxial (HFC) power systems;
 - (F) pole-mounted infrastructure; and
 - (G) security and building management systems associated with information telecommunications infrastructure [Information Communication Technology (ICT)].
- (ii) Single or dual plane power systems.
- (iii) Float charged battery systems.
- (iv) Partial state of charge battery systems.
- (v) Telecommunications off-grid power systems e.g. solar, wind or fuel cell.

This document does not apply to power systems of the following types —

- (A) portable equipment;
- (B) electric vehicles;
- (C) uninterruptible power systems (UPS) that are in accordance with AS 62040.1.1 and AS 62040.1.2 (with the exception of HFC UPS systems);
- (D) non-telecommunications industrial premises; or

(E) domestic dwellings.

NOTE Solar PV systems used as standalone and as part of solar hybrid systems that operate at ELV are within the scope of this document.

This document applies to telecommunication carriers or other organizations and entities that opt to use this document.

Use of this document is recommended for all other entities that install or operate telecommunications equipment.

1.2 Application

This document applies to the installation of ELV power supplies in RALs of telecommunications networks, e.g. telephone exchanges, telecommunications transmission sites, wireless sites, outdoor cabinets and pole-mounted infrastructure. Application of the requirements shall ensure that the installation is safe and that continuity of the ELV supply is maintained for telecommunications services or telecommunications carriers and other entities at all times.

Where this document applies as defined in the scope of this document and conflict exists between this document and other Australian Standards, the provisions of this document apply. This includes conflict with the section on ELV in AS/NZS 3000, or with any other Australian Standard.

The requirements of AS/NZS 3000, AS/NZS 3100 and related Standards shall apply to power supplies that are not installed in RALs within the telecommunications carrier's network.

1.3 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document.

NOTE Documents referenced for informative purposes are listed in the Bibliography.

AS 1170.4, *Structural design actions, Part 4: Earthquake actions in Australia*

AS 2676.2, *Guide to the installation, maintenance, testing and replacement of secondary batteries in buildings, Part 2: Sealed cells*

AS 3011.1, *Electrical installations — Secondary batteries installed in buildings, Part 1: Vented cells*

AS 3011.2, *Electrical installations — Secondary batteries installed in buildings, Part 2: Sealed cells*

AS/NZS 1768, *Lightning protection*

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

AS/NZS 3008.1.1, *Electrical installations—Selection of cables, Part 1.1: Cables for alternating voltages up to and including 0.6/1 kV—Typical Australian installation conditions*

AS/NZS 3008.1.2, *Electrical installations—Selection of cables, Part 1.2: Cables for alternating voltages up to and including 0.6/1 kV—Typical New Zealand conditions*

AS/NZS 3010, *Electrical installations—Generating sets*

AS/NZS 3100, *Approval and test specification—General requirements for electrical equipment*

AS/NZS 5000.1, *Electric cables—Polymeric insulated, Part 1: For working voltages up to and including 0.6/1 (1.2) kV*

AS/NZS 5000.2, *Electric cables—Polymeric insulated, Part 2: For working voltages up to and including 450/750 V*

AS/NZS 5139, *Electrical installations — Safety of battery systems for use with power conversion equipment*

AS/NZS 61000.6.2, *Electromagnetic compatibility (EMC), Part 6.2: General standards—Immunity for industrial environments*

AS/NZS 62368.1, *Audio/video, information and communication technology equipment — Part 1: Safety requirements (IEC 62368-1:2014 (ED. 2.0) MOD)*

AS/NZS CISPR 32, *Electromagnetic compatibility of multimedia equipment—Emission requirements*

AS/NZS IEC 61000-4.2, *Electromagnetic compatibility (EMC), Part 4.2: Testing and measurement techniques—Electrostatic discharge immunity test*

AS/NZS IEC 61000-4.3, *Electromagnetic compatibility (EMC), Part 4.3: Testing and measurement techniques — Radiated, radiofrequency, electromagnetic field immunity test*

AS/NZS IEC 61000-4.4, *Electromagnetic compatibility (EMC), Part 4.4: Testing and measurement techniques—Electrical fast transient/burst immunity test*

AS/NZS IEC 61000-4.5, *Electromagnetic compatibility (EMC), Part 4.5: Testing and measurement techniques—Surge immunity test*

AS/NZS IEC 61000-4.6, *Electromagnetic compatibility (EMC), Part 4.6: Testing and measurement techniques—Immunity to conducted disturbances, induced by radio-frequency fields*

IEC 60896-21, *Stationary lead-acid batteries – Part 21: Valve regulated types – Methods of test*

IEC 60896-22, *Stationary lead-acid batteries – Part 22: Valve regulated types – Requirements*

ETSI EN 300-132-2, *Environmental Engineering (EE); Power supply interface at the input of Information and Communication Technology (ICT) equipment; Part 2: –48 V Direct Current (DC)*

EN 55032, *Electromagnetic compatibility of multimedia equipment - Emission requirements*

EN 55035, *Electromagnetic compatibility of multimedia equipment - Immunity requirements*

EN 61000-6-4, *Electromagnetic compatibility (EMC), Part 6-4: Generic standards – Emission standard for industrial environments (IEC 61000-6-4:2018)*

CISPR 35, *Electromagnetic compatibility of multimedia equipment - Immunity requirements*

ITU-T Recommendation K.27, *Bonding configurations and earthing inside a telecommunication building*

1.4 Terms and definitions

For the purposes of this document, the terms and definitions in AS/NZS 3000 and the following apply.

1.4.1

appliance

electrical device, conforming to AS/NZS 62368.1, that does not house the main a.c. switchboard, but may incorporate internal a.c. distribution within its housing

Note 1 to entry: Connection to the main a.c. switchboard is via a dedicated active, neutral and protective earth connection.

1.4.2

arc flash

electrical explosion or energy discharge, which occurs between electrified conductors during a fault or short-circuit condition

1.4.3

arc flash incident energy

measurement applied to determine the available incident arc flash energy at a specified distance originating from an arc flash

Note 1 to entry: This measurement is used to determine the level of personal protection equipment (PPE) and the relevant arc flash protection boundary.

1.4.4

arc flash protection boundary

boundary marked by the distance from electrical equipment at which the arc flash incident energy is equal to 1.2 calories/cm² (equivalent to 5 J/cm²)

Note 1 to entry: Correct personal protective equipment (PPE) is required within this boundary to protect burns.

Note 2 to entry: PPE is rated in calories (cal), therefore the unit of joules is not used in this application.

1.4.5

authorized person

authorized personnel

person authorized by the telecommunications carrier to be in charge of the premises, or a *competent person* ([1.4.23](#)) appointed or selected by the person in charge of the premises to perform certain duties associated with the telecommunications power systems installation

1.4.6

battery bank

one or more battery strings connected in parallel to provide the required storage capacity within a battery system and meets the requirements of associated power conversion equipment (PCE)

1.4.7

battery cabinet

enclosure or cabinet for mounting cells/monoblocs or battery modules

1.4.8

battery cell

assembly of electrodes and electrolyte within a container, which constitutes the basic unit of a battery

1.4.9

battery energy storage system

BESS

consists of *PCE* ([1.4.45](#)), battery system(s), and isolation and protection devices

Note 1 to entry: May also includes auxiliary equipment, cables, battery management module(s), and battery management system

1.4.10

battery management system

electronic system that monitors and manages a battery or battery system's electric and thermal states enabling it to operate within the safe operating region of the particular battery

Note 1 to entry: The battery management system provides communications between the battery or battery system and the *PCE* ([1.4.45](#)), and potentially other connected devices (e.g. vents or cooling).

Note 2 to entry: The battery management system monitors cells, battery or battery modules to provide protective actions for the battery system in the case of overcharge, overcurrent, over discharge, overheating, overvoltage and other possible hazards that could occur.

Note 3 to entry: Additional battery management system functions may include active or passive charge management, battery equalization, thermal management, specific messaging or communications to the *PCE* ([1.4.45](#)) regarding charge rates and availability.

1.4.11**battery module**

battery (typically lithium-ion) manufactured within a single housing that has one or more separate but electrically-connected battery cells and terminals or interconnections as well as a battery cell management system integrated into the module

Note 1 to entry: These may also have incorporated electronics for monitoring, charge management and/or protection.

Note 2 to entry: Other technologies may have control electronics. Examples include nickel salt batteries, super capacitors and flow batteries.

1.4.12**battery monobloc**

battery (typically lead acid) manufactured within a single housing that has one or more separate but electrically-connected battery cell compartments, each of which is designed to house an assembly of electrodes, electrolyte, terminals or interconnections and possible separators

1.4.13**battery rack**

frame or structure that physically supports the battery

1.4.14**battery room**

room intended for the installation of batteries

1.4.15**battery string**

one or more *battery cells* ([1.4.8](#)), *battery monoblocs* ([1.4.12](#)) or *battery modules* ([1.4.11](#)) connected in series to produce the required voltage

1.4.16**battery system**

system comprising one or more battery cells, monoblocs, battery modules, battery strings or battery banks connected to the ELV power system

Note 1 to entry: Depending on the type of technology, the battery system may include one or multiple battery management system(s) and auxiliary supporting and/or protective equipment for the system.

Note 2 to entry: This does not include the *PCE* ([1.4.45](#)).

1.4.17**boost-charge****boost****equalizing charge**

charge at higher voltage than float charge voltage

1.4.18**buildings and shelters**

telecommunication housing that one can walk inside

1.4.19**capacity (of a battery)****C_{xx}**

quantity of electrical energy which a fully charged cell or battery can deliver under specified conditions

Note 1 to entry: Capacity is measured in ampere hours (A h) or in watt hours (W h).

Note 2 to entry: The capacity of a cell or battery is denoted by the symbol C. As the capacity varies with rate of discharge, the symbol C is followed by a numerical suffix (e.g. C_{xx}) giving the rate of discharge. Thus, C₁₀ is the capacity in ampere hours at the 10 h rate of discharge. The specified temperature is usually 25 °C. The final voltage depends on battery type and conditions of service.

Note 3 to entry: The specified conditions are rate of discharge, final voltage and temperature.

Note 4 to entry: Rated capacity normally refers to the rated capacity for a new battery and *actual capacity* ([1.4.19.1](#)) normally refers to the capacity that can be obtained from the battery after a period of time where the effects of age reduces the capacity of the battery.

1.4.19.1

actual capacity (of a battery)

quantity of electrical energy, in ampere hours, that can be withdrawn from a cell or battery for a specific set of operating conditions including discharge rate, temperature, initial state of charge, age, and final voltage

Note 1 to entry: Capacity is measured in ampere hours (A h) or in watt hours (W h).

1.4.19.2

rated capacity (of a battery)

quantity of electrical energy in ampere hours, which a cell or battery can deliver after a full charge under specified conditions

Note 1 to entry: Capacity is measured in ampere hours (A h) or in watt hours (W h).

1.4.20

charge (of a battery)

operation during which a battery receives, from an external circuit, electrical energy which is then converted into chemical energy

1.4.21

charge (recharge)/discharge rate (of a battery)

current at which a battery is charged or discharged, which may be expressed in amperes or as a multiple of the *rated capacity* ([1.4.19.2](#)) of the battery

Note 1 to entry: For example, if a battery is rated at 500 A h at the 10 h rate of discharge and is being discharged at a current of 50 A, its discharge rate is expressed as 0.1 C₁₀.

1.4.22

common d.c. return

DC-C

two-wire

2-wire

system where only two conductors are required to be connected to the equipment: positive and negative

Note 1 to entry: This is the case where there is no earth bonding wire and either the positive or negative conductor is bonded to earth at the ELV d.c., SPC, SEB or SEB tap-off.

Note 2 to entry: This is typically the case when the equipment is internally earthed to the relevant wire that is bonded to the SEB or SEB tap-off (usually the positive conductor in a telecommunications facility).

1.4.23

competent person

person who has acquired, through education, training, qualification or experience or a combination of these, the knowledge and skill enabling that person to perform the task required

1.4.24

custom-designed outdoor cabinets and enclosures

cabinets and enclosures that are assembled by the telecommunications carrier or other entity, as opposed to appliances which come to site pre-wired and conform to AS/NZS 62368.1

1.4.25

earth bonding terminal

EBT

earth bar provided as a means of bonding a.c. protective earth to service earth bar (SEB)

1.4.26**electrical equipment**

wiring systems, switchgear, controlgear, accessories, appliances, luminaires and fittings used for such purposes as generation, conversion, storage, transmission, distribution or utilization of LV electrical energy above ELV

Note 1 to entry: Electrical equipment is electrically connected to an LV supply (and conforms with AS/NZS 3000 installation requirements) and may consume electrical power for either directly or indirectly powering telecommunications equipment within a telecommunications network.

1.4.27**electrical installation**

electrical equipment installed for the purposes of conveyance, control, measurement or use of electricity, where electricity is or is to be supplied for consumption

Note 1 to entry: Electrical installations include electrical equipment supplied from a distributor's system or a private generating system, but do not include telecommunications equipment or telecommunications cables.

Note 2 to entry: An electrical installation usually commences at the point of supply and finishes at a point (in wiring) but does not include portable or stationary electrical equipment connected by plug and socket-outlet (other than where a socket-outlet is used to connect sections of the fixed installation).

Note 3 to entry: Unless the context otherwise requires, the term "installation" is used to mean electrical installation.

Note 4 to entry: For telecommunications networks, the electrical installation commences at the point of supply and finishes at the terminals of either an appliance, or the power conversion equipment. Wiring beyond this point is either equipment wiring, ELV electrical distribution wiring or telecommunication cables such as twisted pairs and coaxial cables.

1.4.28**enclosure**

housing with the type and degree of protection for the intended application

Note 1 to entry: Examples of enclosures include: indoor equipment racks, pole mounted infrastructure and outdoor cabinets that one cannot walk inside.

1.4.29**equipment bonding wire****EBW**

bonding wire between telecommunications equipment and the rack bonding bar (RBB)

1.4.30**equipment room**

room that houses telecommunications equipment, that is walk-in accessible

1.4.31**extra-low voltage****ELV**

potential existing between conductors and between conductors and earth not exceeding 120 V ripple-free d.c. or for a.c. systems, does not exceed ES2 levels as defined in AS/NZS 62368.1

Note 1 to entry: For more information, refer to AS/NZS 62368.1 definitions for ES1, ES2 and ES3.

1.4.32**feeder entry bar****feeder earth bar****feeder entry earth bar****FEB**

conductive metal bar used for termination of earth cables from coaxial, d.c., waveguides and other feeder cables

1.4.33**float charge**

method of maintaining a battery in a fully charged (float) state by applying a steady voltage above the open circuit voltage of the battery, but below the boost-charge voltage

1.4.34**hybrid fibre-coaxial network****HFC**

telecommunications network —

- (a) that is for use for the transmission of any broadcasting service; and
- (b) that is also capable of being used to supply an internet carriage service; and
- (c) the line component of which consists of optical fibre to connecting nodes, supplemented by coaxial cable connections from the nodes to the premises of end-users

1.4.35**inverter**

device whereby electrical energy is converted from d.c. to a.c

1.4.36**isolated bonding network****IBN**

bonding network that has a single point of connection (SPC) to the service earthing system and is isolated from all other IBNs

Note 1 to entry: Where the SPC is still connected to the SEB or SEB tap-off.

1.4.37**isolated d.c. return****DC-I****three-wire****3-wire**

system that uses positive, negative and a separate earth bonding wire to power equipment

1.4.38**lead-acid cell**

electrochemical cell using lead oxide as the positive electrode, sponge lead as the negative electrode and sulphuric acid as the electrolyte

1.4.39**live**

term applied to an ELV conductor or conductive part, intended to be energized in normal operation

1.4.40**main earthing terminal****MET**

main earth terminal or busbar as per AS 30129 which is part of the earthing arrangement of a LV data room enabling electrical connection to SEB

1.4.41**main service earthing conductor**

conductor that connects the telecommunications service earth bar (SEB) or SEB tap-off of an installation to the telecommunications service earthing electrode system

1.4.42**may**

indicates the existence of an option

1.4.43**mesh isolated bonded network****mesh-IBN**

bonding network in which all associated equipment frames, racks and cabinets are bonded together at multiple points to a dedicated mesh

Note 1 to entry: The mesh-IBN is usually below the raised floor, with the mesh bonded to the Main Earth Terminal (MET) as defined in AS 30129.

Note 2 to entry: The MET has a single connection to the service earth bar (SEB). These are used mostly in LV powered data rooms.

1.4.44**nominal voltage**

stated value of voltage used to identify a type of cell

Note 1 to entry: The nominal voltage of a lead-acid cell is 2.00 V, whether the cell is vented or valve-regulated and of a nickel-cadmium cell is 1.20 V, whether the cell is vented or valve-regulated.

1.4.45**power conversion equipment****PCE**

electrical device converting and/or manipulating one kind of electrical power from a voltage or current source into another kind of electrical power with respect to voltage, current and/or frequency

Note 1 to entry: Examples include but are not limited to d.c./a.c., inverters, d.c./d.c. converters, a.c./d.c. rectifiers and charge controllers.

Note 2 to entry: Battery management systems are not considered to be PCEs for the purpose of this document.

1.4.46**primary d.c. distribution**

d.c. conductors and other equipment from the PCE output terminals, up to and including the terminals of a battery and the input terminals of the first switchboard, at which the secondary d.c. distribution commences

1.4.47**protective earthing**

connection to the general mass of the earth, in a manner that ensures the electrical isolation of any defective equipment within a mains supplied electrical installation, through the operation of protective devices

1.4.48**rack bonding bar****RBB**

earth bar inside rack or cabinet used for terminating equipment earth wires

1.4.49**rack bonding distributor****RBD**

bonding wire between SEB or SPC and the equipment suite

1.4.50**rack bonding wire****RBW**

bonding wire between SBB and the equipment rack

1.4.51**remote radio unit****remote radio head****RRU****RRH**

remote radio transceiver used in telecommunications wireless networks, typically located on a tower, rooftop or pole

1.4.52**restricted access location****RAL**

location for equipment where both of the following apply:

- (a) Access can only be gained by *authorized personnel* ([1.4.5](#)), or by users who have been instructed about the application of the restrictions to the location and about any precautions that should be taken.
- (b) Access is through the use of a special tool, or lock and key, or other means of security, and is controlled by the authority responsible for the location.

1.4.53**safeguard**

physical part, system or instruction specifically provided to reduce the likelihood of pain or injury, or, for fire, to reduce the likelihood of ignition or spread of fire

Note 1 to entry: Various safeguards are defined in AS/NZS 62368.1.

1.4.54**secondary bonding bar****SBB**

earth bar provided in racks, rows or floor level for bonding of telecommunications equipment

1.4.55**secondary d.c. distribution**

first d.c. distribution switchboard and the protected circuits originating from it, for the purpose of distributing the d.c. power to the telecommunications equipment

1.4.56**service earth bar****SEB**

termination point for the main service earthing conductor and other service earthing and bonding conductors

1.4.56.1**service earth bar tap-off**

extension earth bar that is directly connected to the service earth bar (SEB)

Note 1 to entry: Typically this may be used in large sites where it is impractical to run earthing conductors to the SEB that is very distant. This may also be used when all connection points on SEB are utilized.

1.4.57**service earthing system**

comprises SEB, SEB tap-off, SPC, service earth electrode systems and all connections to these

Note 1 to entry: Service earthing system is primarily provided for the earthing of the ELV system, but may interface with other earthing systems as described in this document.

1.4.58**shall**

indicates that a statement is mandatory

1.4.59**should**

indicates a recommendation

1.4.60**single point connection****SPC**

connecting point for earthing and bonding conductors from the power conversion equipment frame, the battery return, equipment bonding wires and service earthing system

Note 1 to entry: Where multiple (dual-plane) power conversion equipment are located together and feed common equipment, one SPC is used with both PCE bonded to the SPC.

1.4.61**string (of cells)**

two or more cells connected in series electrically, so as to provide the required terminal voltage

1.4.62**switchboard**

assembly of circuit protective devices, with or without switchgear, instruments or connecting devices, arranged and mounted for distribution to, and protection of, one or more submains or final subcircuits or a combination of both

1.4.63**telecommunication cables**

cabling system that is owned and operated by a telecommunications carrier such as, optic fibre, twisted pair copper cables (PSTN/ISDN), ethernet and coaxial cables, or any other telecommunications cabling system used for the supply of telecommunication services

1.4.64**telecommunications carrier**

person or organization licensed by the Government of Australia as an authorized carrier of telecommunications services

1.4.65**telecommunications equipment**

equipment whose primary purpose is to distribute telecommunication services to customers, via the telecommunications network

Note 1 to entry: Equipment includes switches, routers, servers, transmission equipment, telecommunication cables, amplifiers, passive elements, telecommunications ducts, radio equipment and antenna.

1.4.66**telecommunications exchange**

aggregate of switching equipment and auxiliary equipment at a node in a telecommunication network enabling connections to be established

1.4.67**telecommunications facility**

all or part of the infrastructure of a *telecommunications network* ([1.4.68](#)); or any line, equipment, apparatus, tower, mast, antenna, tunnel, duct, hole, pit, pole or other structure used, or for use, in or in connection with a *telecommunications network* ([1.4.68](#))

1.4.68**telecommunications network**

network that is available for the supply of telecommunications services and is owned and operated by a *telecommunications carrier* ([1.4.64](#)) or other entity and consists of a system, or series of systems that carries, or is capable of carrying, communications by means of guided and/or unguided electromagnetic energy

1.4.69**telecommunications service earth**

connection to the general mass of earth provided by the *telecommunications carrier* ([1.4.64](#)) in a way that provides a functional requirement for the telecommunications equipment and cabling

Note 1 to entry: Conductors used in a telecommunications service earthing system do not normally carry battery return current.

1.4.70**valve-regulated cell**

cell that is closed under normal conditions but which allows the escape of gas if the internal pressure exceeds a predetermined value

Note 1 to entry: Electrolyte is not normally added to a valve-regulated cell.

1.4.71**vented (flooded) cell**

cell that is housed in a non-sealed container and which may require the addition of distilled water during its service life

1.5 Alterations, additions and repairs**1.5.1 General**

Alterations and repairs to an existing installation shall conform to the requirements of this document. [Table 1.1](#) provides a guide to alterations, additions and repairs.

1.5.2 Alterations

This requirement need not apply where the alteration uses methods and equipment that were acceptable when the facility was installed, provided that the safety and operation of the original installation is not affected. For example, where a power system has been designed to conform to the prevailing requirements, with specific provision for the addition of extra components.

1.5.3 Repairs

Repairs to existing electrical installations or parts thereof may be carried out using methods, fixtures and fittings that were acceptable when that part of the electrical installation was originally installed or with methods, fixtures and fittings currently available as direct replacement, provided that the methods satisfy the fundamental safety principles that are relevant to ES1, ES2 and ES3, see [Clause 2.2](#).

Table 1.1 — Guide to alterations, additions and repairs

Examples of type of work	Requirements	Rationale
New ELV power system installed.	ELV power system installation shall conform to the requirements of this document. ^a	Brand new system.
Existing ELV power system modified in a way that was outside the scope of the original design e.g. substituting from valve regulated lead-acid (VRLA) to lithium-ion batteries on a power system.	ELV power system installation shall conform to the requirements of this document. ^a	Modifying the original function, safety or performance of the system.

Table 1.1 *(continued)*

Examples of type of work	Requirements	Rationale
Repair a serviceable module e.g. rectifier module, controller module, battery bloc or string.	May choose to retain the original installation requirements.	Not modifying the original function, safety or performance of the system.
Expanding the ELV power system capacity e.g. adding more rectifier modules, battery strings.	May choose to retain the original installation requirements, so long as the power system was designed to be expanded without compromising the original function, safety or performance.	Power system was designed to be expanded. Not modifying the original function, safety or performance of the system.
Installing a new equipment suite.	Installations of new equipment suites shall conform to the requirements of this document.	Brand new suite.
Adding additional racks to an existing equipment suite.	May choose to retain the original installation requirements, so long as the equipment suite was designed to be expanded without compromising the original function, safety or performance.	Suite was designed to be expanded. Not modifying the original function, safety or performance of the system.
^a The downstream equipment suites should be examined to confirm their original function, safety or performance remains unchanged.		

The telecommunications installation should be examined as a whole, even if the work is limited to only one part of the installation. If a change to part of the existing installation causes the original function, safety or performance to no longer be maintained, then the existing installation shall be upgraded to the latest requirements of this document.

Section 2 General requirements

2.1 Demarcation points between standards

2.1.1 General

The requirements of this document apply to the ELV power systems and service earthing and bonding systems, regardless of the location of the ELV electrical and earthing components within the facility or enclosure. Enclosures that meet the requirements of AS/NZS 62368.1 shall also meet the installation requirements of this document for all relevant ELV power, earthing and bonding systems.

There are three installation deployment scenarios:

- (a) *Equipment rooms and custom-designed outdoor cabinets and enclosures.* This scenario covers exchanges and enclosures provided by the telecommunications carrier and includes a number of discrete components, assembled by the carrier, to provide a power and earthing solution.
- (b) *Outdoor cabinets and enclosures provided “as an appliance”.* The main switchboard is located externally to the enclosure and a.c. installation wiring is provided from the external main switchboard. This is functionally equivalent to powering an appliance. These enclosures shall conform to AS/NZS 62368.1, and are powered from an external main switchboard. AS/NZS 3000 requirements apply up to the input a.c. terminals of the appliance. All a.c. installation wiring after the a.c. terminal is regarded as equipment wiring and shall conform to AS/NZS 62368.1.
- (c) *Outdoor cabinets and enclosures provided “as an installation”.* These conform to AS/NZS 62368.1, and are powered from an internal main switchboard. The internal main switchboard shall conform to the installation requirements in AS/NZS 3000 and/or AS/NZS 3010. A.C. wiring from the output of the main switchboard is regarded as equipment wiring and shall conform to AS/NZS 62368.1.

NOTE For information on off-grid telecommunication exchanges and enclosures, powered by alternative energy sources, see [Appendix D](#).

2.1.2 Equipment rooms and custom-designed outdoor cabinets and enclosures

The equipment room and custom-designed (or bespoke) outdoor cabinets or enclosures shall be in accordance with the requirements of AS/NZS 3000, AS/NZS 3010 and this document throughout the entire facility, regardless of the location of the main switchboard.

A typical equipment room or custom-designed outdoor cabinet or enclosure incorporates individual components that conform to AS/NZS 62368.1, such as the rectifier chassis. A.C. installation wiring up to the terminals of such equipment shall conform to AS/NZS 3000. Cabling within components that conform to AS/NZS 62368.1 is regarded as internal cabling.

2.1.3 Outdoor cabinets and enclosures provided “as an appliance”

The site design shall be in accordance with the a.c. requirements of AS/NZS 3000 up to the a.c. terminals provided on the electrical equipment within the enclosure. This is known as installation wiring, refer to AS/NZS 3000. A.C. wiring and distribution within the electrical equipment or enclosure (in accordance with AS/NZS 62368.1) is deemed to be equipment wiring and shall be in accordance with AS/NZS 62368.1 requirements.

The ventilation requirements of batteries, clearances and cable colours for positive, negative and earth, shall conform to this document.

[Figure 2.1\(a\)](#) illustrates the demarcation of conformance with required standards.

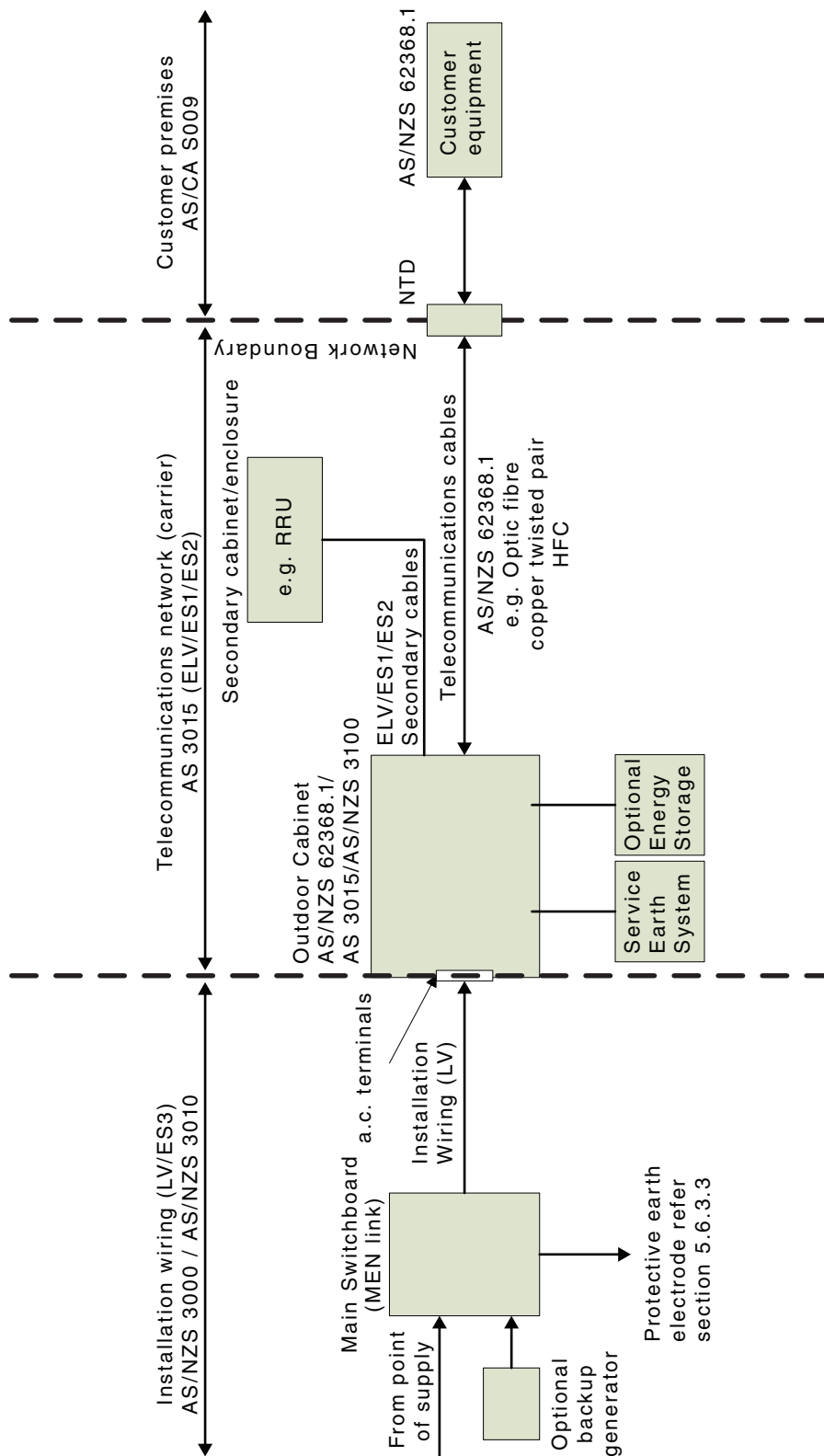


Figure 2.1(a) — Demarcation between standards — Enclosure "as an appliance"

NOTE 1 The a.c. wiring within the enclosure, downstream of the a.c. terminals and including any a.c. sub-main switchboards, is equipment wiring.

NOTE 2 The outdoor cabinet may house the following:

- (a) Power conversion equipment.
- (b) Telecommunications equipment.
- (c) Energy storage systems.
- (d) Service earth bar (SEB), single point connection (SPC) bars and the earth bonding terminal.
- (e) Surge protective devices for a.c. and telecommunications cables.
- (f) Telecommunications cable distribution systems.
- (g) A.C. sub-main switchboards and other a.c. loads (the multiple earthed neutral (MEN) link is not housed in the cabinet, it is located in the external main switchboard).

NOTE 3 The requirements of both this document and AS/NZS 62368.1 apply within the cabinet.

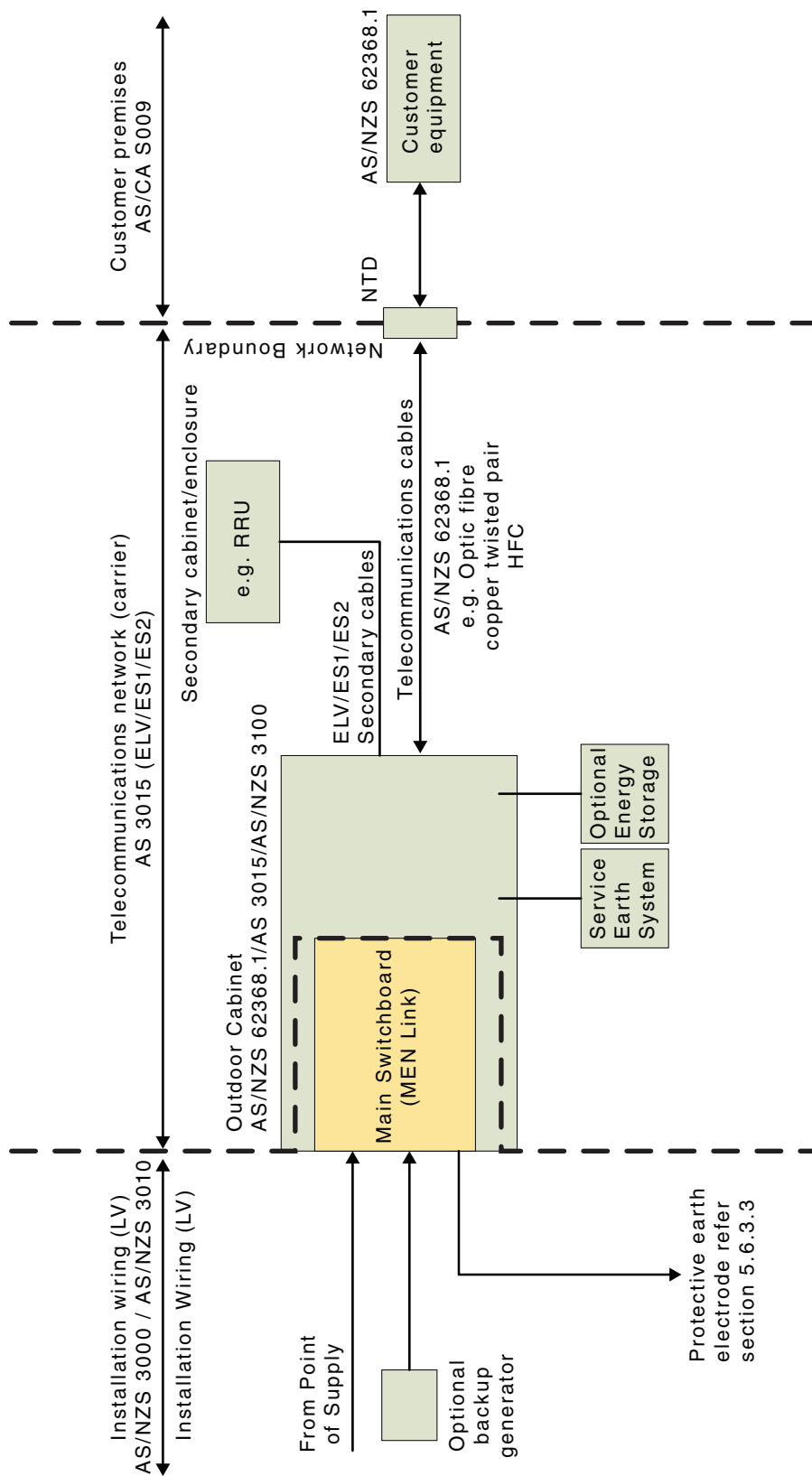


Figure 2.1(b) — Demarcation between standards — Enclosure “as an installation”

NOTE 1 The a.c. wiring of the main switchboard, up to the terminals of the power conversion equipment and other ancillary a.c. loads derived from the main switchboard, is as per AS/NZS 3000 and AS/NZS 3010 and is installation wiring, within the cabinet (see [Clause 2.1.3](#) for details).

NOTE 2 The outdoor cabinet may house the following:

- (a) Power conversion equipment.
- (b) Telecommunications equipment.
- (c) Energy storage systems.
- (d) SEB, SPC bars and the earth bonding terminal.
- (e) Surge protective devices for a.c. and telecommunications cables.
- (f) Telecommunications cable distribution systems.
- (g) A.C. main switchboard and other a.c. loads (the MEN link is housed in the cabinet, within the main switchboard).

NOTE 3 The requirements of both this document and AS/NZS 62368.1 both exist within the cabinet.

2.1.4 Outdoor cabinets and enclosures provided “as an installation”

Standalone outdoor cabinets and enclosures that contain the main switchboard shall be in accordance with installation requirements of AS/NZS 3000 and/or AS/NZS 3010 within the enclosure. Requirements apply up to and including the a.c. distribution switchboard(s), and up to the a.c. terminals of the power conversion equipment and other ancillary a.c. loads.

[Figure 2.1\(b\)](#) illustrates the demarcation of conformance with required Standards.

2.1.5 Cable sizing requirements

AS/NZS 3008.1.1 and AS/NZS 3008.1.2 shall apply for all a.c. and d.c. cables throughout the installation.

2.2 Voltage standards

2.2.1 General

The power system installations described in this document shall operate within the ELV voltage range as defined in this document.

The power equipment described in this document shall conform to the requirements of AS/NZS 62368.1, which details the energy source classifications and safeguards required.

The voltage range for network telecommunication equipment is defined in ETSI EN 300 132-2 and is in the range of -40.5 V to -60 V d.c. All d.c. powered network equipment shall be capable of operating over this voltage range.

Power systems and cable distribution systems supporting such equipment shall provide reliable backup power over this voltage range at the terminals of the equipment.

Electrical energy source classifications in AS/NZS 62368.1 define the limits for ES1, ES2 and ES3 electrical energy sources. The response to the energy class is defined in [Table 2.1](#).

Table 2.1 — Energy class response

Energy source	Effect on the body	Effect on combustible materials
Class 1 (ES1)	Not painful, but may be detectable	Ignition not likely
Class 2 (ES2)	Painful, but not injurious	Ignition possible, but limited growth and spread of fire
Class 3 (ES3)	Injury	Ignition likely, rapid growth and spread of fire

NOTE Refer to AS/NZS 62368.1 for the energy source classification.

For d.c. only energy sources, the energy source classifications align with present ELV and LV definitions as shown in [Table 2.2](#).

Table 2.2 — DC only energy source classifications

Energy source classification	Energy source voltage range	Equivalent voltage classification
ES1	0 to 60 V d.c. nominal	ELV
ES2	60 to 120 V d.c. nominal	ELV
ES3	> 120 V d.c. nominal	LV

NOTE Refer to AS/NZS 62368.1 for the energy source classification.

For a.c. only energy sources, the energy source classifications align with AS/NZS 62368.1 as shown in [Table 2.3](#).

Table 2.3 — A.C. only energy source classifications

Energy source classification	Energy source voltage range	Equivalent voltage classification
ES1	0 to 30 V a.c. rms	ELV
ES2	30 to 50 V a.c. rms	ELV
ES3	> 50 V a.c. rms	LV

NOTE Refer to AS/NZS 62368.1 for the energy source classification.

2.2.2 Extra-low voltage work

All extra-low voltage (ELV) wiring should be performed by a competent person who is trained for ES1 and ES2 work. For hybrid fibre-coaxial network (HFC) applications, quasi square wave systems that operate up to 65 V a.c. rms are deemed to be ES2 systems and do not require licensing or registration.

2.2.3 Low voltage work

All low voltage (LV) work on low voltage installation wiring greater than 120 V d.c. or greater than 50 V a.c. shall be performed by a competent person who is trained for ES3 systems.

Where the electrical energy source is an analogue telephone network ringing signal as defined in AS/NZS 62368.1, the energy source class is considered ES2, and does not require licensing or registration but should be performed by a competent person.

2.2.4 Co-location of ELV and LV power in equipment room

2.2.4.1 General

2.2.4.1.1 Considerations

Co-location of LV power with ELV power within a rack or suite of racks is highly undesirable due to safety concerns and should be avoided where possible. Where LV and ELV power are co-located within a rack or suite of racks, additional requirements apply, and a competent person trained in ES3 systems may be required (see [Table 2.3](#)).

Examples of situations where co-location of ELV and LV power may be unavoidable include —

- (a) powering exhaust fans;
- (b) small sites with limited rack space;
- (c) powering mission critical equipment which is only available with LV supply; or
- (d) critical cooling systems which are only available with LV power.

Co-location of ELV and LV may pose the following risks —

- (i) inadvertent contact with energized parts of the LV system;
- (ii) existence of two different earthing systems (LV and ELV), which may pose hazards if not bonded as per this document;
- (iii) injection of high d.c. fault currents from the ELV battery system into the LV protective earth system, which is generally not designed to carry this large current.

2.2.4.1.2 Requirements

ELV and LV equipment within a telecommunication facility shall be segregated and isolated from each other. Equipment racks or suites of racks shall be installed as either dedicated ELV, or dedicated LV.

NOTE 1 As a guide it is desirable to keep the distance between ELV and LV suites at a minimum of 1 m from each other in an equipment room.

NOTE 2 Isolation is achieved by separation of the LV earthing and bonding system and the ELV bonding system except via the earth bonding terminal (EBT).

Exception 1: The power conversion equipment may have a.c. and d.c. installation wiring.

Exception 2: Both ELV and LV equipment racks or suites of racks may exist together within a single room, provided there is segregation and isolation of both the equipment suites and their respective dedicated earthing systems. Where it is not feasible to install dedicated suites of equipment, an LV inverter may be provided within an ELV rack, or on a wall of the equipment room for powering a.c. exhaust fans, small a.c. telecommunications equipment, security equipment or other a.c. powered load.

In the above exceptions, d.c. power may be provided within an a.c. powered rack, by including a rectifier within the rack, without batteries.

The a.c. installation wiring and earthing of the rectifier chassis shall conform to AS/NZS 3000. The d.c. cabling and earthing from the rectifier shall conform to the requirements of this document. In this case, the d.c. powered equipment and the d.c. return of the d.c. power system may be earthed to the a.c. protective earth system if there is no service earth system available.

NOTE 3 Typically, backup power to the a.c. rack is provided by an upstream UPS system.

2.2.4.2 Low voltage inverters in telecommunications facilities

2.2.4.2.1 Considerations

Low voltage inverters in telecommunications facilities are powered by the ELV power system, with an output voltage that is within the LV limits prescribed in AS/NZS 3000.

Inverters may have an a.c. bypass from the main switchboard supply (for maintenance or redundancy).

The main risks with locating LV inverters in telecommunications facilities are —

- (a) hazardous voltage exposure via LV a.c. faults circulating through the d.c. service earth system, or ineffective touch safeguards to prevent inadvertent contact with live power conversion equipment (PCE) terminals; and
- (b) high current ELV faults circulating through the a.c. protective earth system (via the a.c. bypass, if installed).

2.2.4.2.2 Requirements

The installation of LV inverters shall conform to all of the following:

- (a) LV inverters shall conform to the requirements of AS/NZS 3000.
- (b) The LV inverter and associated loads shall be installed by an ES3-competent person if —
 - (i) there is exposure to LV hazards when installing ELV cabling;
 - (ii) the LV inverter and associated loads are not designed as an appliance, refer to AS/NZS 62368.1; and
 - (iii) there is LV wiring that is hard-wired to the LV inverter or associated loads.
- (c) LV inverters shall include touch-guards regarding live LV terminals and conductors, to mitigate the risk of contact with energized parts to non-ES3 competent persons once the inverter is installed in a telecommunications facility.
- (d) The following conductive material shall be electrically isolated with a minimum rating of 1 kV a.c. from all surrounding building fabric, service earth-based equipment and conductors —
 - (i) the LV inverter (and rack in which it is mounted, if applicable);
 - (ii) associated LV output conductors and switchgear;
 - (iii) associated LV cable support structures; and
 - (iv) associated LV powered equipment (and rack in which it is mounted, if applicable).

NOTE 1 Surrounding building fabric, service earth-based equipment and conductors may include walls, floor, building steel, adjacent equipment racks, and overhead cable trays.

The items below shall be earthed to the LV inverter's protective earth in accordance with AS/NZS 3000:

- (A) Low voltage conductors from the LV inverter shall conform to the requirements of [Clause 4.16.3](#) and AS/NZS 3000.
- (B) The LV inverter's output shall provide protective earth connections or terminals in accordance with AS/NZS 3000 and AS/NZS 62368.1.
- (C) The LV inverter's chassis and d.c. return terminals shall be bonded to the service earth system. The earth bonding wire shall conform to all of the following:
 - (i) The route length shall be as short as possible.

- (ii) The size of the earth bonding wire shall be sized to carry the maximum prospective d.c. fault current, or a minimum cross-sectional area of 35 mm², whichever is greater.
- (iii) There shall be a dedicated earth bonding wire between the LV inverter positive input and service earth bar (SEB) or single point connection (SPC).
- (iv) The earth bonding wire shall be clearly and indelibly labelled to identify its function as a dedicated LV inverter.

NOTE 2 The ELV d.c. side of the LV inverter installation is considered isolated d.c. return (DC-I), see [Clause 5.12.2.2](#).

- (D) LV inverters and their enclosures/racks shall be clearly labelled with hazardous voltage labels in accordance with AS/NZS 62368.1.
- (E) Where there are conductive communications cables between LV-powered equipment (both the LV inverter and connected load) and ELV-powered equipment, the communications ports and communications cabling between devices shall be isolated.

NOTE 3 IEEE 802.3 conforming ethernet ports and CAT5/6 cable or fibre optic cabling should meet this requirement.

NOTE 4 Ethernet cables are considered isolated. RS232, RS485 and RS422 use earth reference and should be avoided as they may carry currents.

[Figure 2.2](#) illustrates an example of co-location of LV and ELV equipment.

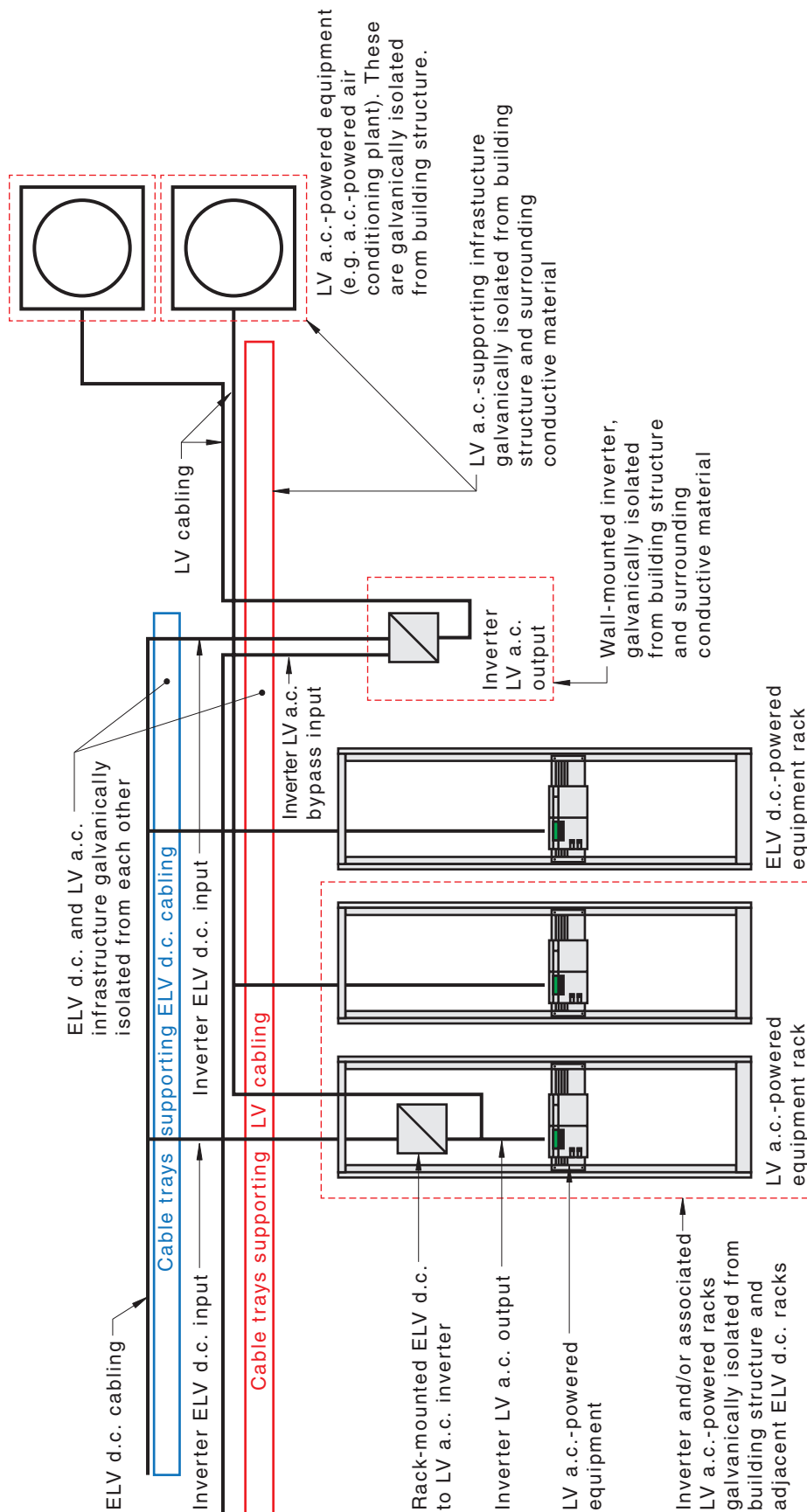


Figure 2.2 — Example of co-location of LV and ELV equipment

2.2.4.3 Inverters without an LV a.c. bypass feed from the a.c. switchboard

An inverter system without an LV a.c. bypass feed from the a.c. switchboard shall have —

- (a) a neutral reference created; and
- (b) an output main switchboard constructed in accordance with AS/NZS 3000, including a local neutral bar, local protective earth bar, and local multiple earthed neutral (MEN) connection.

NOTE No earth electrode is required, as the electricity PCE's protective earth bar is referenced to the service earth via the inverter's chassis, which is then referenced back to the site's a.c. protective earth via the bond terminal earthing system.

Conductor sizing shall be based on the maximum output current of the inverter system.

See [Figure 2.3](#) for an illustrated example of an LV inverter in an ELV equipment rack without LV bypass.

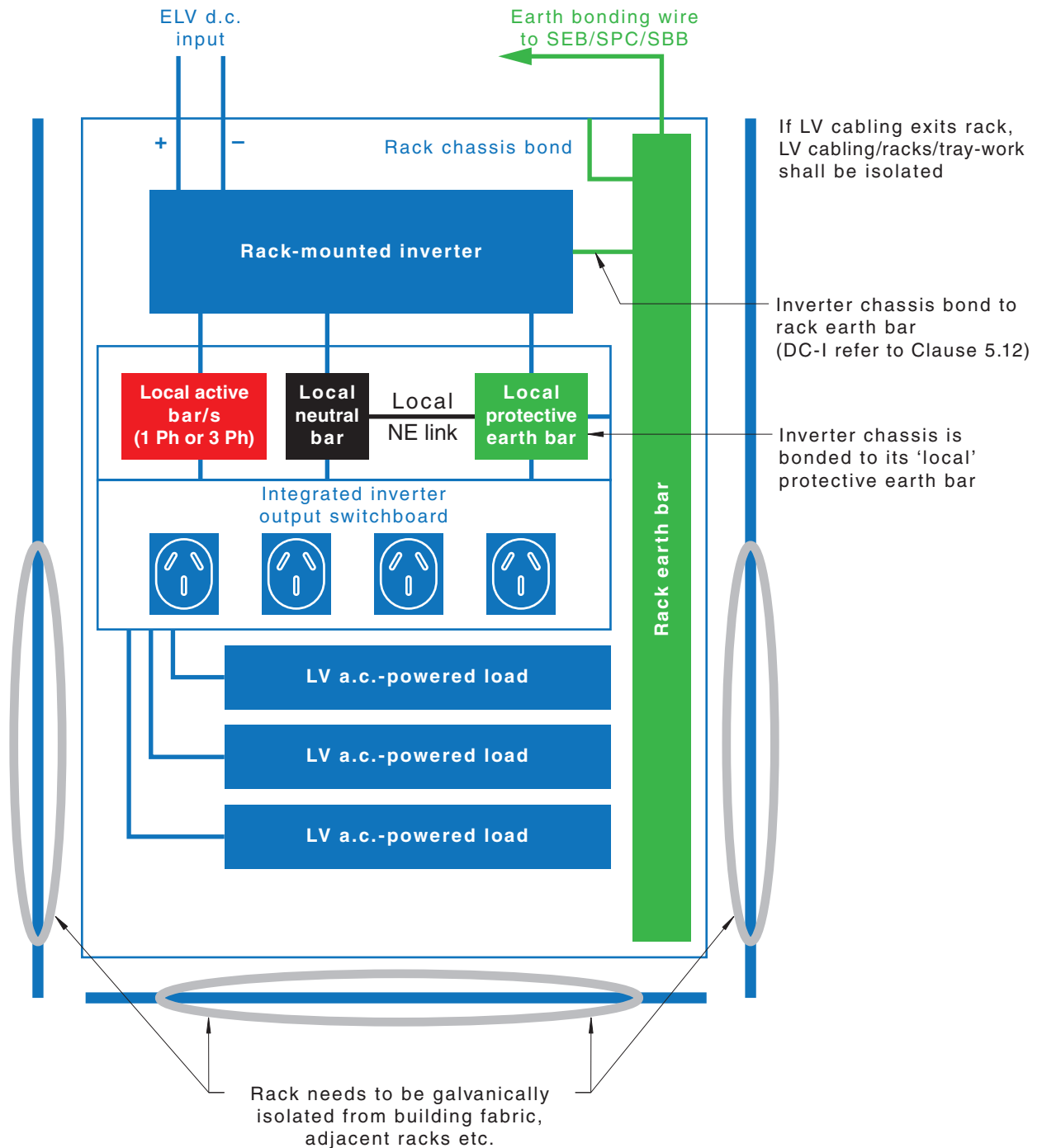


Figure 2.3 — Example of LV inverter in an ELV equipment rack without LV bypass

2.2.4.4 Inverters with an LV a.c. bypass feed from an a.c. switchboard

The NE link cross-sectional area (located in the a.c. main switchboard) shall be sized to support the maximum prospective fault current of the system, including fault current from d.c. batteries.

NOTE 1 The total loop impedance between the NE and the inverter rack may be sufficient to prevent the need to upgrade the NE link in the a.c. main switchboard.

There shall be no link between neutral and protective earth bars inside the inverter output main switchboard. Instead, the inverter system shall obtain the neutral and protective earth reference from the a.c. bypass feed.

NOTE 2 This would create an earth loop between the inverter and the main switchboard NE.

See [Figure 2.4](#) for an illustrated example of an LV inverter in an ELV equipment rack with LV bypass.

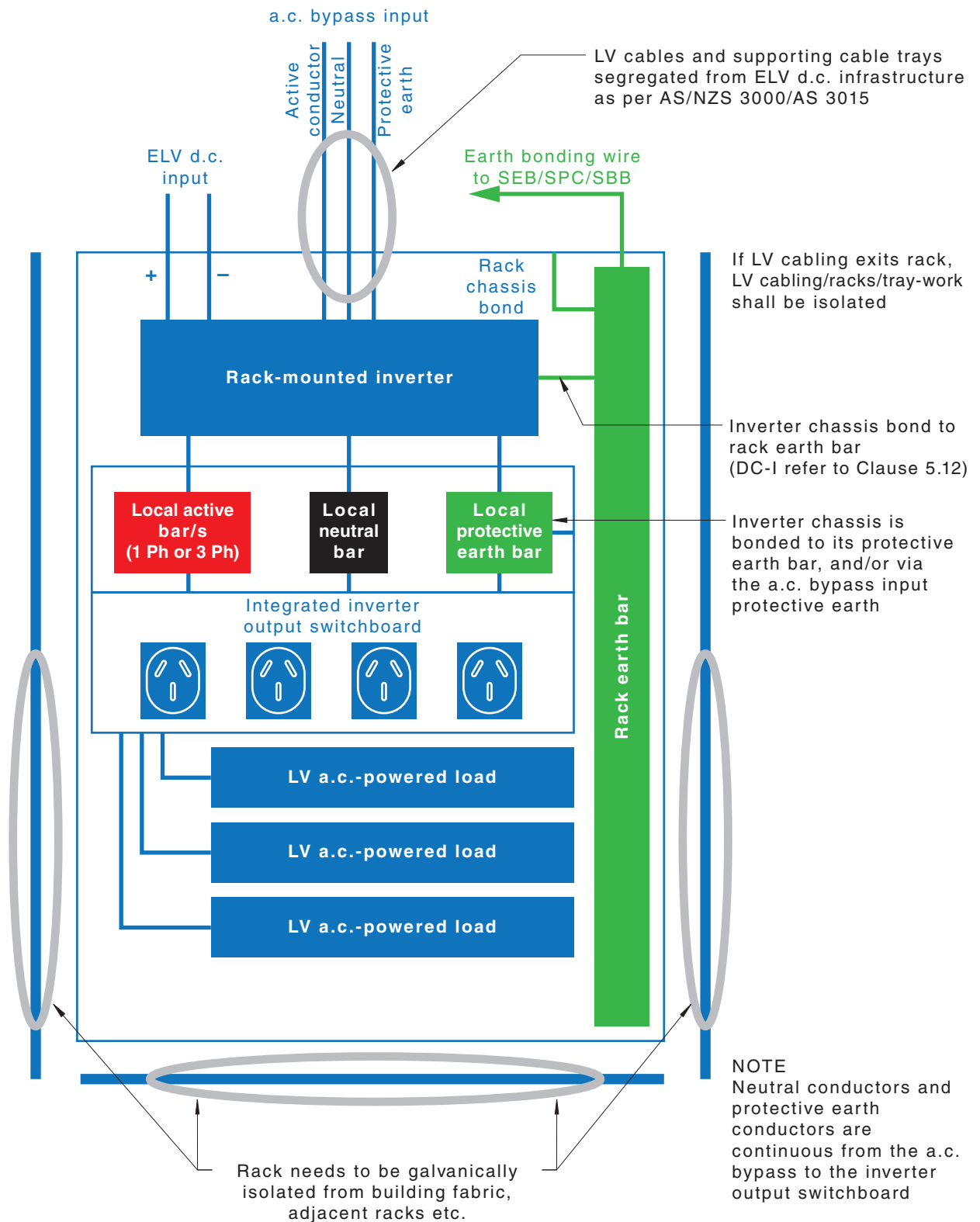


Figure 2.4 — Example of LV inverter in an ELV equipment rack with LV bypass

2.2.5 Emergency powering of street enclosures

Where there are prolonged utility mains failures, street enclosures providing ICT functionality to more than 40 premises should be provisioned with a means for connection to a backup energy source.

For street enclosures that consume less than 15 A single phase, the method of connection within the street enclosure to the emergency power source shall be either —

- (a) a dedicated d.c. plug fitted to the enclosure for direct current backup power from an ES1 or ES2 external emergency d.c. power source; or

NOTE 1 A generator with an integral d.c. rectifier system conforms, provided there is isolation between a.c. and d.c. of greater than 1.5 kV.

- (b) a dedicated, redundant rectifier unit (battery charger) provisioned within the enclosure and connected to the same d.c. bus as the rectifier system powering the critical loads, and a dedicated a.c. plug for connection to an external a.c. power source such as a backup generator.

Both methods effectively parallel the d.c. outputs of the main and backup rectifier units on the d.c. bus within the street enclosure. This method does not require an a.c. mains changeover switch and mitigates the issues surrounding residual current devices (RCD) tripping within backup generators.

NOTE 2 A basic control system should be incorporated into the system design to sense the battery state of charge and control the external emergency energy source accordingly.

For outdoor cabinets or enclosures that consume more than 15 A single phase, either a d.c. backup method as described in (a) or (b), or an a.c. mains changeover switch conforming to AS/NZS 3000 and AS/NZS 3010 shall be used, in conjunction with an a.c. generator.

Benefits of d.c. backup energy sources include:

- (i) Improved safety for operational staff, as backup power is provided from an ES1/ES2 energy source.
- (ii) No backfeeding of power into utility.
- (iii) No tripping of RCDs in the generator, which may require temporary removal of NE link to power the site.
- (iv) Either isolated winding or non-isolated winding generators may be used.
- (v) A d.c. to d.c. PCE powered directly from a support vehicle or other compatible emergency d.c. energy source may be used in lieu of a generator.
- (vi) AS/NZS 3000, AS/NZS 3010 and various service installation rules (that vary from state to state) do not apply.
- (vii) No manual a.c. change over switch is needed.
- (viii) Fast charging the batteries is possible, if the d.c. cables and connectors of the system are designed to support high d.c. recharge currents and batteries that are capable of being fast charged are utilized in the system.