AS/NZS 3010:2017

Australian/New Zealand Standard™

Electrical installations—Generating sets

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Australian Building Codes Board
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Consumers Federation of Australia
Electrical Contractors Association of New Zealand
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Electrical Safety Organisation, New Zealand
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Energy Networks Association
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Australian/New Zealand Standard™

Electrical installations—Generating sets

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PREFACE

This Standard was prepared by the joint Standards Australia/Standards New Zealand Committee EL-001, Wiring Rules, to supersede AS/NZS 3010:2005 and AS 2790—1989.

The objective of this Standard is to set out the minimum safety requirements related to the use of generating sets for the supply of electricity at voltages normally exceeding 50 V a.c. or 120 V d.c.

This Standard differs from AS/NZS 3010:2005 as follows:

(a) Inclusion of several new figures showing a variety of generator connection methods which are acceptable and conform with the requirements of this Standard.

(b) The modification of existing figures to show clearly the intent of the associated clauses, especially in relation to main switches.

(c) The inclusion of some updated provisions of AS 2790 as a normative Appendix of this document (see Appendix D).

(d) Inclusion of an exception in relation to the mechanical interlock requirements of the changeover device.

(e) Inclusion of additional definitions, e.g. safety services and essential services.

(f) General reinforcement of the MEN connection requirements.

(g) Clarification of when switching of the neutral conductor is or is not permitted.

(h) Clauses added in relation to carrying out additions, alterations and repairs in line with AS/NZS 3000.

(i) Clauses added to clarify the use of three and four pole changeover devices.

(j) Requirements of AS/NZS 3000 where not amended or changed by this Standard included within the Figures, e.g. mechanical maintenance isolating devices.

Any requirements that may be applicable in Australia only or New Zealand only are indicated in the text and by a symbol in the right margin as follows:

‘In Australia……’ **A**

‘In New Zealand……’ **NZ**

Statements expressed in mandatory terms in notes to Figures and Tables are deemed to be requirements of this Standard.

The terms ‘normative’ and ‘informative’ have been used in this Standard 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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S E C T I O N 1 S C O P E A N D G E N E R A L

1.1 SCOPE

This Standard sets out the minimum safety requirements related to the use of generating sets for the supply of electricity at low voltage, that is, not exceeding 1000 V a.c or 1500 V d.c.

The Standard applies to electricity generating sets that are driven by internal combustion engines, and forms any of the following:

(a) Normal supply source for electrical installations.

(b) Alternative supply source for electrical installations.

(c) Electrical supply source for the connection of electrical appliances and portable tools.

(d) Supply sources that operate in parallel with the normal supply in the electrical installation.

This Standard does not—

(i) apply to uninterruptible power supplies; or

(ii) apply to other renewable energy generation systems, such as, the following:

(A) Inverters.

(B) Photovoltaic arrays.

(C) Water or wind driven turbines.

NOTE: While intended to be applied to low voltage generating sets driven by internal combustion engines, the electrical principles could be applied to other types of energy sources.

1.2 APPLICATION

In addition to being in accordance with the requirements of AS/NZS 3000 and the additional requirements of this Standard, the generating set installation may be required to comply with requirements of electricity distributors and other relevant regulatory authorities. It is, therefore, recommended that these authorities be consulted prior to the installation of equipment.

Section 2 outlines general requirements for the installation of generating sets to an electrical installation. Sections 3 and 4 introduce additional requirements for permanently connected and plug and socket outlet connected generating sets respectively.

Appendix A specifies the fault current path when the generating set is fixed wired to an electrical installation.

Appendix B specifies a New-Zealand-only guidance for the connection of portable generating sets when directly supplying portable tools connected to the generating set by plugs and sockets. NZ

Appendix C specifies a New Zealand-only provision for the connection of a dedicated wiring system within an electrical installation. NZ

Appendix D sets out the requirements and recommendations for the performance and construction of transportable generating sets up to 25 kW.

Requirements for the design, installation and operation of emergency power supplies in hospitals are given in AS/NZS 3009.

Requirements for the design, installation and operation of uninterruptible power supplies are given in AS 62040 (series).

Requirements for renewable energy systems are given in AS/NZS 4777 (series), AS/NZS 4509 (series) and AS/NZS 5033.

Requirements for transportable structures are provided in AS/NZS 3001.

Requirements for shows and carnivals are provided in AS/NZS 3002.

Requirements for marinas and boats are provided in AS/NZS 3004.

Requirements for construction and demolition sites are provided in AS/NZS 3012.

Attention is drawn to the fact that some regulatory authorities have requirements for limitation of noise levels, pollution emissions and for fuel systems.

1.3 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

AS

1019 Internal combustion engines—Spark emission control devices

1319 Safety signs for the occupational environment

1668 The use of ventilation and airconditioning in buildings

1668.2 Part 2: Mechanical ventilation in buildings

1940 The storage and handling of flammable and combustible liquids

2221 Methods for measurement of airborne sound emitted by compressor units including primemovers and by pneumatic tools and machines

2221.1 Part 1: Engineering method for measurement of airborne sound emitted by compressor/primemover units intended for outdoor use

2676 Guide to the installation, maintenance, testing and replacement of secondary batteries in buildings (series)

3011 Electrical installations—Secondary batteries installed in buildings (series)

4594 Internal combustion engines—Performance

4594.1 Part 1: Standard reference conditions, declarations of power, fuel and lubricating oil consumptions, and test methods

4594.4 Part 4: Engines for land, rail-traction and marine use—Speed governing

4594.5 Part 5: Engines for land, rail-traction and marine use—Torsional vibrations

60034 Rotating electrical machines

60034.1 Part 1: Rating and performance (IEC 60034-1, Ed. 11(2004) MOD)

60529 Degrees of protection provided by enclosures (IP Code)

62040 Uninterruptible power systems (UPS) (series)

AS/NZS

1768 Lightning protection

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

AS/NZS	
3007	Electrical installation—Surface mines and associated processing plant—General requirements for equipment and ancillaries (series)
3009	Electrical installations—Emergency power supplies in hospitals
3012	Electrical installations—Construction and demolition sites
3100	Approval and test specification—General requirements for electrical equipment
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4024	Safety of machinery
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4509	Stand-alone power systems (series)
4777	Grid connection of energy systems via inverters (series)
5033	Installation and safety requirements for photovoltaic (PV) arrays
60079	Explosive atmospheres (series)
60269	Low-voltage fuses (series)
60947	Low-voltage switchgear and controlgear (series)
60898	Electrical accessories—Circuit-breakers for overcurrent protection for household and similar installations
60898.1	Part 1: Circuit-breakers for a.c. operation (IEC 60898-1, Ed. 1.2 (2003) MOD)
61008	Residual current operated circuit-breakers without integral overcurrent protection for household and similar uses (RCCBs)
61008.1	Part 1: General rules (IEC 61008-1, Ed. 3.2 (2013) MOD)
61009	Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBOs)
61009.1	Part 1: General rules (IEC 61009-1, Ed. 3.2 (2013) MOD)
61439	Low voltage switchgear and controlgear assemblies (series)

AS/NZS CISPR

12 Vehicles, boats and internal combustion engines—Radio disturbance characteristics—Limits and methods of measurement for the protection of off-board receivers

14 Electromagnetic compatibility—Requirements for household appliances, electric tools and similar apparatus

14.1 Part 1: Emission

IEC

60309 Plugs, socket-outlets and couplers for industrial purposes (series)

60364 Low-voltage electrical installations (series)

61557 Electrical safety in low voltage distribution systems up to 1 000 V a.c. and 1 500 V d.c.—Equipment for testing, measuring or monitoring of protective measures

61557-8 Part 8: Insulation monitoring devices for IT systems

ISO

8528 Reciprocating internal combustion engine driven alternating current generating sets

8528-1 Part 1: Application, ratings and performance

8528-8 Part 8: Requirements and tests for low-power generating sets

1.4 DEFINITIONS

For the purposes of this Standard, the definitions given in AS/NZS 3000 and those below apply.

1.4.1 Alternative supply (standby)

A supply system intended to maintain the functioning of an electrical installation or a part or parts thereof, in case of interruption of the normal supply.

1.4.2 Changeover devices

Consist of switchgear that provide load switching between the normal supply and the output of a generating set connected to an electrical installation.

The switchgear is interlocked to prevent the simultaneous connection of the normal supply and the generating set output.

Typical switchgear arrangement may be a—

(a) one manual switch with multiple contacts, or, two or more manual switches ganged together on a common operating shaft;

(b) mechanically interlocked pair of contactors; or

(c) mechanically interlocked pair of circuit-breakers (with or without overcurrent protection).

The operation of the changeover device may be manually or electrically operated.

1.4.3 Closed transition changeover device

A device that permits the transfer of the generating set output to the normal supply without interruption of the supply to the load when transferring the load from the generator supply to the normal supply.

The closed transition changeover device operates in a ‘make before break’ mode when the normal supply and the generating set output are synchronized and then operates in parallel only for a very short duration.

The duration of the parallel connection is dependent on the connected load, the type of loading and the ability of the normal supply to deliver a high step increase in loading.

NOTE: The installation and use of a closed transition changeover device system in an electrical installation is subject to a formal agreement with the electricity distributor.

1.4.4 Detachable connection

A means of connecting a generating set to an electrical installation by an assembly consisting of a plug, flexible cable (or cord) and cord connector.

1.4.5 Essential services (client)

The portion(s) of an electrical installation associated with life preserving equipment, airport safety equipment, airport traffic control and other electrical equipment the owner/occupier believes to be essential to the safe operation of the premises.

1.4.6 Generating set

An alternator, d.c. generator or combination thereof, including an internal combustion engine and associated switchgear and control equipment.

1.4.7 TN-S earthing system

A system with separate protective earth and neutral conductors from the transformer or generator to the consuming device, which are not connected together at any point after the neutral and earth connection at the transformer or generator.

1.4.8 Normal supply

The source of supply that the electrical installation is supplied from under normal conditions of operation (mains supply) and excludes any alternative supply(s).

1.4.9 Residual current circuit-breaker with overload (RCBO)

A combination of both a residual current circuit-breaker and overload protection provided by the one device.

1.4.10 Reduced low voltage (RLV)

NZ

A supply voltage giving additional protection against electric shock such as the following:

(a) A single-phase system in which—

  (i) the nominal line-to-line voltage does not exceed 110 V a.c.;

  (ii) the nominal line-to-earth voltage does not exceed 55 V a.c.; and

  (iii) all exposed conductive parts are connected to the protective conductor.

  or

(b) A three-phase system in which—

  (i) the nominal line-to-line voltage does not exceed 110 V a.c.;

  (ii) the nominal line-to-earth voltage does not exceed 63.5 V a.c.; and

  (iii) all exposed conductive parts are connected to the protective conductor.

1.4.11 Safety services

A system or component that operates to identify an emergency, or is intended to operate during an emergency, and is primarily associated with—

(a) the safety of person evacuating a building;

(b) fire-fighting operations; or

(c) fire suppression systems.

1.4.12 Shall

Indicates a statement is mandatory.

1.4.13 Should

Indicates a recommendation.

1.4.14 Normative

A term used to describe an element of a Standard to which it is necessary to conform in order to be able to claim conformance with the Standard.

NOTE: Normative elements may include the following:

(a) Notes to Figures and Tables.

(b) Text.

(c) Appendices.

1.4.15 Informative

For information and guidance only.

NOTE: Informative elements may include the following:

(a) Notes to clauses.

(b) Appendices.

1.5 SYMBOLS

All symbols contained in Figures 2.1 to D1 are defined in Table 2.1.

SECTION 2 GENERAL REQUIREMENTS FOR THE INSTALLATION OF GENERATING SETS

2.1 GENERAL

2.1.1 Scope of Section

This Section specifies general requirements for the following:

(a) Location.

(b) Mechanical and thermal protection.

(c) Control.

(d) Earthing arrangements.

(e) Electrical installations and connection of generating sets.

Additional requirements, relevant to permanently connected generating sets and the use of a detachable connection for portable generating sets, are given in Sections 3 and 4 respectively.

2.1.2 Rating classifications

Generating sets are assigned output power rating classifications based on the following descriptions of the intended application:

(a) *Standby* Maximum output rating is available from the generating set operating at a variable load for the duration of the normal mains power interruption. There is no sustained overload capability.

(b) *Prime* Maximum output rating is available from the generating set operating at a variable load for an unlimited time. There is 10% overload capability for short periods and infrequent operations.

(c) *Continuous* Maximum output rating is available from the generating set operating at constant load for an unlimited time. There is no sustained overload capability.

NOTE: Definitions for these ratings are based on Standards such as AS 4594.1 and ISO 8528-1 but may be further qualified in manufacturer's recommendations.

2.1.3 Selection of generating set rating

The selection of the generating set rating is dependent on characteristics of the connected load, the alternator type and alternator voltage control system.

Electrical issues that determine the selection of generating set minimum output rating and alternator type are as follows:

(a) Issues regarding induction motor loading include:

  (i) *Load inertia* A high inertia load requires higher starting current and duration.

  (ii) *Type of motor starter used for each motor* Due to the limited maximum starting current available from a generating set at start up or when running on load, this may require use of a reduced current starter.

  (iii) *The number of motor(s) starting simultaneously* If a large motor and a number of smaller motors, starting the large motor first and then arranging to start the smaller motors after the large motor is up to full speed adds inertia to the whole system, reduces the peak kilovolt-ampere required.

(iv) *Maximum voltage dip on the generating set output when motors are starting* If the voltage dip is excessive and of long duration, this may affect the motor starting time and the starting current drawn. In some cases, an excessive voltage dip may release the motor starter contactor(s) and stop or prevent starting of the motors.

(b) Non-linear loading, for example uninterruptable power supplies (UPSs), variable speed drives and rectifiers with a battery connected. The ability of a generator to supply a non-linear load is dependent on the type of equipment being supplied and the generating set alternator voltage control system.

(c) Load power factor. To ensure stable output voltage control of the generating set, the power factor of the operating load should not have a leading value when operating from generating set output.

NOTE: It may be necessary to remove from service any power factor correction systems when the electrical installation is being supplied by a generating set output, this action being to prevent the electrical installation power factor having a leading value.

(d) Absorbing regenerative loading. Generating sets have no ability to absorb any regenerated energy that may be produced by a load. Accordingly, where a regenerating load is supplied by a generating set, it is important to ensure that the regenerative energy is able to be absorbed by other loads supplied by the installation.

The recommendation of the generating set manufacturer or supplier should be sought when selecting the generating rating. If available, use of a generating set software design package available from generating set manufacturers is an alternative.

2.1.4 Generating set system of supply

Where an electrical installation is arranged to operate from multiple sources of supply (such as occurs when normally supplied by an electricity distributor's network, or alternatively from a generating set output) the system of supply configuration connected to the installation loading shall be the same system of supply, e.g. MEN, irrespective of the supply source.

2.2 LOCATION

Generating sets shall not be operated in locations where exhaust gases, smoke or fumes could reach dangerous concentrations or enter either directly or indirectly any enclosed areas occupied by persons.

In tunnelling operations, reduced low voltage diesel engine generating sets fitted with an exhaust conditioning system or appropriate ventilation systems, may be used. NZ

In addition, generating sets shall not be installed—

(a) in damp situations or exposed to the weather unless suitably protected;

(b) in hazardous areas, unless the equipment and method of installation is in accordance with AS/NZS 3000 and AS/NZS 60079 (series) and the requirements of any relevant regulatory authority; or

(c) in locations that would provide a fire hazard for the fuel tank(s) and associated fittings provided for the generator set.

2.3 MECHANICAL AND THERMAL PROTECTION

2.3.1 Protection from mechanical damage

All components of a generating set, including mechanical parts, fuel systems, wiring, switches, instruments and controls, shall have adequate protection against mechanical damage.

2.3.2 Protection from moving parts

All moving parts of a generating set that may cause injury to persons shall be either positioned or protected by barriers or guards to prevent accidental personal contact when running.

NOTES:

1 Regulatory authorities may have additional requirements for the guarding of machinery.

2 Guidance on the protection of moving parts by guarding is provided in AS/NZS 4024.1601.

2.3.3 Protection against thermal effects

All parts of a generating set that operate at temperatures in excess of 120°C shall be protected by barriers, guards or positioned to prevent accidental personal contact when running.

NOTE: Guidance on temperature limits for electrical equipment is given in AS/NZS 3000.

2.3.4 Protection against fuel leakage

Any tanks or filling facilities associated with flammable fuels shall not be—

(a) installed in the vicinity of high temperature surfaces or equipment that may emit arcs, sparks or hot particles; or

(b) located in such a position that spilled or leaking fuel could fall on such high temperature surfaces or equipment.

NOTES:

1 Attention is drawn to additional requirements that may be specified by relevant Regulatory Authorities. These may include the specific location of the fuel tank(s), the standard used for the construction of the fuel tank, the need for secondary containment of the fuel tank and associated pipework. Certification of the completed fuel system installation may also be required.

2 In Australia, refer to AS 1940 for additional requirements affecting the storage and handling of flammable and combustible fuels. A

3 In New Zealand, the WorkSafe New Zealand (http://www.worksafe.govt.nz) has additional requirements controlling the storage and handling of flammable and combustible fuels associated with generating sets. NZ

2.4 CONTROL OF GENERATING SET

2.4.1 General

Adequate means shall be provided to control—

(a) the sequence of operations necessary for the safe starting, running and shutting down of the generating set;

(b) the voltage and frequency of the generating set output supply;

(c) the speed of the prime mover; and

(d) the load changeover device, if it is required to be automatically operated by contactor coils, motor(s) or solenoids.

2.4.2 Prime mover isolating devices

Every prime mover shall be provided with an isolating device, which may be an engine shutdown device, to prevent the starting of the generating set engine when inspection, repair or maintenance is being carried out.

NOTE: An emergency shutdown device may also be necessary under certain conditions. Examples include two stroke diesel engines.

2.4.2.1 *Operation*

The isolating device when in the ‘off’ or ‘isolated’ position shall prevent the generating set engine being started by any automatic control device or remote control switch.

Where a switch located in a control or starting circuit is used for this purpose, it shall disconnect all live conductors of the circuit.

Electronic equipment or devices shall not be used as an isolation device.

2.4.2.2 *Location*

The isolating device shall be readily accessible to maintenance or other authorized personnel and be—

(a) installed adjacent to or on the generating set so that a person operating the device has a clear view of any person working on the machine; and

(b) provided with a means of securing the device in the isolated or open position that requires a deliberate action to engage or disengage it.

2.4.3 Synchronization

Where generating sets are to be synchronized with an electricity distributor’s network, the requirements for synchronization shall be obtained from the electricity distributor.

Automatic controls shall be provided to ensure that the output voltage and frequency of a generating set is synchronized with—

(a) the normal supply when connected during transfer or for extended parallel operation; or

(b) the output of other generating sets when connected to a multiple generating set installation.

Synchronization check controls shall be installed for each connection or changeover device where parallel operation is to occur, to prevent the closure of the changeover device across unsynchronized sources of supply.

NOTES:

1 For most installations, a formal agreement with the electricity distributor is required to permit operation of a generating set output in parallel with an electricity distributor’s network.

2 For interlocking, see Clause 2.7.3.

2.4.4 Starting batteries and battery charging

Batteries associated with prime movers shall be suitable for continuous float charging and the generating set starter motor current required.

The charging of batteries is to be achieved by one or both of the following:

(a) The generating set starter battery generator when it is running.

(b) A battery charger operating from a power supply when the generating set is running or when it is stationary.

NOTES:

1 Suitable batteries include the flooded lead-acid and valve regulated lead-acid sealed types that are suitable for constant float charging and are able to supply the engine starter motor current required.

2 Attention is drawn to the additional requirements for batteries for emergency supply systems in other Australian/New Zealand Standards.

3 Attention is drawn to the provisions of the AS 2676 (series) and AS 3011 (series) for the installation and maintenance of batteries.

2.5 EARTHING ARRANGEMENTS

When the multiple earth neutral system (MEN) is to be employed, the following connection principles shall apply:

(a) The MEN connection shall be made at the main switchboard. This will require disconnection or removal of the alternator winding neutral to frame links within the generating set where that generating set switchboard is not nominated as the main switchboard.

(b) Where a generating set is connected to an electrical installation as either the primary source supply or alternative source of supply to the normal power supply, the alternator winding shall have no internal connection to the earthing system of the generating set.

The only connection between the neutral conductor of the supply system and the earthing arrangement is the MEN link located within the main switchboard.

(c) Where the normal power supply is the MEN system of supply, the incoming neutral conductor of the supply system shall not be switched prior to the MEN link.

(d) In Australia, neutral and earth conductors shall not operate in parallel, except as specified below. **A**

When the earth neutral system is to be employed and, when operating under generator or transformer supply, the generator neutral and earthing conductors shall be installed such that—

(i) generator neutral and earth conductors are individually suitable for the maximum calculated fault current to be carried by each conductor;

(ii) the nominal size of generator earthing conductors be in accordance with the requirements of AS/NZS 3000; and

(iii) the current-carrying capacity of generator neutral conductors be in accordance with the requirements of AS/NZS 3000.

(e) Where a MEN connection or link is located at a main switchboard of an electrical installation to which a generating set is connected, the electrical installation earth electrode shall be connected to the main switchboard in accordance with AS/NZS 3000 requirements. An earth electrode shall not be directly connected to the generating set.

(f) The changeover device shall be selected so as to maintain the function(s) of and prevent damage to the electrical installation being supplied.

NOTE: Examples of functions to be maintained include the overlapping of neutrals, the operation of residual current devices or the continued operation of uninterruptible power supplies.

(g) In New Zealand, a generating set supplying an installation shall be connected only to the main switchboard of the electrical installation. **NZ**

New Zealand only exceptions: **NZ**

The generating set may be connected to a distribution switchboard provided—

(i) the generating set is arranged to cease supply of electricity in the event that the supply to that distribution switchboard is interrupted; and

(ii) the supply to the distribution switchboard from any other source is disconnected, a MEN earthing arrangement is established, and a protective system to control earth potential rise is provided.

2.6 ELECTRICAL INSTALLATION

2.6.1 General requirements

2.6.1.1 *General*

The electrical installation shall be in accordance with the appropriate requirements of AS/NZS 3000 and the additional requirements of this Standard.

For installations with multiple generating sets, a generator set switchboard for each generating set or a common generator switchboard for a group of generating sets may be used to group the generating set controls and if required, the changeover device(s) and the synchronization controls and associated switchgear installed within the common switchboard.

2.6.1.2 *Isolation from the normal supply system*

Where the generating set is not the normal supply source, all generating sets shall be connected to the electrical installation in such a manner that they remain isolated from the normal supply system.

Where it is intended that a generating set will operate in parallel with the normal supply, formal written approval from the electricity distributor shall be obtained.

NOTE: Requirements for operating a generating set in parallel with the normal supply from an electricity distributor are outside the scope of this Standard.

2.6.1.3 *Generating set neutral conductor*

A generating set neutral conductor is regarded as a live conductor and is required to be isolated when work is being carried out on the generator alternator.

NOTE: Attention is drawn to the need for the neutral conductor and the neutral pole of any isolating device or changeover device to have adequate current rating to be in accordance with AS/NZS 3000 requirements for neutral connections.

2.6.2 Overcurrent protection

All outgoing circuits from a generating set shall be provided with overcurrent protection at the generating set, except where an alternative position, or the omission of overcurrent protective devices, is permitted by AS/NZS 3000.

NOTES:

1 A generating set has limited fault output current available under fault conditions to operate overcurrent protection devices, the fault current available being dependant on the alternator type and the alternator voltage regulator and the mechanical power available from the engine of the generating set.

2 Suitable overcurrent protection devices for alternator or generator overcurrent protection are made by some, but not all manufacturers. Reference to the overcurrent and alternator data is required for the correct selection of a suitable overcurrent protective device.

Exception:

Wiring systems connecting generating sets to their associated switchboards need not be provided with short-circuit protection provided that the wiring systems are installed in such a way as to reduce the risk of a short-circuit to a minimum. Methods that can achieve this are wiring systems installed within the same fire-rated generator room (2 h minimum) utilizing—

(a) insulated and sheathed cable(s) installed within a dedicated conduit duct or pipe;

(b) insulated and sheathed cable(s) installed on a dedicated cable tray or an area of a cable tray segregated from other cables by barriers; or

(c) busway or busbar systems, including joints and switchboard busbars, having insulation up to the first protective device.

2.6.3 Generator output isolator

Each generating set shall be provided with an isolating switch operating in all live conductors, that is installed adjacent to, or on, the generating set so that a person working on the generating set has a clear view of the isolating device, and may be combined with overcurrent protection required by Clause 2.6.3.

Exception 1:

The isolating switch may be located in the generator switchboard.

Exception 2:

Where the generating set is the sole source of supply, the isolating switch shall not operate in the neutral conductor.

2.7 ALTERNATIVE SUPPLY (STANDBY)

2.7.1 General

Where a generating set is to operate as an alternative supply (standby) system in the case of failure of the normal supply, one or more changeover device shall be provided complying with the requirements of Clauses 2.7.1 to 2.7.13.

Unless otherwise authorized, the changeover device shall be designed to prevent back feed of the generating set output into the electricity distributor's network.

An inverter or regenerative supply source shall not be connected downstream of the generating set changeover device.

Exception: Where suitable control systems prevents backfeed to the generator the above provision does not apply.

NOTES:

1 A generating set cannot absorb energy imported from external sources into the generating set.

2 Automatic transfer switches in accordance with the relevant requirements of AS/NZS 3947.6.1 or AS/NZS 60947.6.1 may conform with these requirements.

2.7.2 Operation

The operation of changeover devices shall be such that the operation of the changeover device does not inadvertently or intentionally breach the integrity of the neutral conductor with reference to the MEN connection contained either within the installation's main switchboard or the switchboard to which the generator is connected, as follows.

(a) *General* Changeover devices shall interrupt one source of supply before connecting the other source of supply.

Exception: When a closed transition changeover device is fitted, the interruption of one source of supply before the connection of another source of supply is not required.

(b) *Active switching* Changeover devices shall operate in all active conductors.

(c) *Neutral switching* Where the MEN system of earthing is used, changeover devices shall not disconnect the neutral conductor of the incoming normal supply at the main switchboard where the MEN link is provided.

A switched neutral pole of a mechanical changeover device shall break not before, and shall make not after, the other poles. If a changeover device pole having an appropriate short-circuit breaking and making capacity is used as a neutral pole, then all poles, including the neutral pole, shall operate substantially together.

(d) *Earthing conductor switching* Changeover devices shall not operate in any earthing conductor.

NOTE: Examples of changeover arrangements are shown in Figures 2.1 and 2.2.

2.7.3 Interlocking

Changeover devices shall incorporate a mechanical interlock to prevent the simultaneous connection of the generating set system and the normal supply system, unless the following exception applies.

NOTE: The use of electrical interlocking in addition to mechanical interlocking is not a requirement of this Standard, but is recommended. In the case of electrically operated changeover devices, the controls for the generating set and the operation of the changeover device may provide limited electrical interlocking.

Exception: Where closed transition changeover arrangements are permitted, then a changeover device without a mechanical interlock is allowable. The closed transition changeover device shall be installed to the manufacturer's instructions.

Where the normal supply is from the distributor, the use of a closed transition changeover device(s) shall require a formal agreement with that electricity distributor.

2.7.4 Changeover device with intermediate 'off' position

A permanently connected changeover device having an intermediate 'off' position may be used in place of a main switch or a switch controlling submains, or final subcircuits or an individual final subcircuit, such that the supply to the load may be obtained from either of two sources and is able to be isolated from both. Such a device may also be connected as in Clause 2.7.5 (see Figure 2.1).

A manual transfer switch (MTS) used as a main switch shall have operating handles or controls associated with the MTS that enables the main switch to be manually operated, single action and mechanical. The MTS shall consist of a handle, lever, push buttons or similar device.

Electronic touch screens, programmable control systems or the like shall not be used as a means of operating the MTS where used as a main switch.

NOTE: Changeover devices having an intermediate 'off' position would typically be used for manually operated switches only.

2.7.5 Changeover device without an intermediate 'off' position

A permanently connected changeover device having no intermediate 'off' position shall be connected in one of the following ways, such that supply to the load may be obtained from either of the two sources of supply:

(a) Supply side of a main switch [see Figure 2.2(a)].

(b) Supply side of switch(es) controlling a submain(s) or final subcircuit(s) [see Figure 2.2(b)].

(c) Supply side of a switch controlling an individual final subcircuit [see Figure 2.2(c)].

NOTE: Figures 2.1 and 2.2 are only intended to show the location of changeover devices relevant to other switchgear for the purpose of this Clause.

2.7.6 Rating

Changeover devices shall have a voltage rating of at least the maximum out-of-phase voltage between contacts connected to the different sources of supply.

Changeover devices shall have a minimum current and fault duty rating to cater for the—

(a) maximum load current that is able to flow under both the normal and alternative supply (generating set) operating conditions; and

(b) maximum fault duty available when operating on the normal or alternative supply.

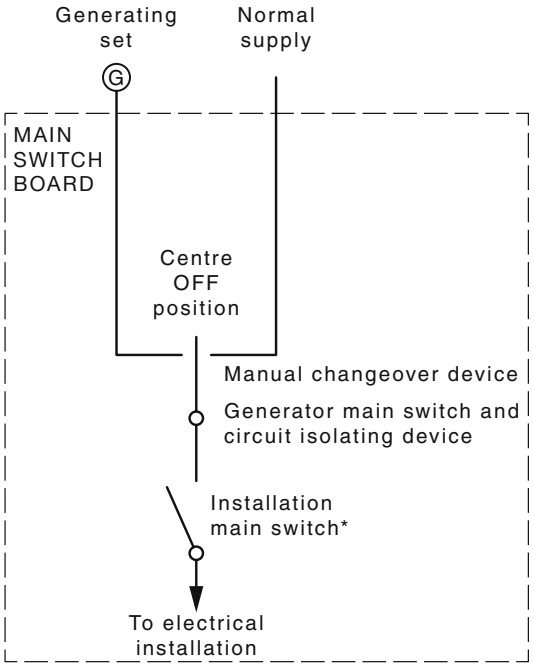
2.7.7 Access

Changeover devices should be accessible only to authorized persons. If manual operation is required, the operating means shall be not more than 2 m above the ground, floor or platform.

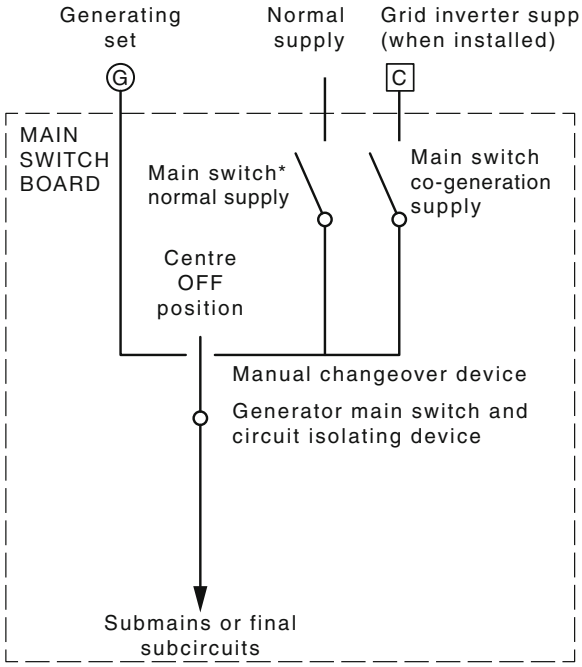
2.7.8 Identification

Changeover devices shall be permanently marked in English to indicate the purpose and switching positions of the device. Terminals of changeover devices shall also be provided with marking to indicate the sources of supply.

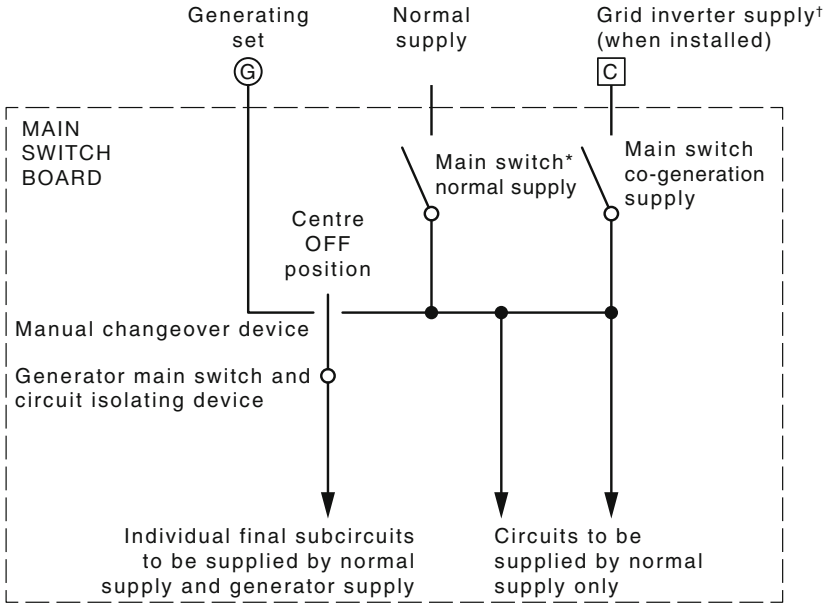
Where the operation of a changeover device automatically brings into service an alternative supply, the purpose of the device shall be permanently marked accordingly.



(a) Ahead of general installation main switch



(b) Main switch generator and switch controlling submain(s) or final subcircuits



(c) Ahead of a switch controlling individual circuit

* May also be a circuit breaker

† Grid connect inverter systems such as solar, wind and/or water

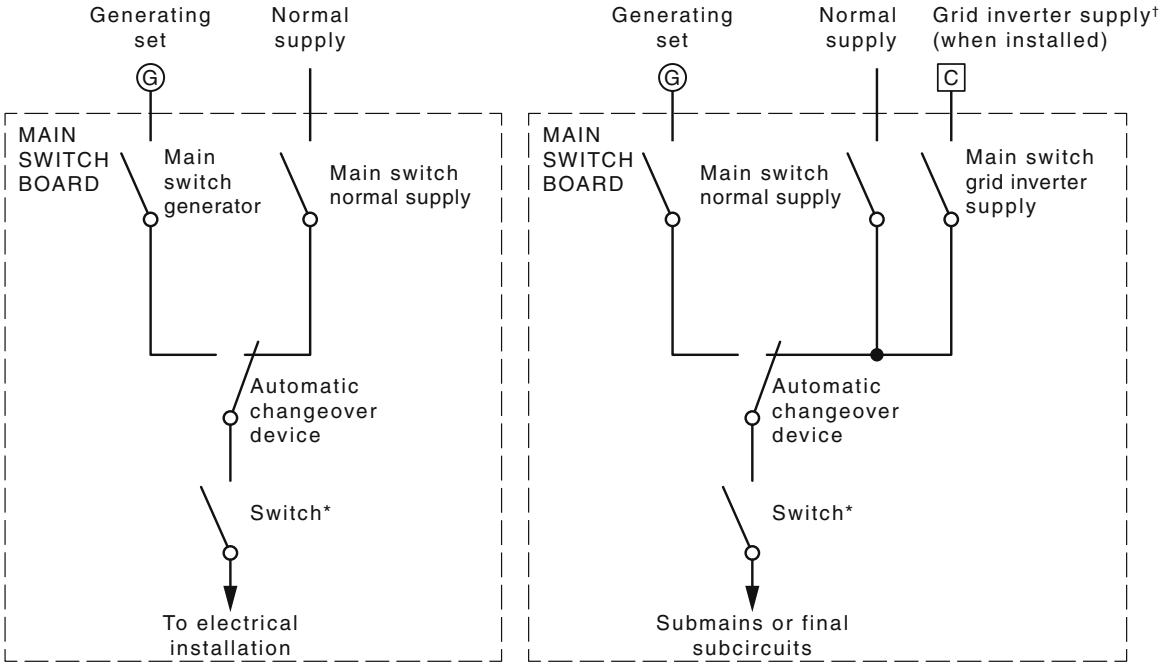
NOTES:

1 These configurations shall be followed to ensure any grid connect inverter supply is not backfeeding into generator while generator is supplying the installation.

2 Manual changeover device is the generator main switch and can be the normal supply main switch.

3 See Clause 2.7.2.

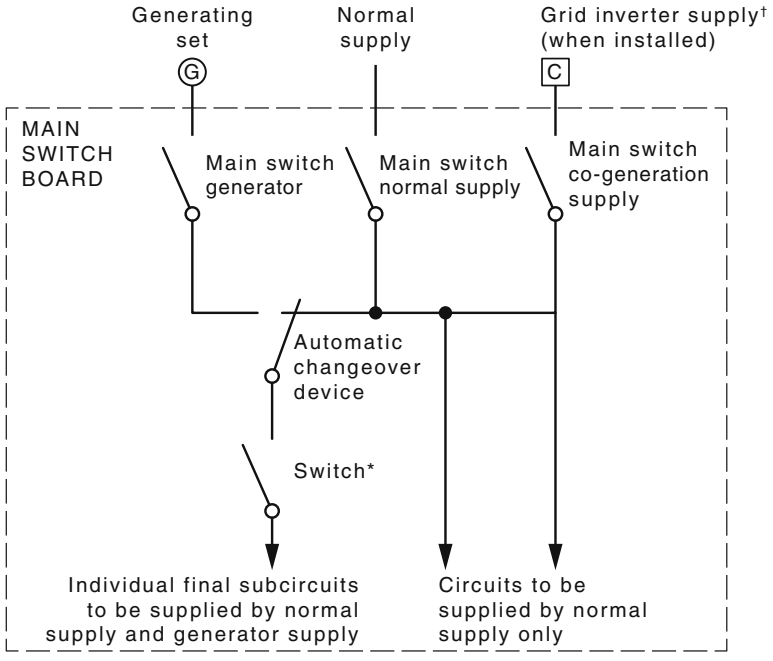
FIGURE 2.1 TYPICAL LOCATION OF MANUAL CHANGEOVER DEVICE WITH AN INTERMEDIATE 'OFF' POSITION LOCATED IN THE MAIN SWITCHBOARD



(a) Ahead of general installation main switch

(b) Ahead of switch(es) controling submain(s) or final subcircuits

NOTE: Co-generation not permitted with this arrangement



(c) Ahead of a switch controlling individual circuit

* May also be a circuit breaker or switch fuse

† Grid connect inverter systems such as solar, wind and/or water

NOTES:

1 These configurations shall be followed to ensure any grid connect inverter supply is not backfeeding into generator while generator is supplying the installation.

2 See Clause 2.7.2.

FIGURE 2.2 TYPICAL LOCATION OF AUTOMATIC CHANGEOVER DEVICE WITHOUT AN INTERMEDIATE 'OFF' POSITION LOCATED WITHIN THE MAIN SWITCHBOARD

2.7.9 Automatic changeover to normal supply

Where an automatic changeover device is provided, it shall operate to transfer loads back to the normal supply after the voltage and frequency of the normal supply have been maintained at normal levels on all phases for a specified period, except that in the case of failure of the generating set supply, the transfer shall occur without delay, provided a normal supply is available.

An automatic transfer switch (ATS) used as a main switch shall have operating handles or controls associated with the ATS that enables the main switch to be manually operated, single action, mechanical and shall consist of a handle, lever, push buttons or similar device.

Electronic touch screens, programmable control systems or the like shall not be used as a means of operating the ATS where used as a main switch.

NOTES:

1 Where the automatic changeover device provides the control for a high reliability site, the transfer of the loading from the generator supply to normal supply may be prevented until a switching break in the supply to the load can be arranged to suit operational requirements, except in the case of the failure of the generating set supply, the transfer should occur without delay, provided a normal supply is available.

2 The specified period is usually controlled by an adjustable delay of between 1 min and 30 min—typically the delay selected is 15 min.

3 A further delay period prior to shutting down the generating set engine may be necessary to allow adequate cool-down of particular engines types.

2.7.10 Changeover device in the generator neutral

Requirements for changeover device in the generator neutral shall conform with Clause 2.7.10.1 for Australia and Clause 2.7.10.2 for New Zealand.

2.7.10.1 *In Australia*

A

In Australia only, a changeover device switching contact in the generator set neutral connection is not the recommended connection method for generating sets that are permanently connected to any switchboard. However, when a changeover device is fitted in a generating neutral connection, the neutral connection shall not disconnect the connection to the main switchboard MEN link connection (see Figures 2.3 to 2.9).

2.7.10.2 *In New Zealand*

NZ

In New Zealand only, the following arrangements apply:

(a) *Switchboards with a MEN link fitted* A changeover device with a neutral switching contact in the generator set neutral shall not be provided for generating sets that are permanently connected to a switchboard containing a MEN link.

The connections for generating sets that are able to be permanently connected to a switchboard with a MEN link fitted are detailed in Figures 2.3 and 2.4.

(b) *Switchboards with no MEN link fitted* If it is not practical or feasible to connect a generating set to a switchboard with a MEN link fitted due to site conditions or layout, the generating set output permanent connection shall be made to a switchboard that does not contain a MEN link or connection. The connections required are detailed in Figures 2.15 and 2.16.

NOTES:

1 The generating set output neutral connection arrangements convert the system of supply of the generating set output, IT system of supply, to one that is the same system of supply when the essential load when operating from a normal power supply, MEN.

2 A four pole/four pole changeover device is used to switch the neutral connection of the normal supply section of the changeover device in the neutral connections to the essential load, the neutral contact being closed when the normal supply is connected to the essential load of the switchboard.

3 The generator set output section of the changeover device neutral connection is used to switch the generating set output neutral, the contact being closed when the generating set is supplying the essential loading connected to that switchboard. This provides a local MEN connection to the switchboard when the generating set is supplying the connected load.

4 A 100 mA RCD should be provided in the generating set active and neutral connections to the switchboard to provide earth fault and earth potential rise (EPR) protection for the generating set output.

5 The generator output neutral connection is connected to the supply system IT to MEN conversion neutral and earth busbars linked together, the earth busbar is connected to the generating set earth electrode and the switchboard earth bar to provide a MEN configuration.

The neutral and earth busbars used for system of supply conversion are to be permanently labelled 'For generating set connections only'. The connection of the distribution switchboard submain or final subcircuit neutral and earth connections is not permitted.

This method of connection generating sets to an electrical installation is not recommended if connection to a switchboard containing a MEN link is practical, see Figures 2.3, 2.4, 2.7 and 2.9.

2.7.11 Three pole/three pole changeover devices

A three pole/three pole changeover device may be used to connect a generating set at a switchboard with a MEN link.

Where a three pole/three pole or a single pole changeover device is used, the generating set neutral and earth conductors shall be connected as shown in Figures 2.10 to 2.16.

2.7.12 Three pole/four pole changeover devices

A three pole/four pole changeover device may be used to connect a generating set at a switchboard without a MEN link fitted.

Where a three pole/four pole changeover device is used, the generating set neutral conductor may be switched.

NOTE: This changeover device configuration should not be used for new installations, but may exist in existing generating set installations.

2.7.13 Four pole/four pole changeover device

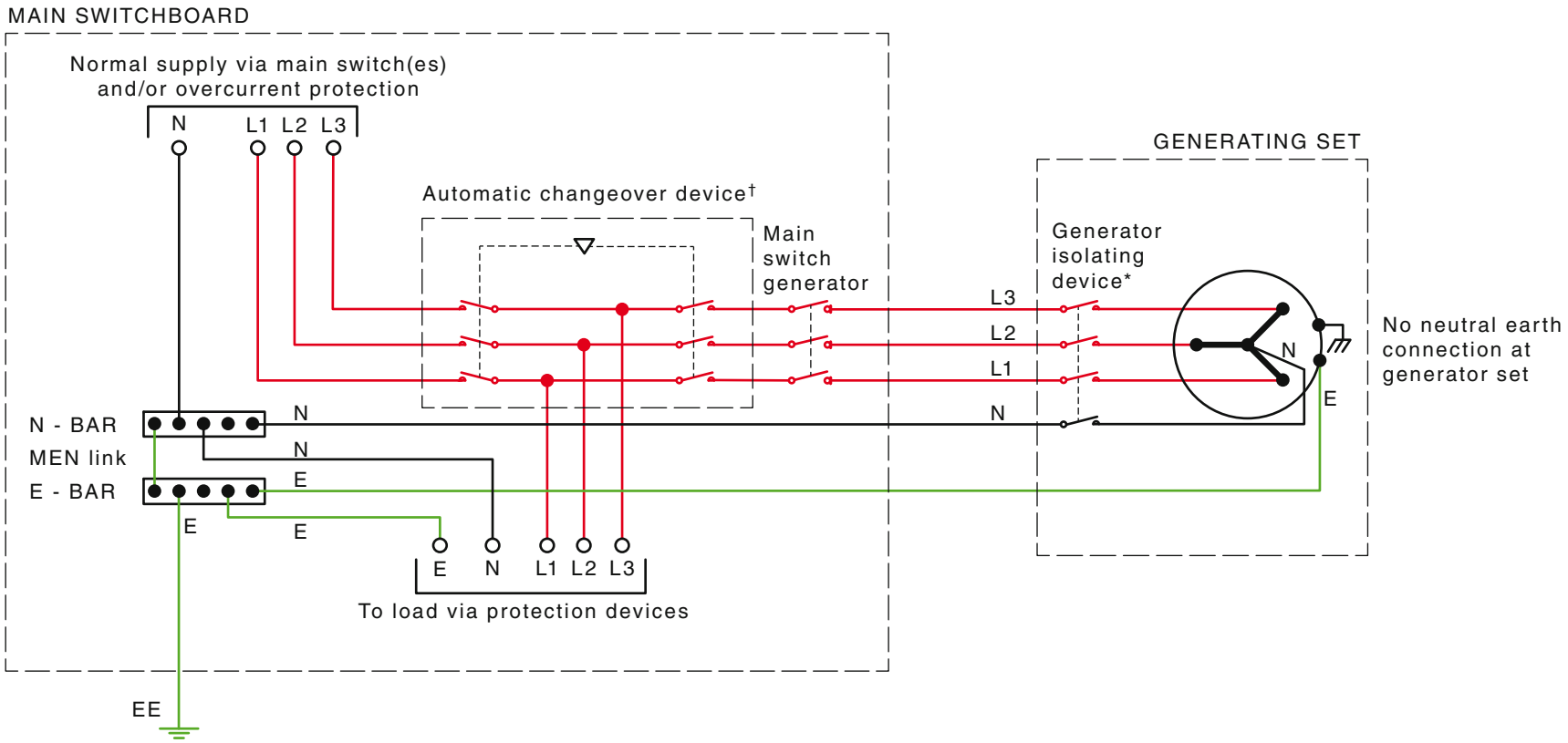
When a four pole/four pole changeover device is used in a main switchboard, the normal supply neutral conductor to the switchboard shall not be switched prior to MEN link.

A four pole/four pole changeover device may be used to connect a generating set at a switchboard without a MEN link fitted (distribution switchboard).

Where a four pole/four pole changeover device is used, the incoming submain and generating set neutral conductors may be switched.

TABLE 2.1
KEY TO SYMBOLS IN FIGURES

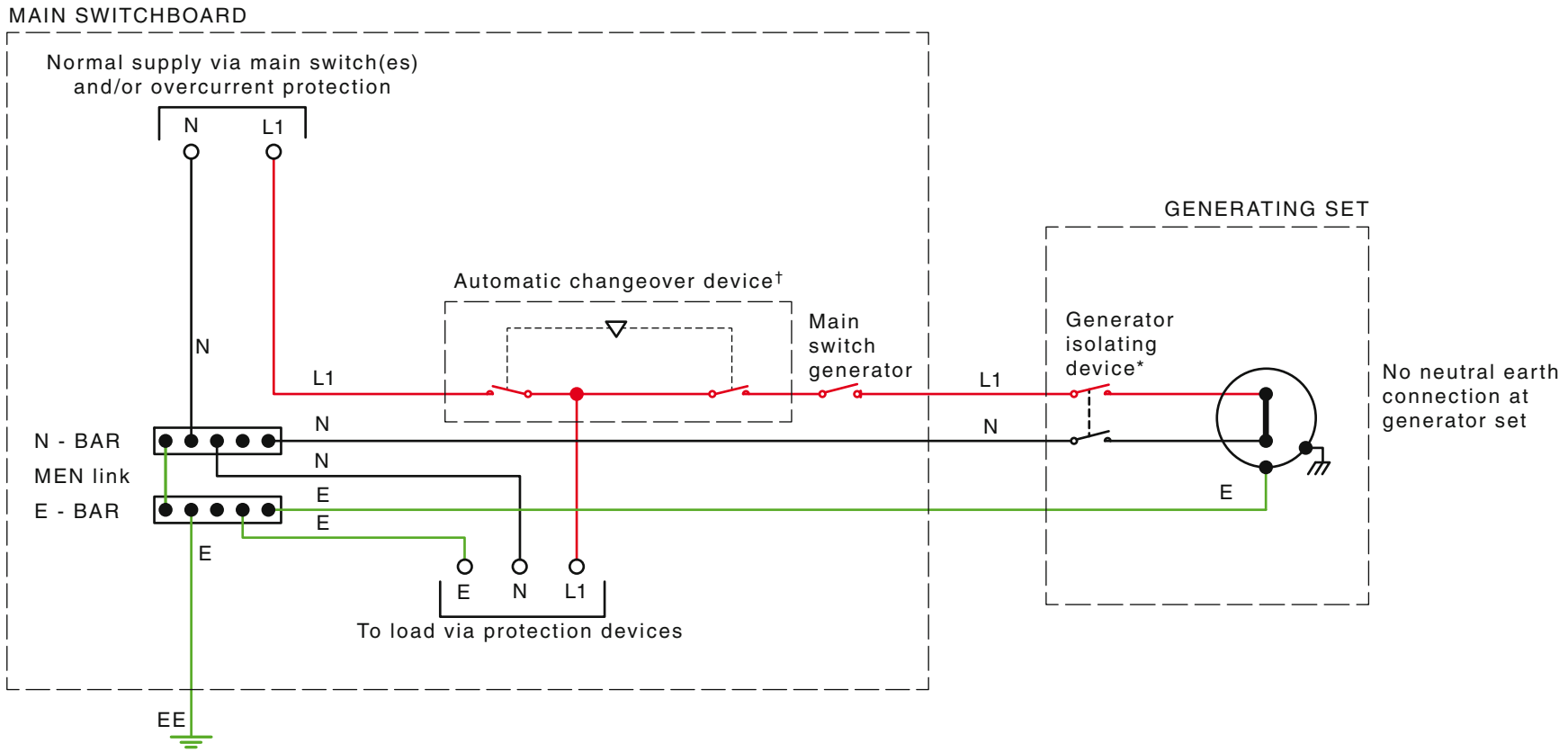
Symbol	Description
C	Co-generation = solar, wind, water
E	Earth conductor
E-BAR	Earth bar
EE or 	Earth electrode
	Generator
L1, L2, L3	Active (phase) conductors
MTS	Manual transfer switch
N	Neutral conductor
N-BAR	Neutral bar
	Contact
	Contact - load break
	Contact - contactor
	Circuit breaker
	Isolating switch
	Chassis or frame
	Interlock
	Termination
	Multiphase conductors



* May include overcurrent protection
† Synchronisation and control equipment not shown

NOTE: See Clause 2.7.11.

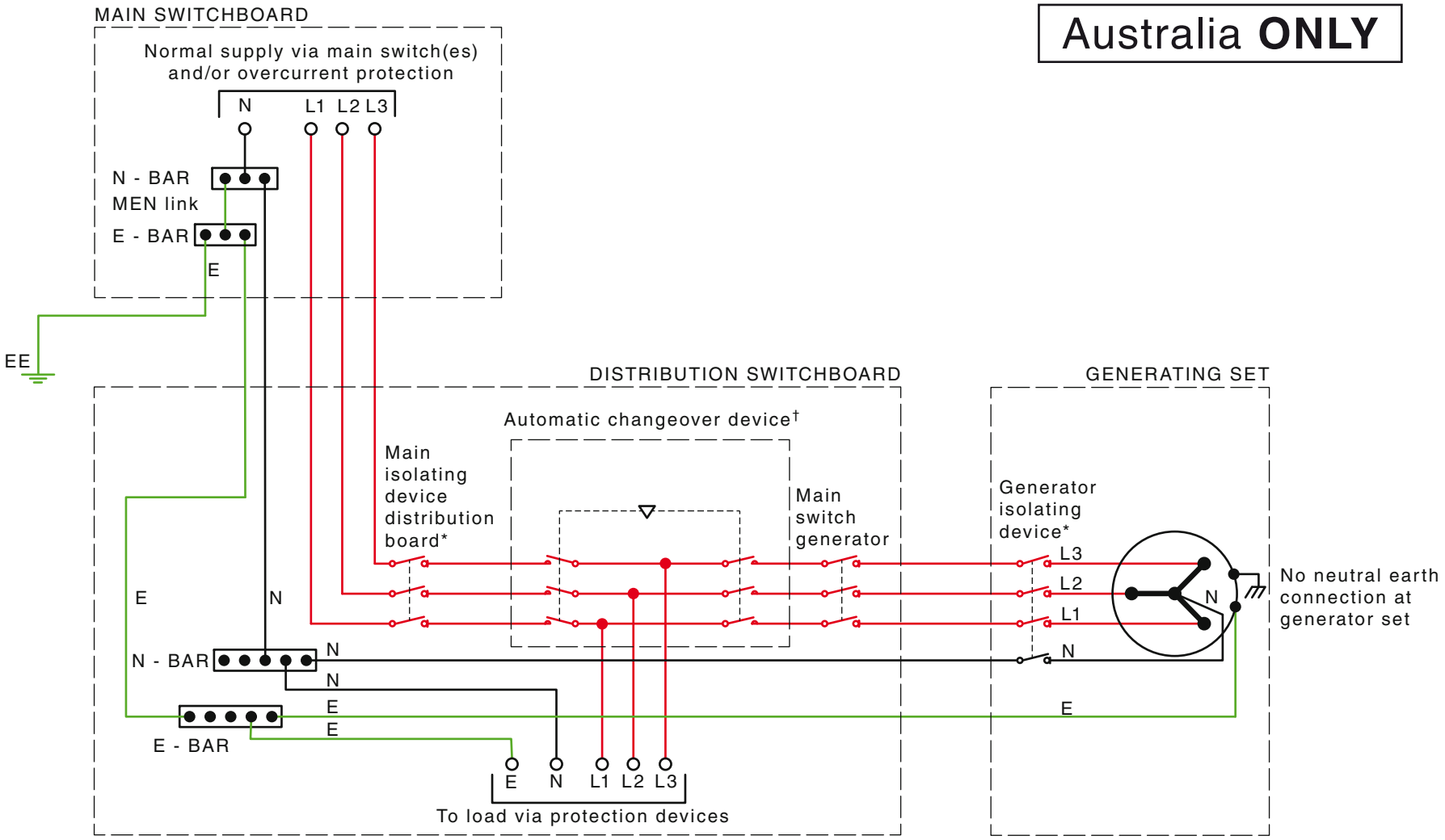
FIGURE 2.3 TYPICAL THREE POLE/THREE POLE AUTOMATIC CHANGEOVER ARRANGEMENT FOR A SINGLE THREE-PHASE GENERATING SET WITH FOUR POLE LOCAL ISOLATION PERMANENTLY INSTALLED AS AN ALTERNATIVE SUPPLY CONNECTED TO A SWITCHBOARD WITH A MEN LINK INSTALLED



* May include overcurrent protection
† Synchronisation and control equipment not shown

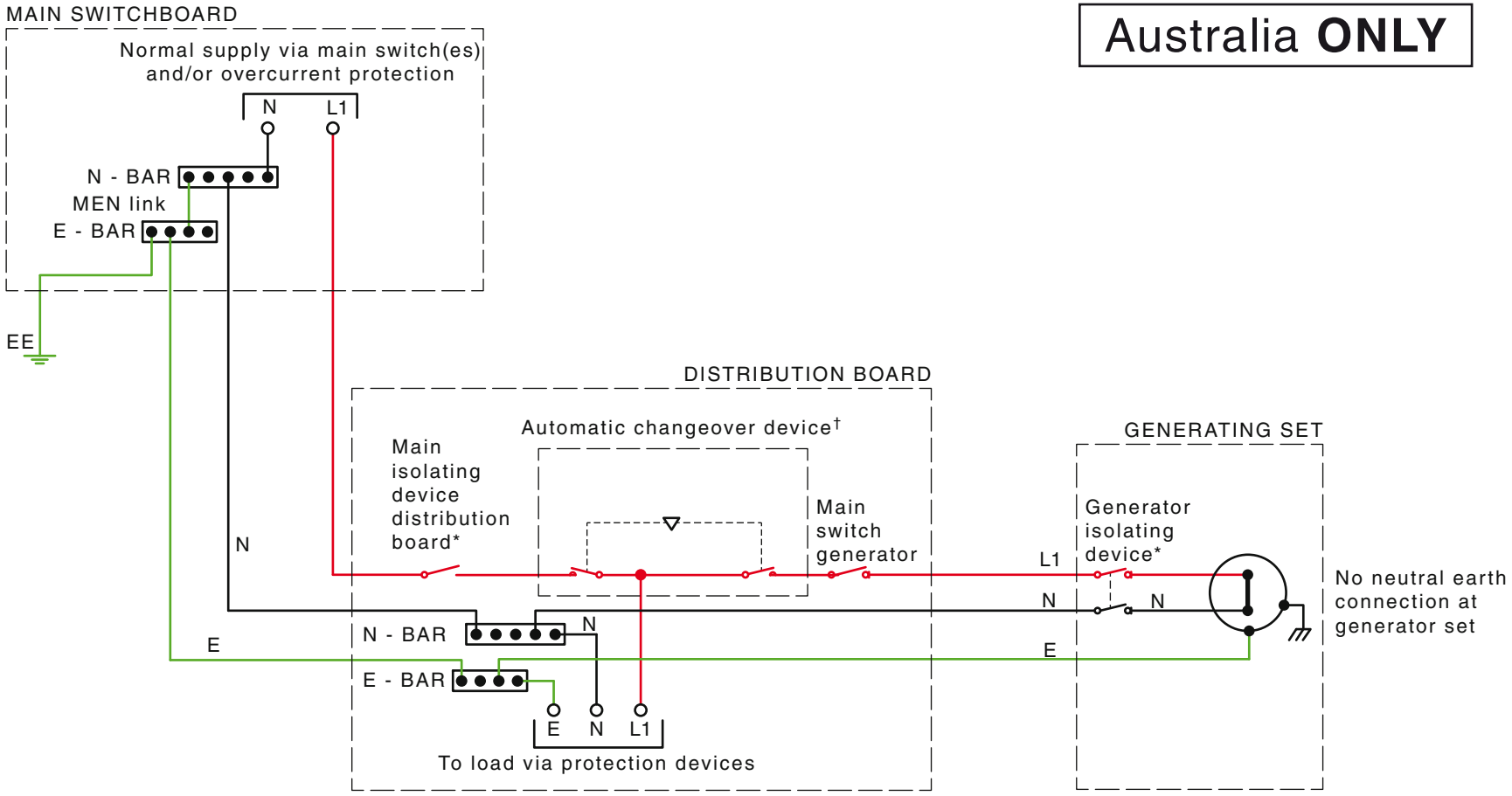
NOTE: See Clause 2.7.11.

FIGURE 2.4 TYPICAL ONE POLE/ONE POLE AUTOMATIC CHANGEOVER ARRANGEMENT FOR A SINGLE-PHASE GENERATING SET WITH TWO POLE LOCAL ISOLATION PERMANENTLY INSTALLED AS AN ALTERNATIVE SUPPLY, CONNECTED TO A SWITCHBOARD WITH A MEN LINK INSTALLED



NOTE: See Clause 2.7.11.

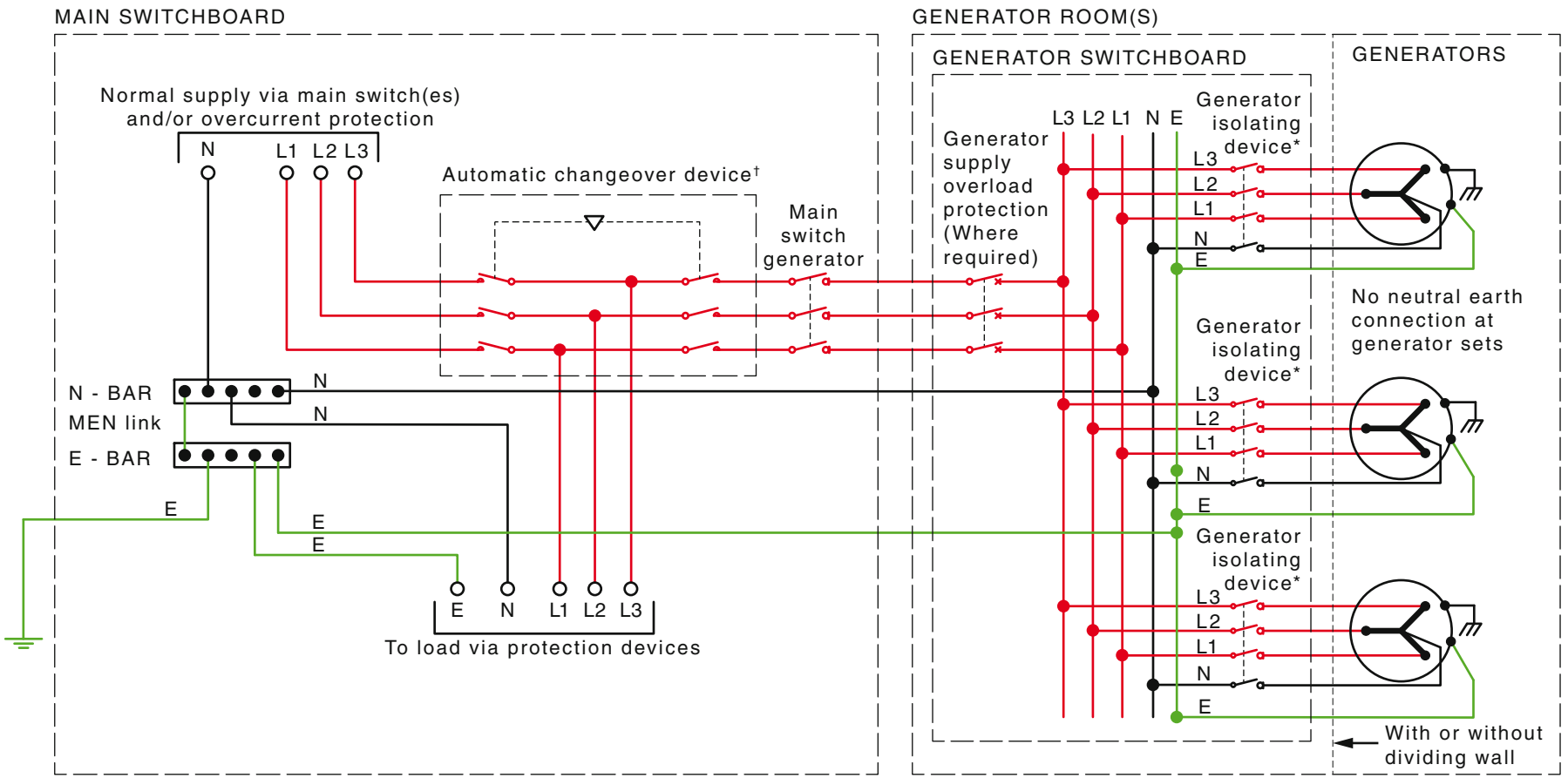
FIGURE 2.5 TYPICAL THREE POLE/THREE POLE AUTOMATIC CHANGEOVER ARRANGEMENT FOR A SINGLE THREE-PHASE GENERATING SET WITH FOUR POLE LOCAL ISOLATION PERMANENTLY INSTALLED AS AN ALTERNATIVE SUPPLY, CONNECTED TO A SWITCHBOARD WITHOUT A MEN LINK INSTALLED



* May include overcurrent protection
† Synchronisation and control equipment not shown

NOTE: See Clause 2.7.11.

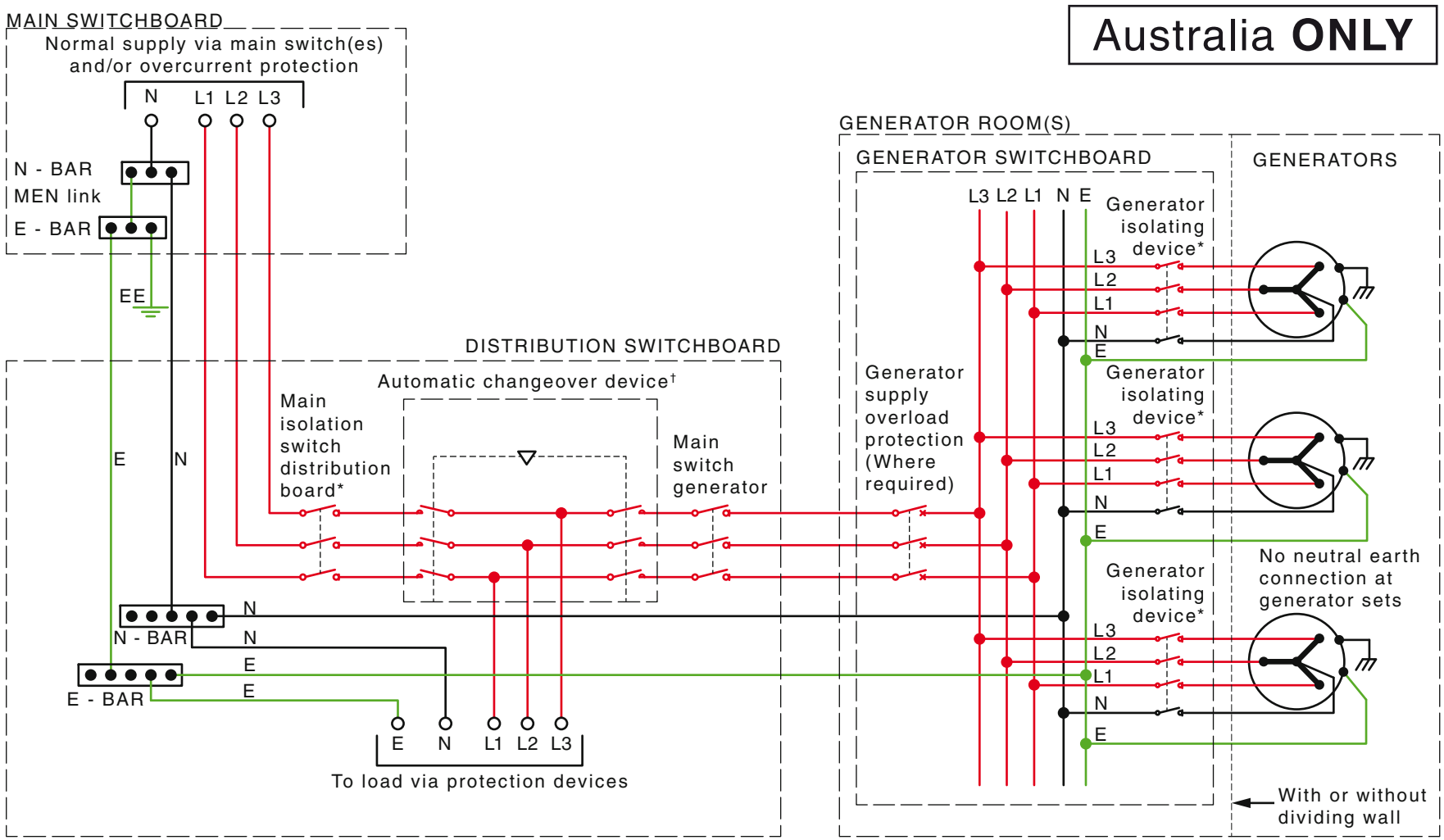
FIGURE 2.6 TYPICAL ONE POLE/ONE POLE AUTOMATIC CHANGEOVER ARRANGEMENT FOR A SINGLE-PHASE GENERATING SET WITH TWO POLE LOCAL ISOLATION PERMANENTLY INSTALLED AS AN ALTERNATIVE SUPPLY, CONNECTED TO A SWITCHBOARD WITHOUT A MEN LINK INSTALLED



* May include overcurrent protection where installed either at Generator, Generator Switchboard or both

NOTE: See Clause 2.7.11.

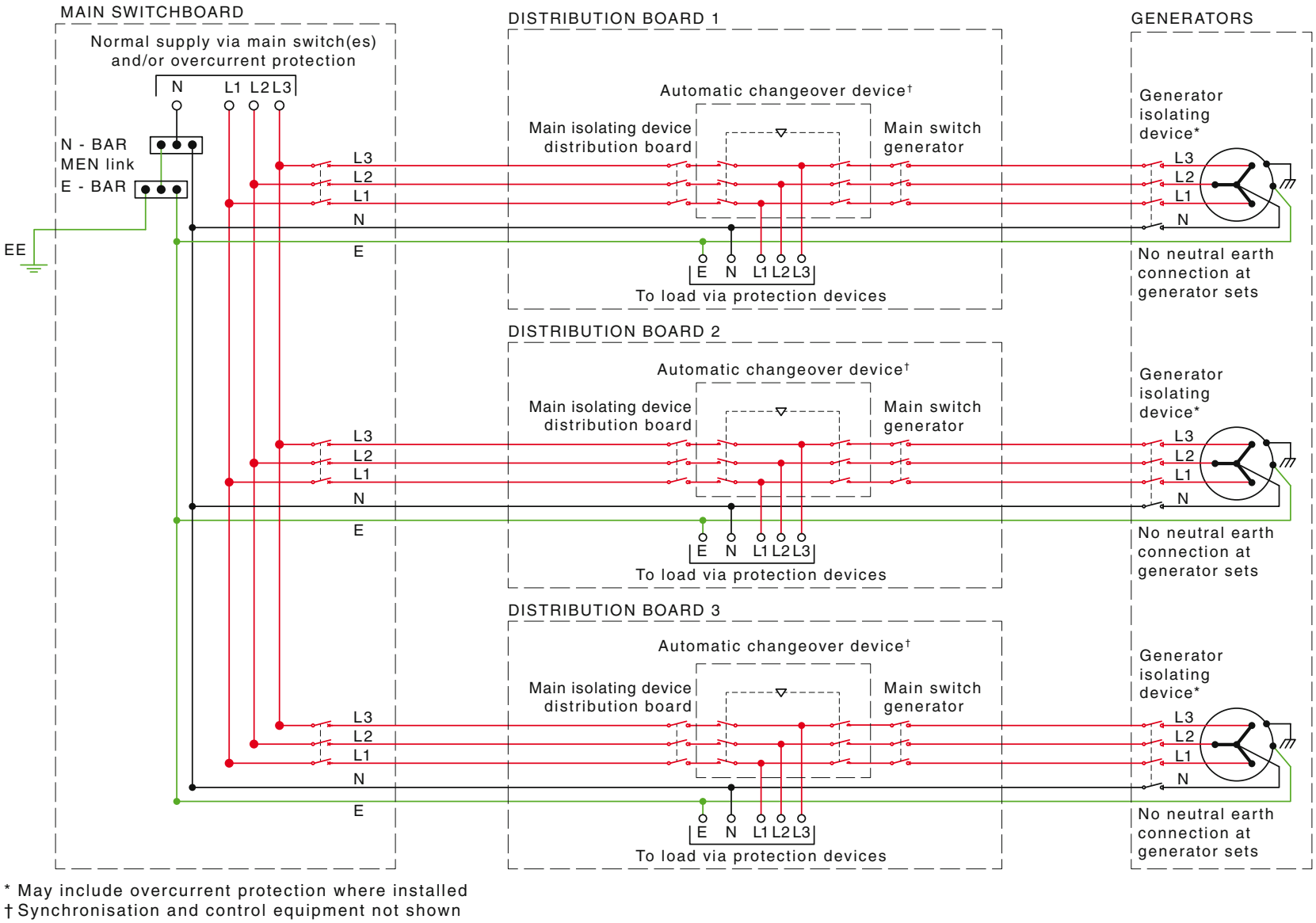
FIGURE 2.7 TYPICAL THREE POLE/THREE POLE AUTOMATIC CHANGEOVER ARRANGEMENT FOR MULTIPLE THREE-PHASE GENERATOR SET INSTALLATION WITH FOUR POLE LOCAL ISOLATION PERMANENTLY INSTALLED AS AN ALTERNATIVE SUPPLY CONNECTED TO A MAIN SWITCHBOARD WITH A MEN LINK INSTALLED



* May include overcurrent protection where installed either at Generator, Generator Switchboard or both
† Synchronisation and control equipment not shown

NOTE: See Clause 2.7.11.

FIGURE 2.8 TYPICAL THREE POLE/THREE POLE AUTOMATIC CHANGEOVER ARRANGEMENT FOR MULTIPLE THREE-PHASE GENERATOR SET INSTALLATION WITH FOUR POLE LOCAL ISOLATION PERMANENTLY INSTALLED AS AN ALTERNATIVE SUPPLY CONNECTED TO A DISTRIBUTION SWITCHBOARD WITHOUT A MEN LINK INSTALLED



NOTE: See Clause 2.7.11.

FIGURE 2.9 TYPICAL THREE POLE/THREE POLE AUTOMATIC CHANGEOVER ARRANGEMENT FOR MULTIPLE THREE-PHASE GENERATOR SET INSTALLATION WITH FOUR POLE LOCAL ISOLATION PERMANENTLY INSTALLED AS AN ALTERNATIVE SUPPLY CONNECTED TO A SEPARATE DISTRIBUTION SWITCHBOARD WITHOUT A MEN LINK INSTALLED

2.8 EARTHING AND BONDING REQUIREMENTS

2.8.1 General

The generating set earthing and earth bonding arrangements shall be as follows for neutral-earth connected generators (for other earthing systems, see Clause 2.11.3):

(a) The neutral to frame link in the generating set shall be permanently removed.

(b) An earth cable in accordance with AS/NZS 3000 requirements for the main earthing conductor shall be installed from the electrical installation to the generating set and connected to the generating set earth bonding connection and the main switchboard earth bar.

(c) An electrical installation earth electrode and main earthing conductor in accordance with AS/NZS 3000 requirements shall be provided for the electrical installation and connected to the main switchboard.

2.8.2 Earthing and bonding alterations to existing installations

All alterations to an existing generator installation shall be as provided in the requirements of alterations and repairs (see Clause 1.9.3) of AS/NZS 3000, unless exceptions 1, 2 or 3 applies.

Exception 1: Neutral-earth connection located within generators.

Where an existing electrical installation is supplied by more than one generator in parallel and the installation has neutral-earth connections existing within the generators and not at the main switchboard location.

Provided the alteration work is limited to no more than 35% of the total generation capacity, it is permissible to upgrade the generator installation (carry out the alterations) maintaining the neutral-earth connection within the generators and a permanent label indicating any neutral-earth link in place shall be fixed to each switchboard supplied by the generators in the following form:

CAUTION: NEUTRAL-EARTH CONNECTIONS ARE LOCATED AT THE GENERATING SETS

Exception 2: Existing installations with more than two generators connected in parallel utilizing three pole/four pole changeover devices.

Exception 3: Where an existing electrical installation is supplied by more than one generator in parallel and the installation has a three pole/four pole changeover device and no neutral or earthing conductors are connected in parallel the existing three pole/four pole changeover device can remain in service.

Where an existing electrical installation is supplied by more than one generator connected in parallel and the electrical installation has the neutral-earth connection existing within the generators and not at the main switchboard location.

Provided the alteration is limited to no more than 35% of the existing generation capacity, it is permissible to upgrade supply (carry out the alteration or additions) with the neutral-earth connection remaining within the generating sets.

A permanent label indicating the neutral-earth arrangements in use shall be placed on each switchboard supplied by the generators in the following form:

CAUTION: INSTALLATION NEUTRAL-EARTH CONNECTION LOCATED WITHIN GENERATING SETS

2.8.3 Generating set bonding system

The following parts of the generating set shall be electrically bonded together to form the generating set bonding system:

(a) The 'star' point or neutral connection of a multiple-phase output isolated winding.

(b) One output connection of a single-phase isolated output winding.

The output winding connection to the generating set bonding system shall be by means of a permanently labelled removable link mounted adjacent to the generating set a.c. output connections.

(c) The engine frame.

(d) The generator or alternator frame. All exposed conductive parts enclosing electrical equipment or wiring.

(e) The 'earth' terminals of any socket outlets fitted.

(f) The frame connection (marked ⏚ or 'FRAME').

When the generating set is permanently connected to a switchboard by installation wiring in an electrical installation, the generating set neutral to frame link shall be permanently removed.

2.8.4 Generating set windings

2.8.4.1 *Multi-phase and single-phase three wire centre-tapped generating sets*

The following points of the generating set windings shall be connected to the electrical installation switchboard neutral bar:

(a) The neutral or star point of a three-phase winding.

(b) The neutral point of a two-phase winding.

No point of the output winding shall be connected to the generating set bonding system.

Exception: In New Zealand only, when the generating set output is connected by installation wiring to a switchboard without a MEN link, the generating set output neutral connection is to be made to the neutral busbar used for the system of supply conversion. NZ

2.8.4.2 *Single-phase portable generating sets*

One output connection of a single-phase isolated output winding shall be connected to the electrical installation switchboard neutral bar.

Exception: In New Zealand only, when the generating set output is connected by installation wiring to a switchboard without a MEN link, the generating set output neutral connection is to be made to the neutral busbar used for the system of supply conversion. NZ

The generating set [see Clause 2.5(b)] shall be earthed by connection to the earthing system of the electrical installation.

Connection of the generating set to the mass of earth shall not be made by means of a separate earth electrode.

Appendix A details the reasons that connection of the generator set bonding system of portable generating sets to the general mass of earth is not required or recommended.

2.8.5 Connection of generating set windings

The following points, as applicable, shall be connected to the relevant neutral conductor of the electrical installation and not be directly connected to the generating set bonding system:

(a) The generating set winding connections referred to in Clause 2.5(b).

(b) One side of an otherwise unpolarized single-phase generating set winding.

Alternatively, the generating set windings referred to in Items (a) and (b) above may be arranged through a protection system in a manner that ensures the disconnection of the electrical installation in the event of an earth fault.

2.8.6 Arrangement of equipment

Switchboards for the control of a generating set or its outgoing circuits, in addition to conforming with AS/NZS 3000, shall be equipped with such instruments, relays and control equipment as may be necessary for safe and correct operation. All starting and shutdown devices, isolating switches, changeover devices and other devices that may require reading or adjustment, shall be accessible.

2.8.7 Rating

Switches, circuit-breakers, fuses, contactors, reclosers and other switchgear shall be selected with appropriate regard to the rated values of voltage, service duty and continuous and in-rush current of the circuits on which they are installed.

All protective devices shall be capable of safely interrupting the prospective short-circuit current at the point where the devices are installed.

All switchgear used to break load current shall be marked with the rated breaking and making current capacity of the device. Switches that are not rated to interrupt the full-load current of the circuit shall be interlocked with load-breaking devices to prevent the possibility of the switches being opened under load.

2.8.8 Provisions for securing isolating devices

Where isolating devices are installed, means shall be provided to secure the device in the open position.

Where the accidental opening of devices may cause a hazard, similar means of securing are recommended for retaining the device in the closed position.

NOTE: This recommendation may apply to manual changeover switches or some switches associated with the security of supply to safety services.

2.8.9 Indication of switch position

Where any equipment or circuit that operates at greater than extra low voltage could be required to be worked on while activated, an isolating switch shall be provided in each unearthed conductor supplying the equipment. Such switches shall be of the visible break type or be marked or provided with a device to indicate clearly whether the switch is open or closed. In addition means shall be provided for securing the device in the open position.

Where withdrawable switchgear equipment is used, the fully withdrawn position of the switchgear, where clearly indicated, constitutes a visible break for this purpose.

NOTE: Provision of protective earthing of equipment during repair or maintenance is recommended.

2.9 GENERATOR SWITCHBOARDS

All generator switchboards shall be—

(a) installed in accordance with the requirements of AS/NZS 3000; and

(b) constructed in accordance with AS/NZS 3439 or AS/NZS 61439 (series).

2.10 LIGHTNING PROTECTION SYSTEMS

Depending on the geographical location, it may be necessary to protect equipment against lightning or excessive overvoltage. Where employed, lightning or overvoltage protection shall be located as close as practicable to the equipment it protects.

NOTE: Information on the protection of equipment against lightning is contained in AS/NZS 3000.

2.11 GENERATING SETS CONNECTED AS NORMAL SUPPLY TO A MAIN SWITCHBOARD IN A PERMANENT ELECTRICAL INSTALLATION

2.11.1 Generating set

The generating set and associated equipment shall be installed to the applicable provisions of this Standard.

Attention is drawn to the additional requirements for a generating set that is providing a normal supply and is continuously running for extended periods. The reduced intervals of engine maintenance, increased fuel storage supply arrangements, high exhaust piping temperatures and enhanced engine cooling arrangements are typical additional requirements to cater for extended periods of continuous operation.

2.11.2 System of supply for generating set and main switchboard

2.11.2.1 *Overcurrent protection*

The generating set shall be provided with output overcurrent protection in accordance with AS/NZS 3000 and Clause 2.6.3 of this Standard.

2.11.2.2 *Connection to the electrical installation*

The connection of the generating set output to the electrical installation shall be by the use of the electrical installation consumer mains installed to AS/NZS 3000 requirements from the generating set output terminals to the electrical installation main switchboard.

2.11.2.3 *Earthing and equipotential bond connections*

The generating set output shall be arranged as an isolated supply and any neutral to earth bonding within the generating set is to be permanently removed.

A protective earthing conductor shall be run from the generating set frame connection to the main earthing terminal/connection or bar of the electrical installation main switchboard. The protective earthing conductor size shall be in accordance with Section 5 requirements of AS/NZS 3000.

The neutral to earth connection shall be made in the electrical installation at the main switchboard.

An earthing conductor, deemed to be the main earthing conductor, shall be taken from the main earthing terminal/connection or bar in the main switchboard to an earth electrode in accordance with Section 5 requirements of AS/NZS 3000.

NOTE: The main switchboard may form part of the generating set.

2.11.2.4 *Unsuitable electrical equipment*

A grid-connected inverter or re-generative load is not suitable for connection to this type of electrical installation.

NOTE: A generating set output cannot be identified as a grid supply, nor can it absorb the energy exported from a grid-connected inverter or regenerative load.

2.11.2.5 *Connection details*

The supply and protective earthing connections are shown in Figure 2.10.

2.11.3 Other systems of supply

Alternative systems of supply are permitted, and shall be in accordance with AS/NZS 3000.

NOTE: The detailed requirements for other systems of supply are outside the scope of this Standard.

2.12 GENERATING SETS CONNECTED TO AN ELECTRICAL INSTALLATION CONNECTED AS AN ALTERNATIVE SUPPLY

2.12.1 General

The generating set and associated switchboards shall be installed to the applicable provisions of this Standard.

NOTE: Typical applications being for construction and demolition sites (refer to AS/NZS 3012), and shows and carnivals (refer to AS/NZS 3002).

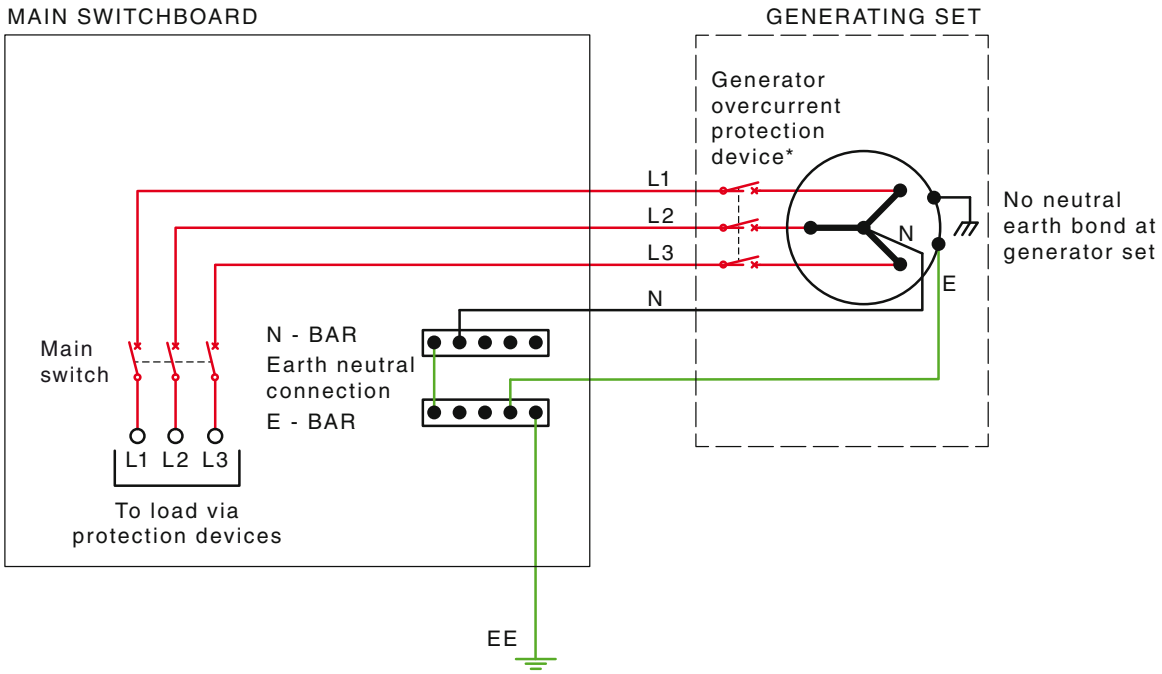
2.12.2 System of supply for the generating set and switchboards

2.12.2.1 *Overcurrent protection*

The generating set shall be provided with output overcurrent protection on the generating set in accordance with AS/NZS 3000 and Clause 2.6.3 of this Standard.

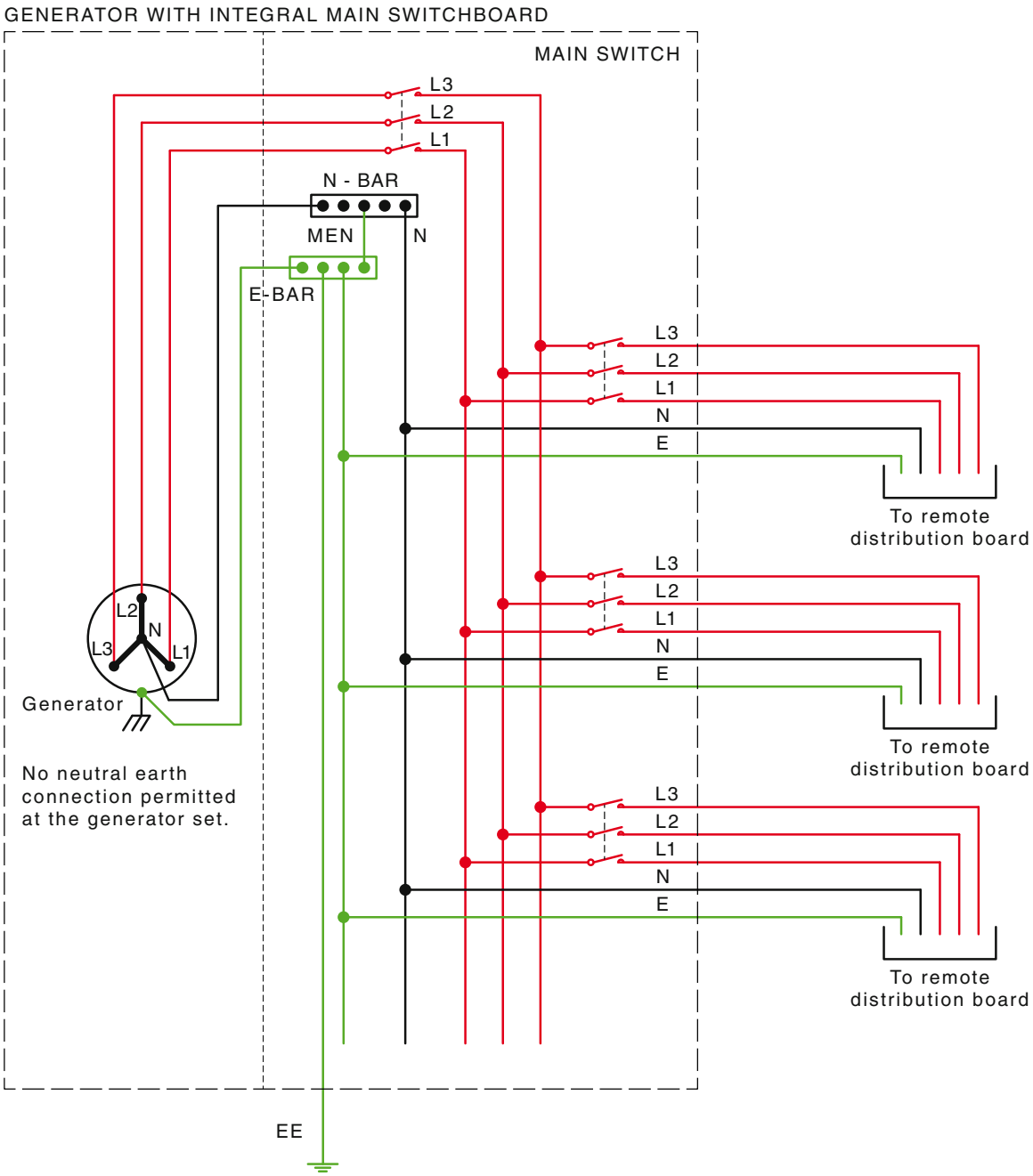
2.12.2.2 *Connection to switchboards*

The requirements for connections to switchboards are shown in Figures 2.3 to 2.9 and Figures 2.13, 2.15 and 2.16.



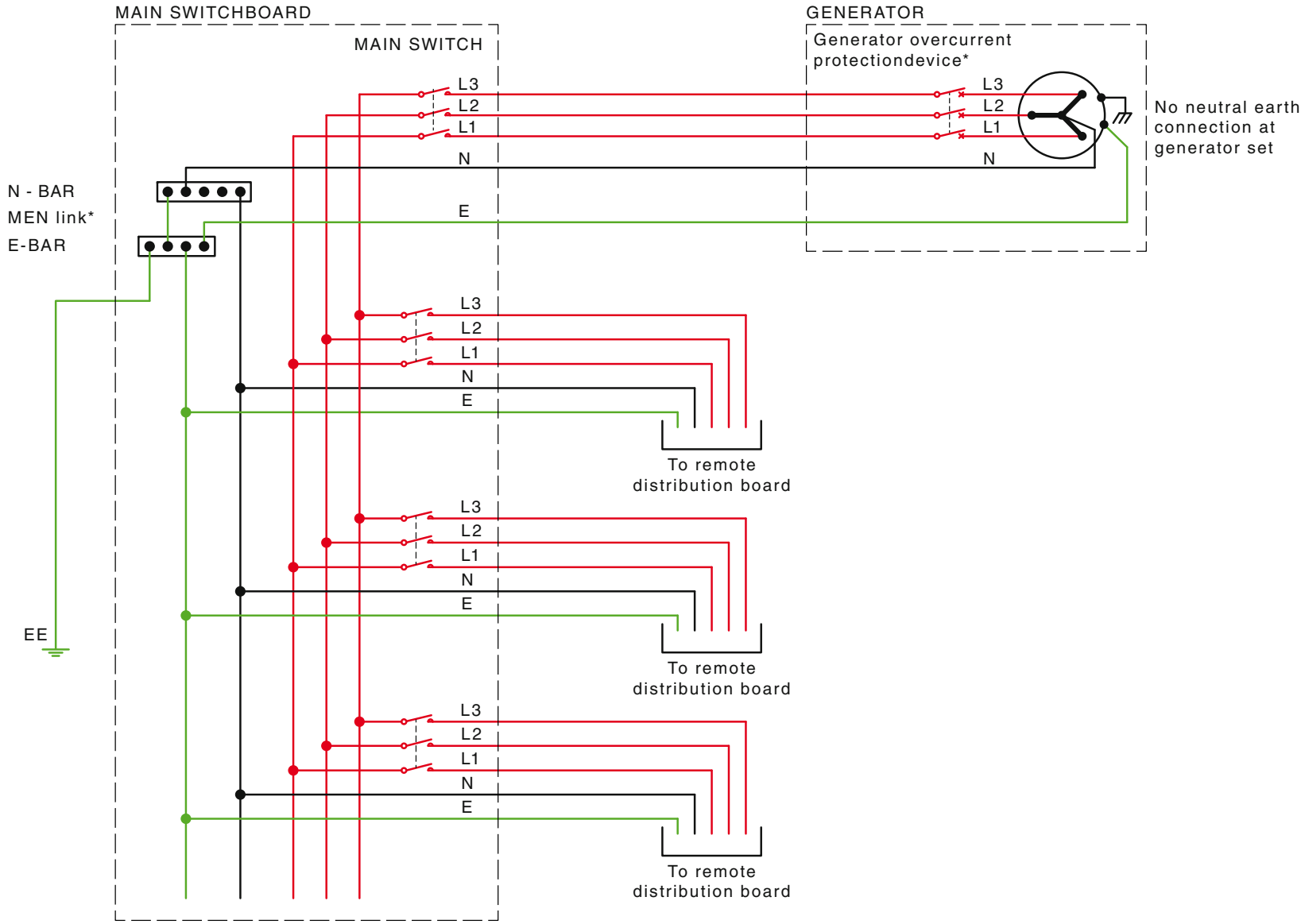
NOTE: See Clause 2.11.1.2.

FIGURE 2.10 TYPICAL ARRANGEMENT FOR A SINGLE THREE-PHASE GENERATING SET INSTALLED AS SITE SUPPLY TO THE MAIN SWITCHBOARD WITH A MEN LINK INSTALLED



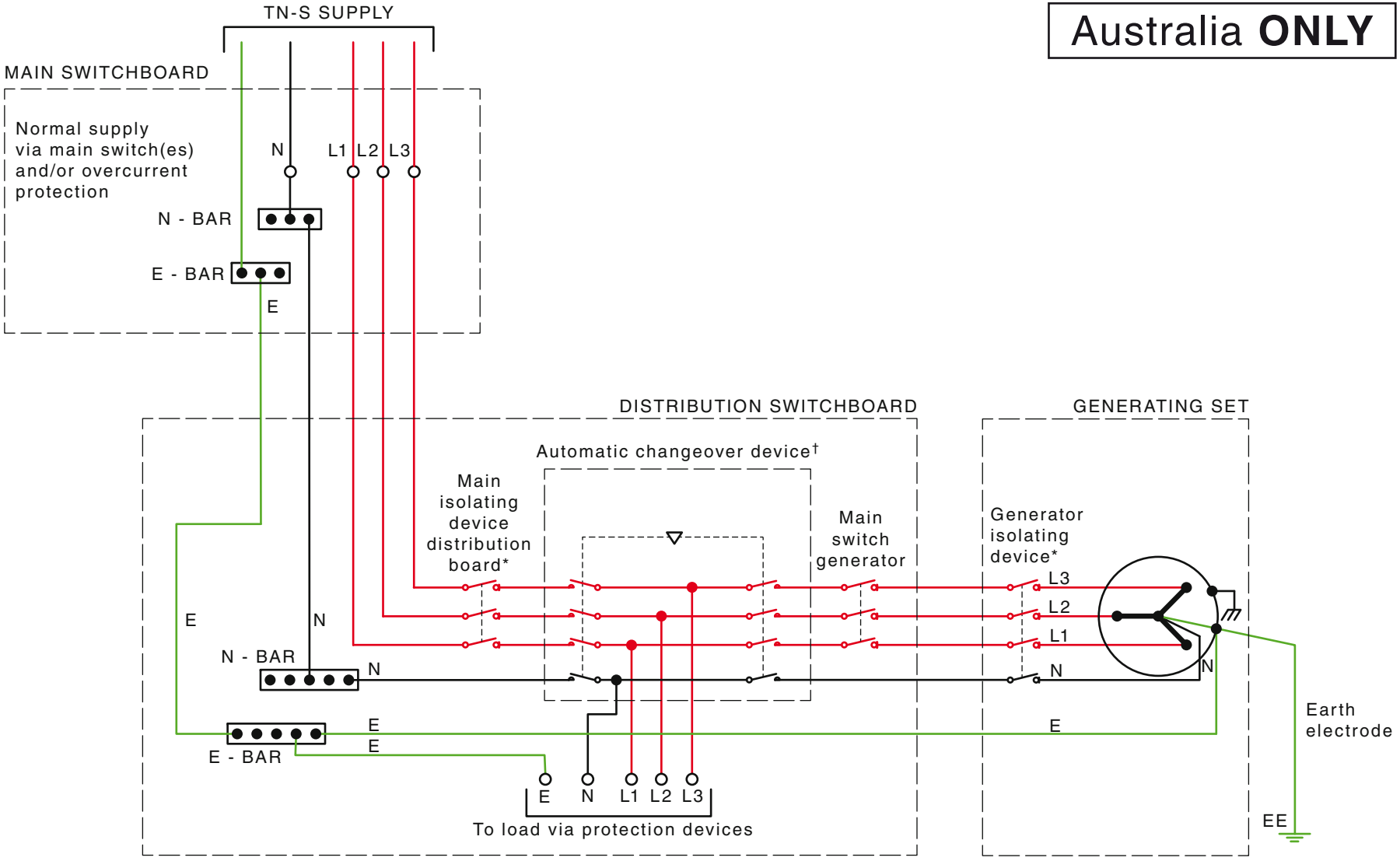
NOTE: See Clause 2.11.1.2.

FIGURE 2.11 TYPICAL ARRANGEMENT FOR A SINGLE THREE-PHASE GENERATING SET AND INTEGRAL SWITCHBOARD INSTALLED AS SITE SUPPLY WITH SUBMAINS TO OTHER SITE STRUCTURES



NOTE: See Clause 2.11.1.2.

FIGURE 2.12 TYPICAL ARRANGEMENT FOR A SINGLE THREE-PHASE GENERATING SET INSTALLED AS SITE SUPPLY TO AN EXTERNAL MAIN SWITCHBOARD WITH A MEN LINK INSTALLED AND SUBMAINS TO OTHER SITE STRUCTURES



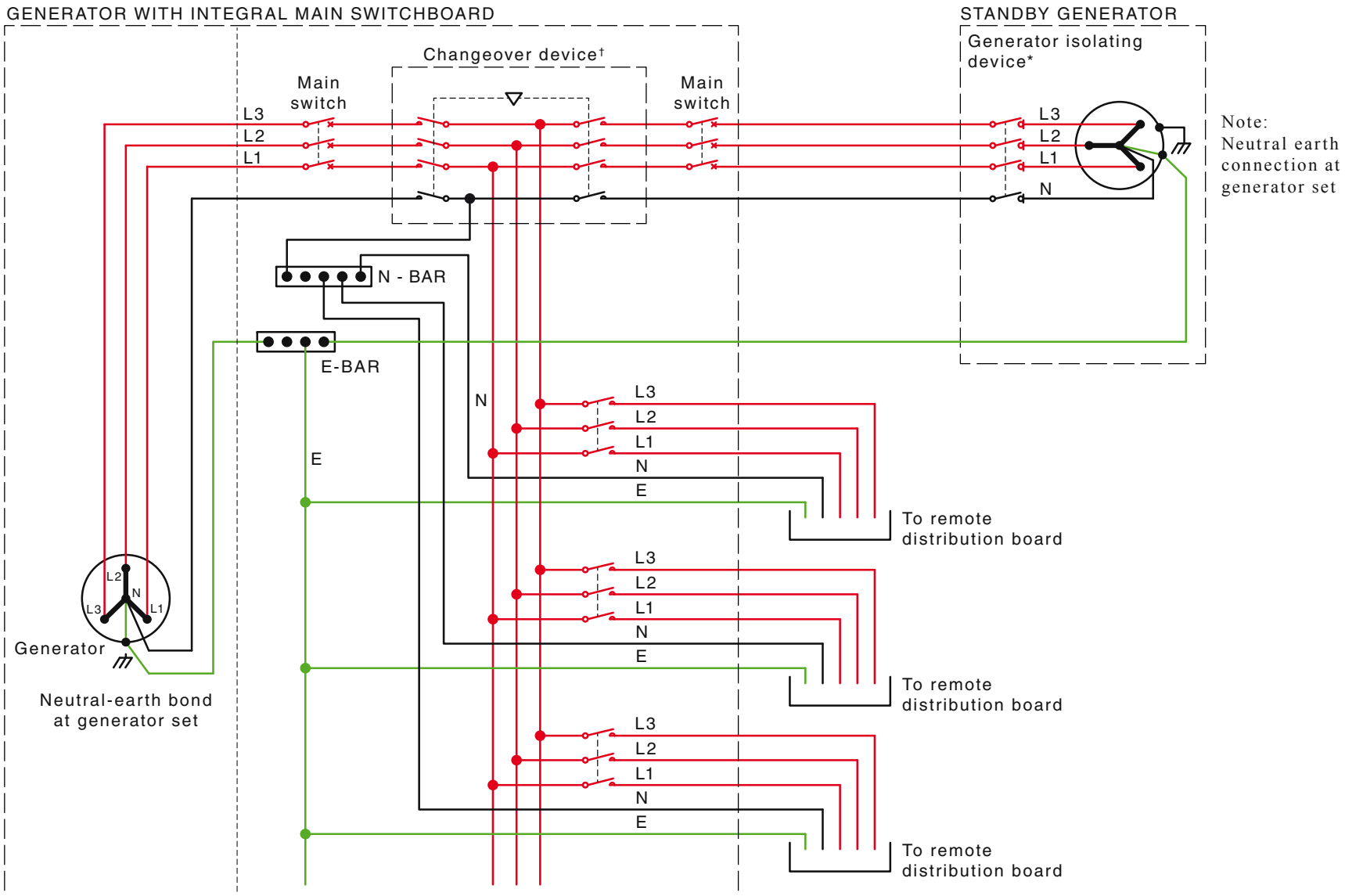
† Synchronisation and control equipment not shown

FIGURE 2.13 TYPICAL FOUR POLE/FOUR POLE AUTOMATIC CHANGEOVER ARRANGEMENT FOR A SINGLE THREE-PHASE GENERATING SET WITH FOUR POLE LOCAL ISOLATION PERMANENTLY INSTALLED AS AN ALTERNATIVE SUPPLY, CONNECTED TO A SWITCHBOARD WITH A TN-S EARTHING SYSTEM

NOTES TO FIGURE 2.13:

1 For guidance on the sizing of the neutral and earth conductors, see Clause 2.11.

2 The generator and normal supply should both be isolated when undertaking repair or maintenance of the main switchboard.

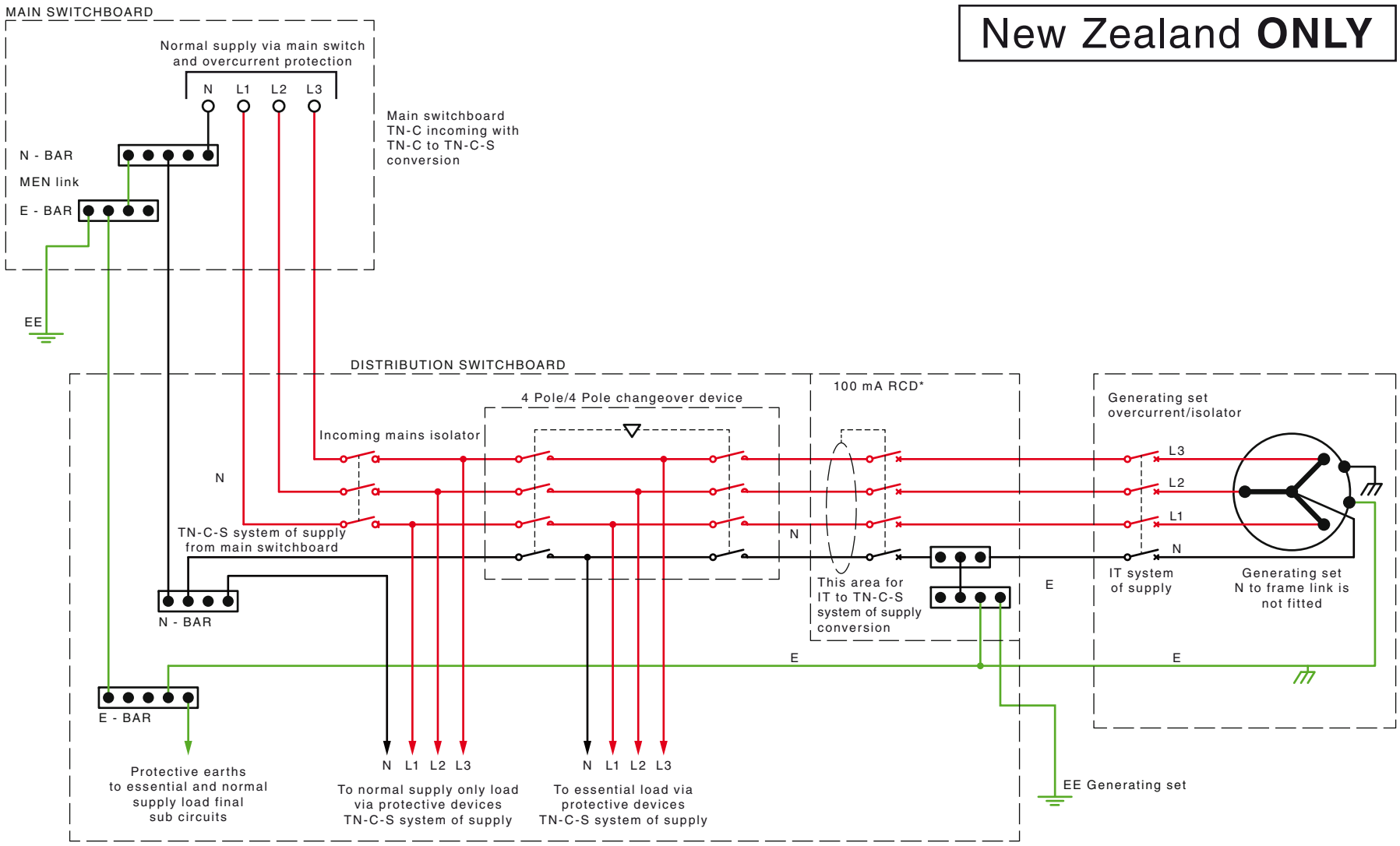


NOTES:

1 See Clause 2.12.2.

2 For this application, earth electrodes are not required as they serve no benefit. See Appendix A.

FIGURE 2.14 TYPICAL FOUR POLE/FOUR POLE AUTOMATIC CHANGEOVER ARRANGEMENT FOR A PRIMARY THREE-PHASE GENERATING SET INSTALLED AS SITE SUPPLY AND A SECONDARY THREE-PHASE GENERATING SET INSTALLED AS ALTERNATIVE SUPPLY A TN-S EARTHING SYSTEM



*Provides protection against earth fault and EPR

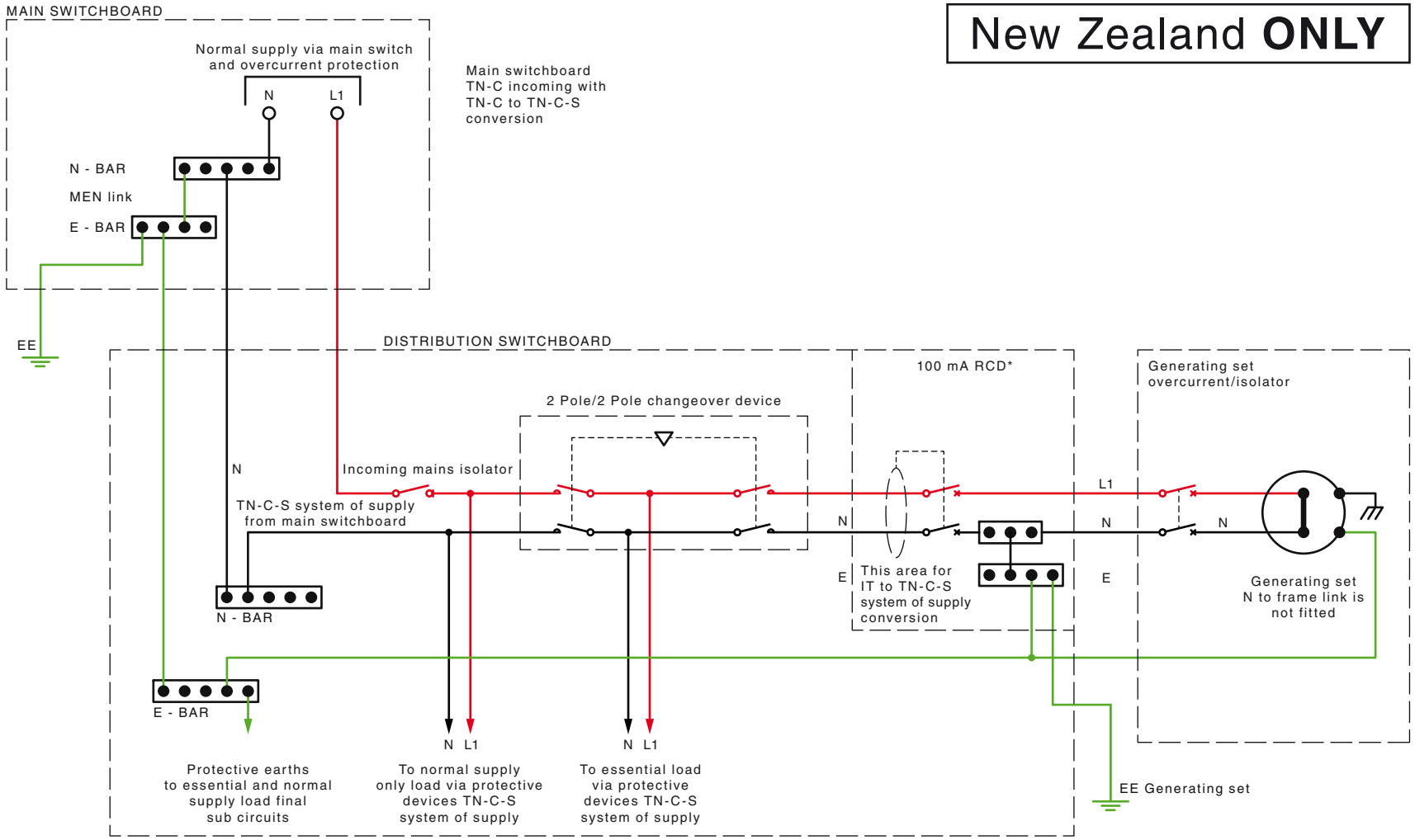
NOTES:

1 Provides protection against earth fault and EPR.

2 See Clause 2.7.10.2.

FIGURE 2.15 TYPICAL FOUR POLE/FOUR POLE CHANGEOVER ARRANGEMENT FOR A THREE-PHASE GENERATOR WITHOUT N TO FRAME LINK FITTED WITH FOUR POLE ISOLATOR PERMANENTLY AS AN ALTERNATIVE SUPPLY, CONNECTED TO A SWITCHBOARD WITHOUT A MEN LINK INSTALLED

New Zealand **ONLY**



*Provides protection against earth fault and EPR

NOTES:

1 Provides protection against earth fault and EPR.

2 See Clause 2.7.10.2.

FIGURE 2.16 TYPICAL TWO POLE/TWO POLE CHANGEOVER ARRANGEMENT FOR A SINGLE-PHASE GENERATOR WITHOUT N TO FRAME LINK FITTED WITH TWO POLE ISOLATOR PERMANENTLY AS AN ALTERNATIVE SUPPLY, CONNECTED TO A SWITCHBOARD WITHOUT A MEN LINK INSTALLED

SECTION 3 ADDITIONAL REQUIREMENTS FOR PERMANENTLY CONNECTED GENERATING SETS

3.1 GENERAL

This Section gives particular requirements for generating sets that are permanently connected to electrical installations, specific equipment or services. These provisions shall be applied in addition to the general requirements for generating sets given in Section 2 of this Standard.

3.2 LOCATION

3.2.1 General

Permanently connected generating sets shall be located and installed in accordance with Clause 2.2 and, in addition, means shall be provided to prevent the entrance of, or interference by, unauthorized persons by the erection of suitable fences, screens, partitions, walls or similar barriers. Such barriers shall not impede the access required for authorized persons for maintenance, testing or inspection as provided in Clause 3.2.2.

This shall not preclude the installation of a generating set in an enclosure or room with other equipment for which access is similarly restricted to authorized persons.

3.2.2 Access space for generating sets

Adequate space shall be provided around a generating set on all sides where persons are to pass, to enable all equipment to be safely and effectively repaired, operated and adjusted.

NOTE: Attention is drawn to additional requirements that may be specified by relevant regulatory authorities.

3.2.3 Exit from generating set area

3.2.3.1 *General*

Where a permanently connected generating set is installed in a room or enclosure the requirements of Clauses 3.2.3.2 to 3.2.3.4 shall apply.

3.2.3.2 *Number of openings*

At least one door or opening shall be provided to enable a person to leave the vicinity of a generating set. However, where any generating set—

(a) has a rated output exceeding 100 kVA; or

(b) is driven by a petrol engine,

not less than two openings or doorways, spaced well apart, shall be provided.

3.2.3.3 *Opening and locking of doors*

All barriers or doors provided to prevent the entry of unauthorized persons to any room or enclosure containing a generating set shall open outwards away from the generating set without the use, on the generating set side of the door, of a key or tool.

3.2.3.4 *Size of doors and openings*

Doors and openings providing entrance to and exit from a generating set area shall have a height of not less than 2.2 m from the floor or walked on surface and a width of not less than 0.9 m.

NOTE: Larger openings may be required to enable entry of a fully assembled generating set.

3.2.4 Ventilation

Any room or enclosure containing a permanently connected generating set shall have adequate ventilation to provide—

(a) removal of engine combustion air, removal of heat radiated from the engine, generating set mounted radiator, exhaust system and output generator to the generating set manufacturer's instructions or recommendations; and

(b) removal of dangerous concentrations of toxic and explosive fumes and gasses.

NOTE: AS 1668.2 gives guidance for contaminant control in buildings using ventilation.

In rooms or enclosures that require the use of electric fan(s) for provision of cooling air for a generating set, provide for the continued operation of such fan(s) immediately after the shutdown of engine to remove the heat radiating from the engine and exhaust system until the room temperature is equal to the ambient conditions.

3.2.5 Noise containment

Any room or enclosure containing a permanently connected generating set, and the exhaust system, shall be arranged so that when the generating set is running at a maximum loading, the noise emitted shall be less than the maximum limits specified by any relevant authority

3.2.6 Lighting

Adequate lighting shall be provided to enable—

(a) all equipment and controls to be effectively and safely operated; and

(b) in the case of generator set failure, adequate lighting shall be provided to allow repairs to be made to any equipment requiring repair.

3.3 GUARDING OF LIVE PARTS

3.3.1 General

In addition to conforming with the general requirements of Clause 2.5, the requirements of Clauses 3.3.2 and 3.3.3 shall apply to permanently connected generating sets.

3.3.2 Walked on surfaces

Walked on surfaces that are located above exposed live parts shall have no openings. Kickboards at least 0.15 m high and handrails shall be provided at all edges of the walked on surfaces.

3.3.3 Outdoor locations

Exposed live parts in outdoor locations shall be enclosed by security fences or walls not less than 2.5 m high and provided with danger notices in accordance with the provisions for outdoor substations in AS 1319.

3.4 TRANSFORMERS

The secondary circuits of instrument transformers shall be effectively earthed except where functional requirements do not permit earthing of such circuits.

Current transformers shall have provision for short-circuiting the secondary winding.

3.5 GENERATING SETS SUPPLYING SAFETY AND ESSENTIAL SERVICES

3.5.1 General

Generating sets providing supply to safety and essential services to ensure the continuation of the electrical supply to safety and essential services such as fire and smoke control equipment, evacuation equipment and lifts, as outlined in AS/NZS 3000, life preserving equipment, airport safety equipment, airport traffic control and other essential services shall conform with the additional requirements of Clauses 3.5.2 to 3.5.7 and AS/NZS 3000.

NOTE: See Figures 3.1 to 3.4 for typical arrangements.

3.5.2 Type

The generating set supplying the safety and essential services, its auxiliaries and associated equipment shall conform with the following requirements:

(a) Where required, be capable of maintaining an adequate supply for a period sufficient to enable the evacuation of all persons to an area of safety.

(b) Be provided with sufficient fuel for the running of the generating set for a minimum of 2 h.

(c) Be provided with protection ensuring fire resistance for a minimum of 2 h.

(d) Be permanently connected to the electrical installation.

(e) Not be adversely affected by the failure of the normal supply.

(f) Not be used for purposes other than the supply of safety or essential services except as permitted in Clause 3.5.5.

NOTE: The consequences of an extended loss of normal supply may also have to be taken into consideration.

3.5.3 Overcurrent protection

Overcurrent protective devices shall be selected and installed to avoid an overcurrent in one circuit impairing the correct operation of other circuits. The reliability of supply, including discrimination of overcurrent protective devices, shall be in accordance with AS/NZS 3000.

3.5.4 Paralleling sources of supply

Sources of supply not intended to be connected and operated in parallel shall be prevented from being so connected (e.g. by switching or mechanical or electrical interlocks).

3.5.5 Supply of other than safety services or essential services

A single generating set shall not be used for purposes other than the supply of essential or safety services in accordance with Clause 3.5.1 unless suitable precautions are taken to ensure that the supply to the essential or safety services will not be affected by the additional loading under any conditions of operation.

Where more than one emergency supply system provides a source of supply, such sources may be used for the supply of other than emergency systems or safety services provided that, in the event of failure of one source, the supply remaining available will be sufficient for the operation of all emergency systems or safety services.

NOTE: This requirement generally necessitates the automatic load-shedding of circuits not supplying emergency systems or safety services.

3.5.6 Automatic changeover to an emergency essential or supply system

Where an alternative supply is provided, an automatic changeover switch shall be installed on the main switchboard to allow supply for the alternative system to be connected to the safety services.

The time taken for automatic changeover to an emergency supply system shall not be greater than that permitted by safety considerations for the type of load supplied.

Changeover times are classified as follows:

(a) *No break* An automatic supply that can ensure a continuous supply within specified conditions during the period of transition, e.g. as regards variations in voltage and frequency.

(b) *Short break* An automatic supply available within 1 s.

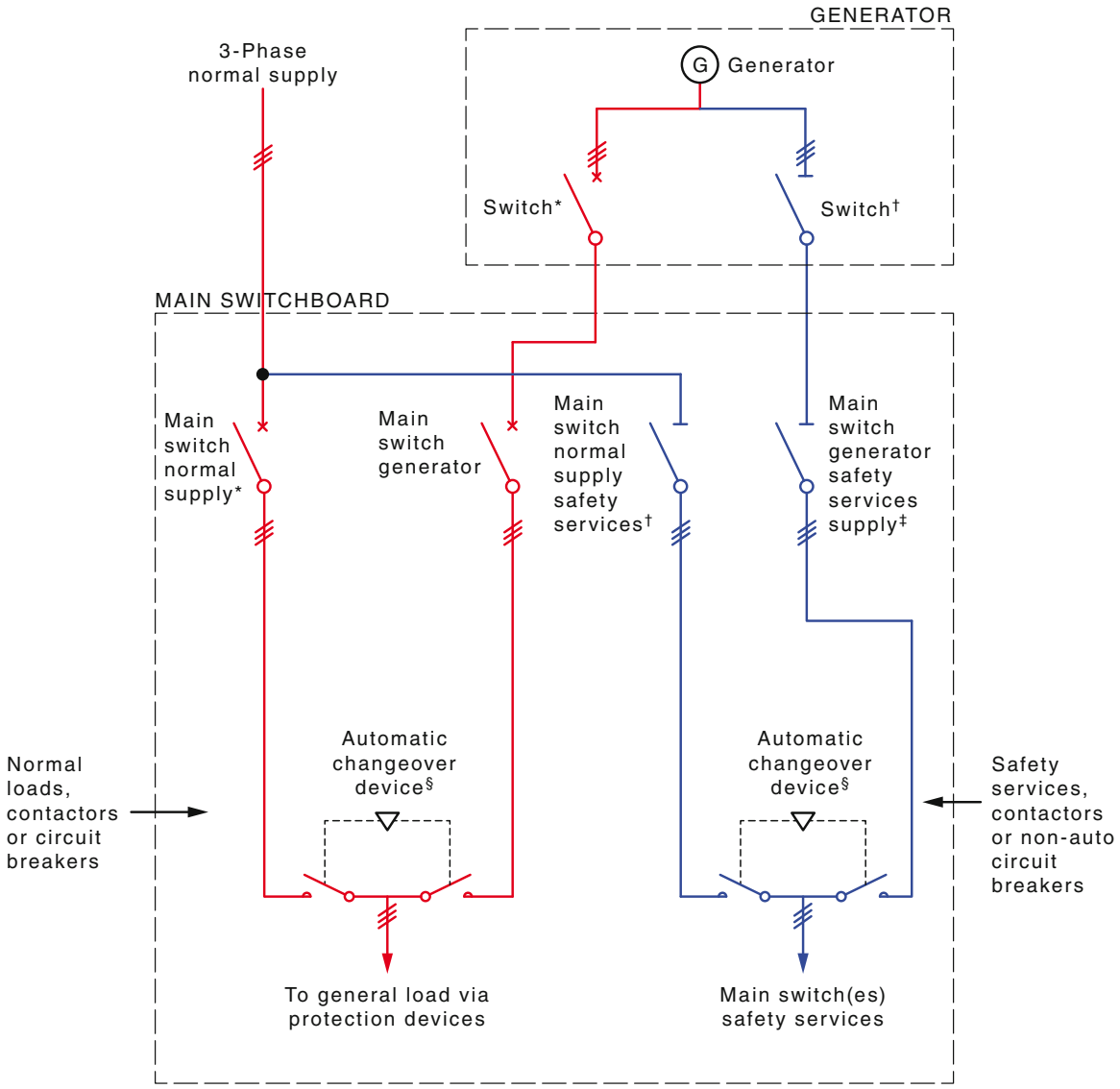
(c) *Medium break* An automatic supply available within 30 s.

(d) *Long break* An automatic supply available in more than 30 s.

NOTE: Where no break in supply can be tolerated, it is not uncommon for the generating set to be run continuously as the normal supply and the electricity distribution system used as the alternative supply system. As stated in Clause 1.1, such forms of supply are not covered in this Standard except for minimum requirements that affect safety.

3.5.7 Switchgear

With the exception of any alarm devices, all switchgear and control gear controlling the output of a generating set or the remote control of a generating set providing supply for essential or safety services, shall be clearly and permanently identified and grouped in locations accessible only to authorized persons.



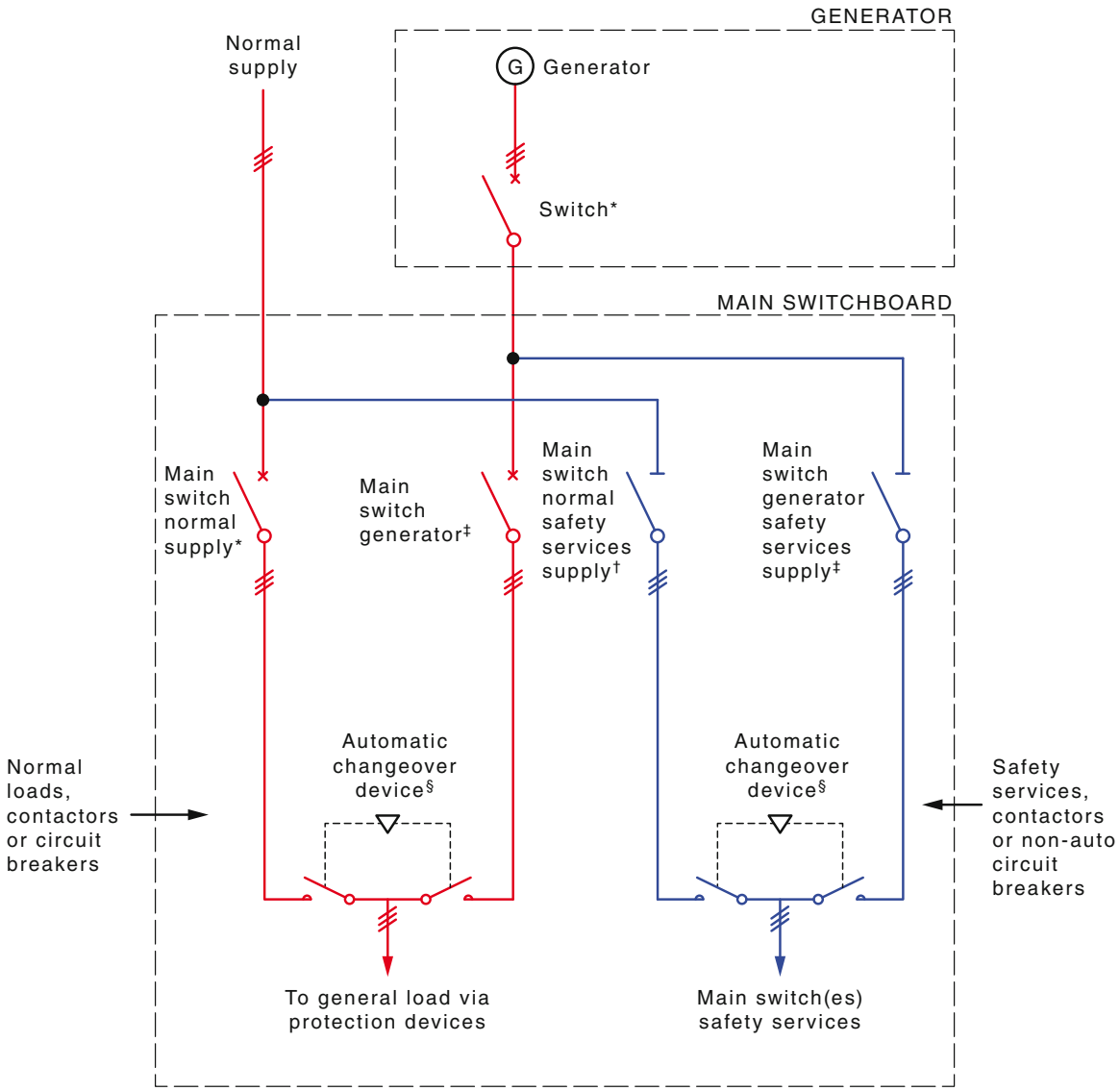
* Overcurrent device.
† Safety services short circuit protection only.
‡ Locking arrangement refer AS/NZS 3000.
§ Synchronisation and control equipment not shown.

NOTES:

1 Switchboard internal separation requirements in accordance with AS/NZS 3000.

2 See Clause 3.5.1.

FIGURE 3.1 TYPICAL ARRANGEMENTS FOR NORMAL AND GENERATOR SUPPLY INCLUDING LOCATION OF AUTOMATIC CHANGEOVER DEVICE FOR AN INSTALLATION CONTAINING SAFETY SERVICES



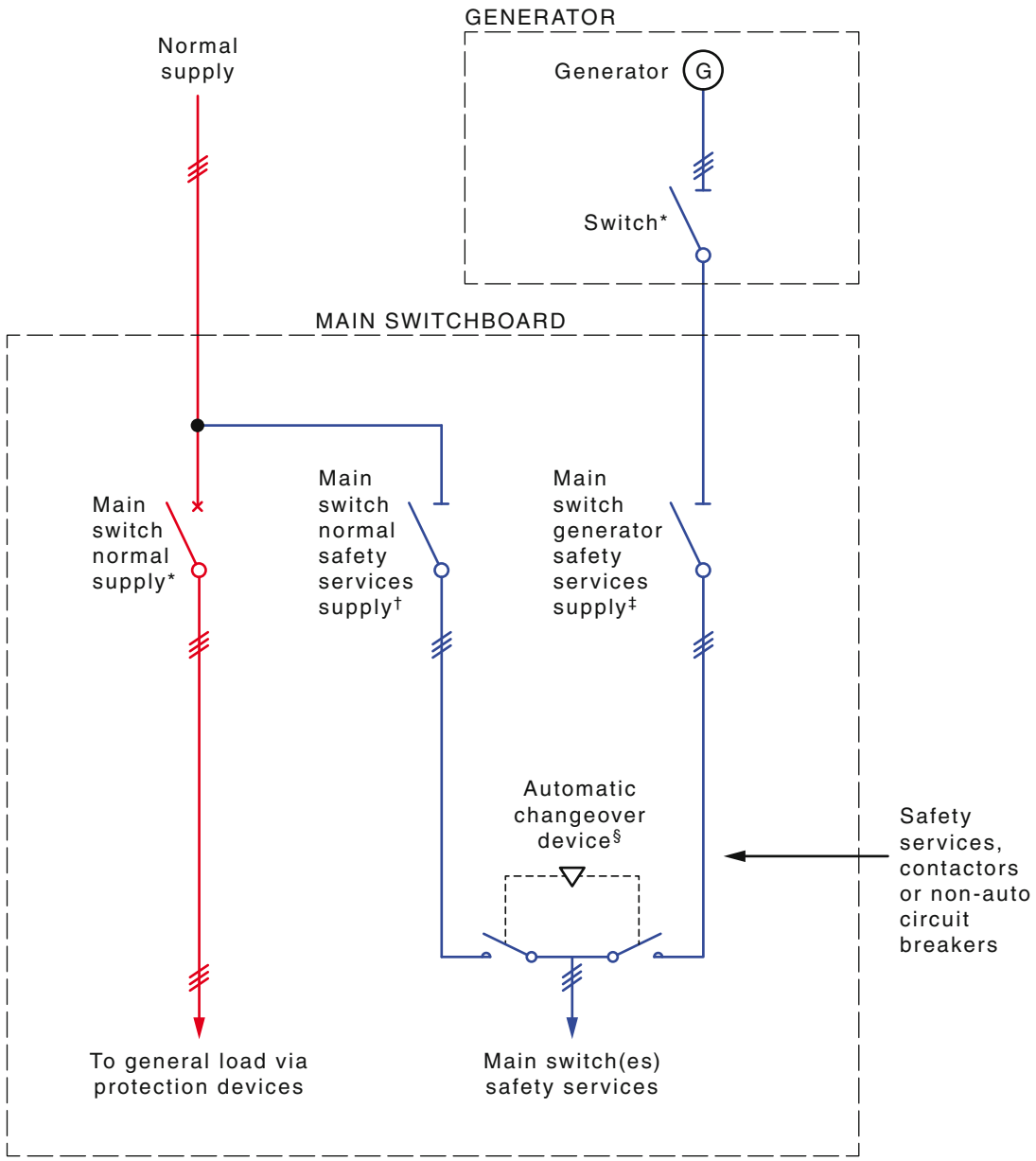
* Overcurrent device.
† Safety services short circuit protection only.
‡ Locking arrangement refer AS/NZS 3000.
§ Synchronisation and control equipment not shown.

NOTES:

1 Switchboard internal separation requirements in accordance with AS/NZS 3000.

2 See Clause 3.5.1.

FIGURE 3.2 TYPICAL ARRANGEMENTS FOR NORMAL AND GENERATOR SUPPLY INCLUDING LOCATION OF AUTOMATIC CHANGEOVER DEVICE FOR AN INSTALLATION CONTAINING SAFETY SERVICES



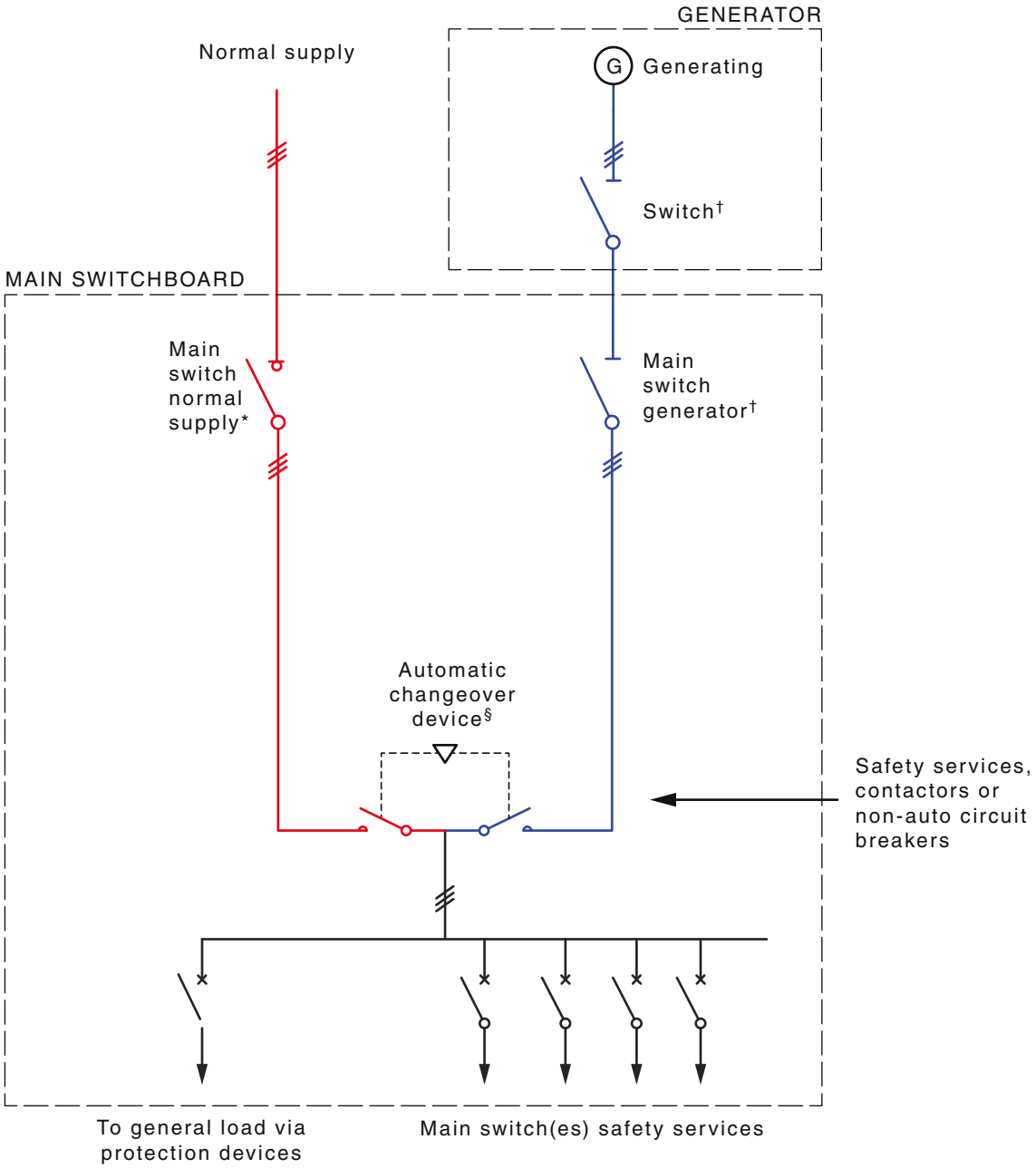
* Overcurrent device.
† Safety services short circuit protection only.
‡ Locking arrangement refer AS/NZS 3000.
§ Synchronisation and control equipment not shown.

NOTES:

1 Switchboard internal separation requirements in accordance with AS/NZS 3000.

2 See Clause 3.5.1.

FIGURE 3.3 TYPICAL ARRANGEMENTS FOR NORMAL SUPPLY TO ALL SERVICES AND GENERATOR SUPPLY TO SAFETY SERVICES ONLY INCLUDING LOCATION OF AUTOMATIC CHANGEOVER DEVICE FOR AN INSTALLATION CONTAINING SAFETY SERVICES



* Overcurrent device.
† Safety services short circuit protection only.
‡ Locking arrangement refer AS/NZS 3000.
§ Synchronisation and control equipment not shown.

NOTES:

1 Switchboard internal separation requirements in accordance with AS/NZS 3000.

2 See Clause 3.5.1.

FIGURE 3.4 TYPICAL ARRANGEMENTS FOR NORMAL SUPPLY AND GENERATOR SUPPLY TO ALL SERVICES INCLUDING LOCATION OF AUTOMATIC CHANGEOVER DEVICE FOR AN INSTALLATION CONTAINING SAFETY SERVICES

SECTION 4 ADDITIONAL REQUIREMENTS FOR PORTABLE GENERATORS

4.1 GENERAL

This Section specifies additional requirements for generating sets that are connected to an electrical installation by means of a detachable connection [e.g. flexible cable (or cord) with plug and cord connector fittings].

Such connections are generally of a temporary nature where an independent or alternative supply is required and where—

(a) the installation of a permanently connected generating set is not justified; and

(b) the connection of the generating set is expected to be carried out by non-qualified persons.

The additional requirements shall be applied to the general requirements for generating sets given in Section 2 of this Standard when connected by installation wiring to the appliance inlet connector.

NOTES:

1 An example of connecting a generating set to an electrical installation main switchboard by a detachable connection are shown in Figure 4.2 for three-phase and Figure 4.3 for single-phase.

2 Other earthing systems Alternatives to MEN and segregated earthing systems may be permitted, provided that the requirements of Part 1 of AS/NZS 3000 are satisfied, e.g. TN-S earthing.

This Section does not apply to generating sets used for the direct supply to portable tools and appliances using the socket outlet(s) fitted to the generating set, see Appendix B for guidance.

4.2 CONNECTION TO AN ELECTRICAL INSTALLATION

4.2.1 General

Where a generating set is connected to an electrical installation through a detachable connection, the connection arrangement shall provide the connections of the corresponding active, neutral, protective earthing and bonding conductors of the isolated output generating set to the electrical installation.

4.2.2 Connection to an installation

Where a generating set is to be connected to an electrical installation by detachable connection, the arrangement shall provide facilities for connection of the corresponding active, neutral, protective earthing and bonding conductors of the generating set and the electrical installation respectively.

4.2.3 Connection

The cord extension socket, cord extension set and socket outlet types used for low voltage socket outlet connections shall be as follows:

(a) Single-phase—

  (i) AS/NZS 3112 (3-pin flat pin) up to 15 A;

  (ii) AS/NZS 3120 (3-pin flat pin) up to 15 A;

  (iii) AS/NZS 3123 (round pins) above 15 A; or

  (iv) IEC 60309 (round pins) above 15 A.

(b) Three-phase—

(i) AS/NZS 3123 (round pins) above 15 A; or

(ii) IEC 60309 (round pins) above 15 A.

When cord extension socket, cord extension set and socket outlet types exceeding the current ratings available for the above listed Standards are required, the detachable connection fittings should conform with other Australian, Australian/New Zealand or international Standards requirements.

4.3 EARTHING AND BONDING

4.3.1 General

The earthing and equipotential bonding requirements for plug and socket outlet connected generating sets shall be in accordance with Clause 2.8.

Attention is drawn to the provisions of Clause 2.8 which require the generating set bonding system to be connected to the exposed conductive parts of any generating set and to the earthing system of the electrical installation.

4.3.2 Connection of generating set windings

4.3.2.1 *Multi-phase and single-phase generating sets*

The active or actives of the generating set windings shall be connected to the active conductor(s) of the switchboard of the electrical installation in accordance with Clause 2.8.4.

The neutral of the generating set windings shall be connected to the neutral conductor of the switchboard of the electrical installation in accordance with Clause 2.8.1.

The generating set frame and the alternator frame shall be connected together to form a common equipotential bonding system and shall be connected to the earth bar of the switchboard of the electrical installation.

4.3.2.2 *Earth electrode*

The connection of the portable generating set equipotential bonding system to the switchboard earthing system provides the protective earthing requirement as detailed in AS/NZS 3000.

The connection of a portable generating set equipotential bonding system to the general mass of earth through a separate earth electrode is not a general requirement of this Standard.

NOTE: In New Zealand, when connecting a generator supply at a switchboard without a neutral earth connection, an earth electrode is required in accordance with Clause 2.7.10.2 (b).

Appendix A explains why the connection of the generator equipotential bonding system to the general mass of the earth is not permitted other than via an electrical installation's earth electrode in accordance with AS/NZS 3000.

4.3.2.3 *Current limiting of the incoming supply*

Each incoming supply to the installation from a generating set shall be protected by a separate overcurrent protection device located within the electrical installation and, operating in all live (active and neutral) conductors.

The operating setting of the protection device shall not exceed the rating of either the supply conductors or the inlet fittings.

4.3.2.4 *Enclosure of live parts*

The electrical installation supply inlet and the generator socket outlet connection shall not expose live parts to direct contact while disconnected or in the normal process of cord extension set insertion or withdrawal.

The neutral pin of the electrical installation supply inlet is considered to be a live part and shall be isolated from the main switchboard neutral connection by the changeover device when in the normal supply or 'off' positions.

NOTE: See Figures 4.1 to 4.3.

4.3.2.5 *Marking*

Any inlet connection fitting provided for the connection of a generating set shall be permanently marked to indicate its purpose.

The marking shall include the following wording:

ISOLATED output generating set only.

RCD protected and centre tapped generating sets shall not be connected.

4.3.2.6 *Control of socket outlets*

Any single- or multi-phase socket outlet installed on the generating set shall be provided with an isolating device that operates in all active conductors.

NOTE: See Figures 4.1 to 4.3.

4.4 CONNECTION OF A PORTABLE GENERATING SET TO A DEDICATED WIRING SYSTEM—NEW ZEALAND ONLY NZ

In New Zealand only, for the connection of a portable generating set to a dedicated wiring system contained in an electrical installation, see Appendix C for details.

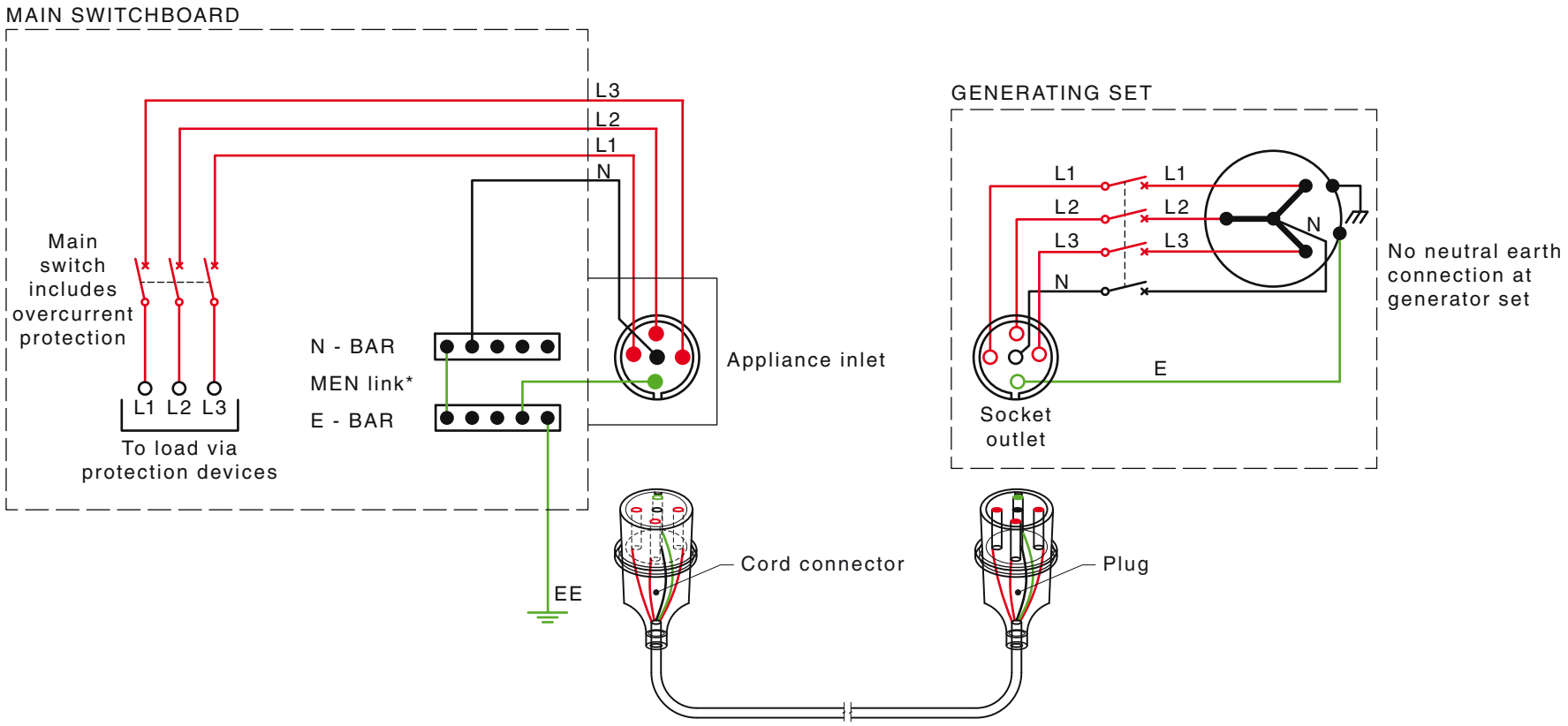
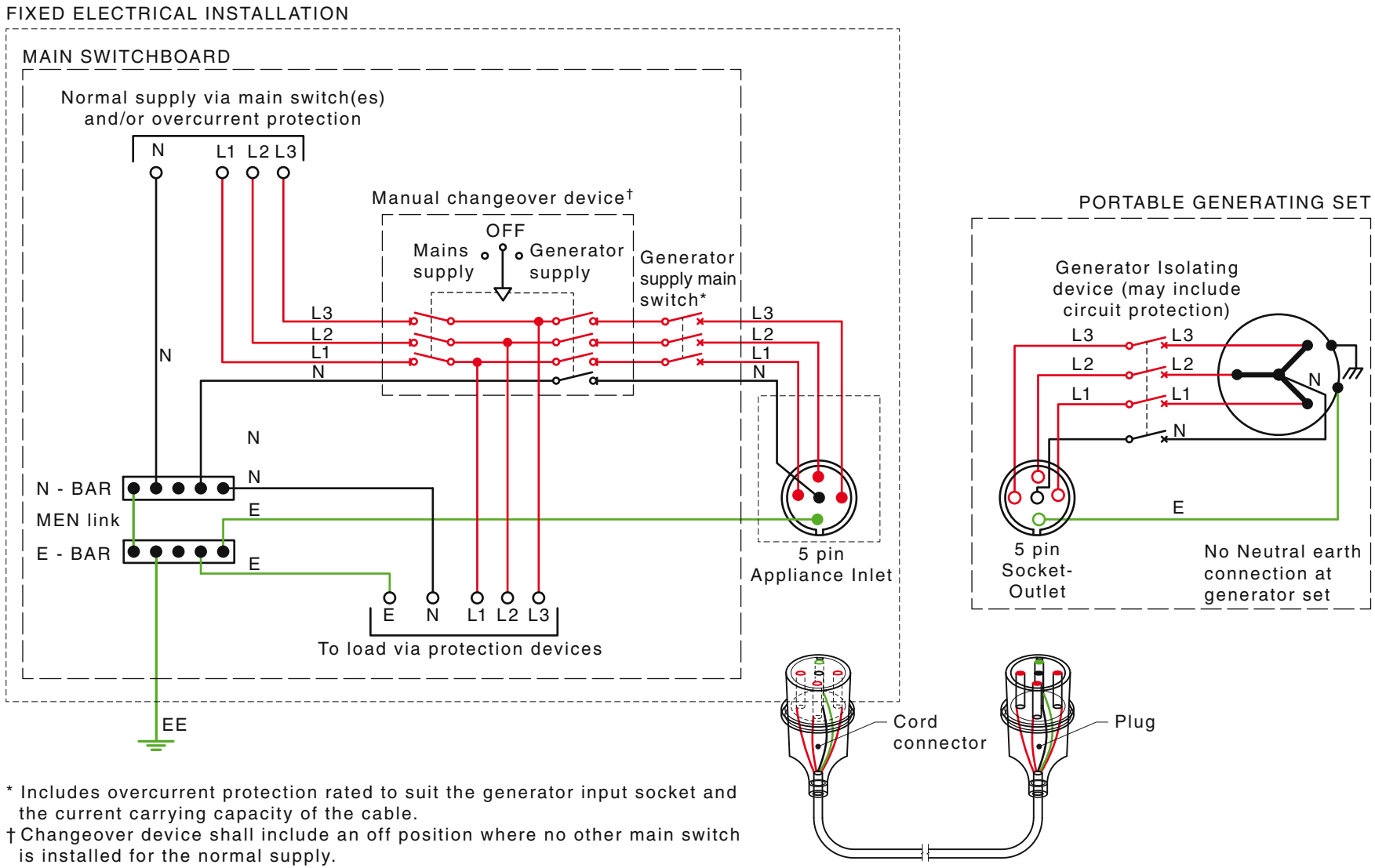


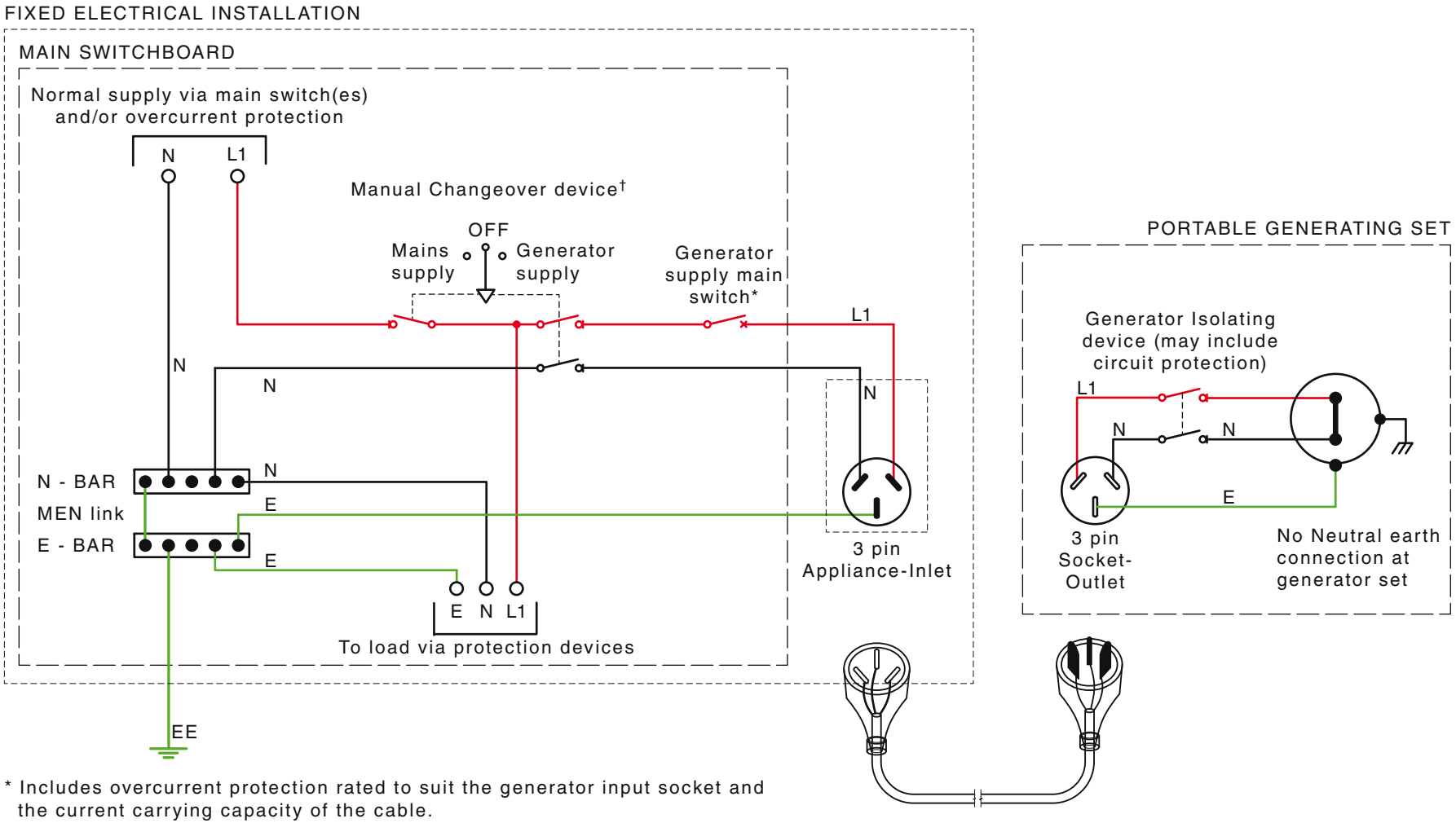
FIGURE 4.1 TYPICAL ARRANGEMENT FOR A SINGLE GENERATING SET CONNECTED VIA SOCKET AND LEAD AS THE PRIMARY SUPPLY TO A MAIN SWITCHBOARD WHICH HAS A MEN LINK INSTALLED



* Includes overcurrent protection rated to suit the generator input socket and the current carrying capacity of the cable.

† Changeover device shall include an off position where no other main switch is installed for the normal supply.

FIGURE 4.2 TYPICAL THREE POLE/FOUR POLE MANUAL CHANGEOVER ARRANGEMENT FOR A THREE-PHASE PORTABLE GENERATING SET WITH THREE POLE LOCAL ISOLATION INSTALLED AS AN ALTERNATIVE SUPPLY, CONNECTED VIA SOCKET AND LEAD TO A SWITCHBOARD WITH A MEN LINK INSTALLED



* Includes overcurrent protection rated to suit the generator input socket and the current carrying capacity of the cable.

† Changeover device shall include an off position where no other main switch is installed for the normal supply.

FIGURE 4.3 TYPICAL ONE POLE/TWO POLE MANUAL CHANGEOVER ARRANGEMENT FOR A SINGLE-PHASE PORTABLE GENERATING SET WITH TWO POLE LOCAL ISOLATION INSTALLED AS AN ALTERNATIVE SUPPLY, CONNECTED VIA SOCKET AND LEAD TO A SWITCHBOARD WITH A MEN LINK INSTALLED

APPENDIX A

EARTHING REQUIREMENTS FOR GENERATING SETS CONNECTED TO FIXED ELECTRICAL INSTALLATIONS

(Normative)

A1 GENERAL

This Appendix specifies the earthing connections required for generating sets connected to an electrical installation as an alternative source of supply.

This Appendix explains the reasons why an earth electrode is not required or recommended to be connected to the generator set.

A2 EARTHING OF GENERATING SETS CONNECTED TO AN ELECTRICAL INSTALLATION BY INSTALLATION WIRING

A2.1 System of supply

Where an electrical installation is arranged to operate from multiple sources of supply (such as occurs when normally supplied by an electricity distributor's network, or alternatively from a generating set output), the system of supply configuration connected to the installation loading shall be the same system of supply, e.g. MEN, irrespective of the supply source.

This means that the connection to earth of the neutral and earthing connections of the generating set shall use the same earthing and neutral bonding connection points in the electrical installation.

A2.2 Earth electrode

As the electrical installation main switchboard will have an earthing system with an earth electrode in accordance with the requirements of AS/NZS 3000, the installation of an additional earth electrode for exclusive use by the generating set is not required.

A2.3 Earth bonding of neutral connection

The bonding of the generating set neutral connection to earth is dependent on the system of supply required MEN. The connection of the generating set neutral to the neutral busbar of the main switchboard MEN is the only connection required.

Figure A1 details the output connections required and shows the path of earth fault current (dotted line) under earth fault conditions located near the load when the generating set is supplying the load.

On the occurrence of an earth fault near the load; earth fault current flows through the generating set active overcurrent protection device → changeover device → final subcircuit protective device → control switch of the load → the earth fault → final subcircuit earth conductor → MEN link → generating set neutral conductor to the overcurrent device in the generating set.

The earth fault current flow would be interrupted by the tripping of the generating set overcurrent protection or final subcircuit protection.

On the occurrence of a fault between the live conductors, fault current will flow in the live conductors only and trip the overcurrent device in the generating set.

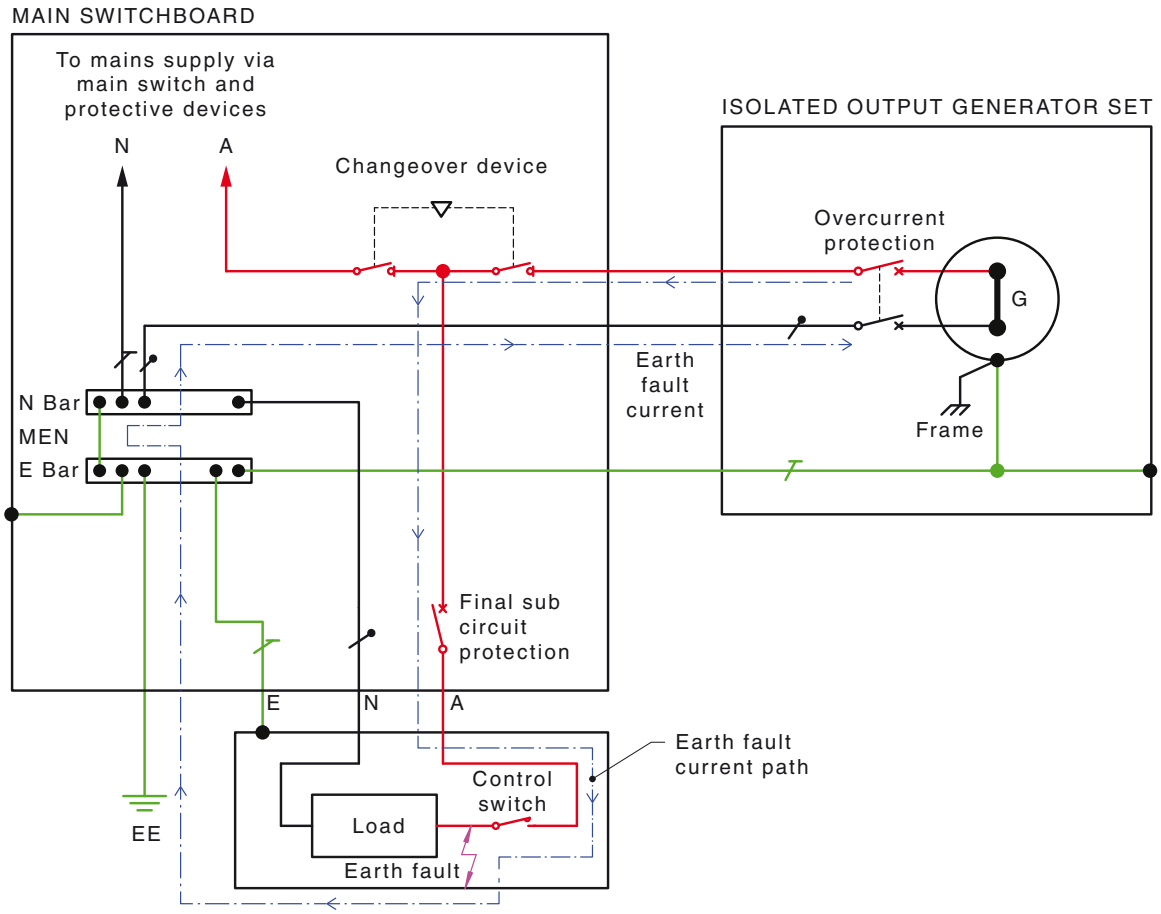


FIGURE A1 TYPICAL EARTH FAULT PATH FOR GENERATING SETS CONNECTED TO FIXED ELECTRICAL INSTALLATIONS

APPENDIX B

NZ

RECOMMENDATIONS FOR PORTABLE GENERATING SETS SUPPLYING ELECTRICAL EQUIPMENT (NEW ZEALAND ONLY)

(Informative)

B1 GENERAL

This Appendix provides information on portable or semi-portable generating sets and the equipotential bonding connections that are required for connection of a generating set to electrical appliances, electrical equipment or portable tools by means of detachable plug and socket outlet connections.

This Appendix does not detail the use of terminals on the generating set as the means of connection between the generating set and directly connected electrical appliances, electrical equipment or portable tools, as this form of connection would require connection by licensed electrical workers only.

This Appendix also covers the use of reduced low voltage (RLV) to supply electrical tools operating at 110 V supply at voltages no greater than 55 V (single-phase) or 63.5 V (three-phase) to earth when the generating set is being used to power portable tools in tunnelling locations. Details for reduced low voltage generating sets are contained in Paragraph B5.

B2 PORTABLE GENERATING SET CONFIGURATIONS

B2.1 System of supply

The system of supply provided by the generating set configuration should be one of the following:

(a) Isolated output—single-phase or multi-phase (two-phase or three-phase).

(b) RCD protected output—single-phase or multi-phase (two-phase or three-phase).

(c) Isolated output with enhanced personal protection by use of an insulation monitoring device (IMD) in accordance with IEC 61557-8.

(d) Isolated output provided by a generator set with an electronic inverter module fitted.

(e) Reduced low voltage (RLV) generating sets.

B2.2 Earthing and equipotential bonding

When a generating set output is arranged to directly supply electrical equipment, such as electrical appliances and portable tools, the earthing connections of the electrical equipment and the generating set are arranged to form a common equipotential bonding system.

This equipotential bonding arrangement ensures that the correct operation of overcurrent, and residual current devices if any, under earth fault conditions and that all earth fault leakage currents are returned to the generating set output connections.

The equipotential bonding system additionally provides touch voltage control between the conductive surfaces of the generating set and any electrical equipment fittings being supplied by the generating set.

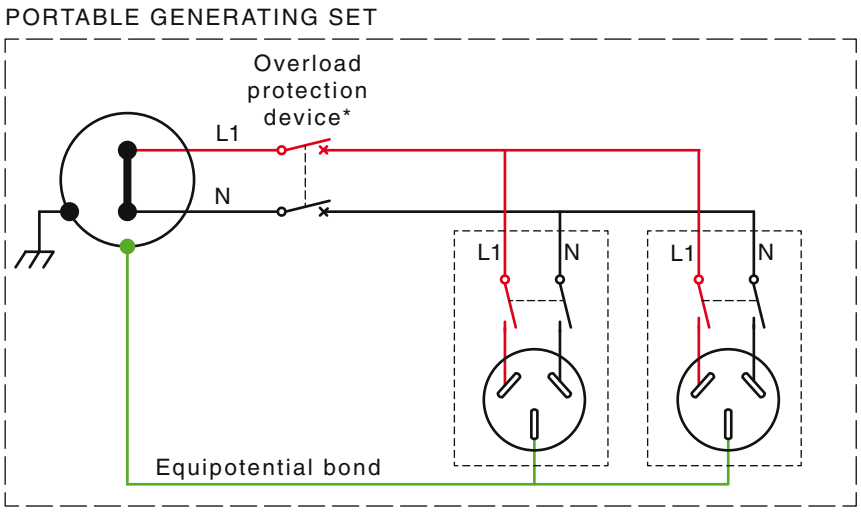
B2.3 Bonding of output winding to generating set frame

B2.3.1 *Isolated supply*

The generating set output winding is isolated from the frame of the generating set to provide electrical separation (isolated) supply to AS/NZS 3000 requirements.

Figure B1 single-phase and Figure B2 three-phase shows the internal wiring of the generating sets.

Figure B3 details the output connections and details the fault current paths under the fault conditions shown.



* Rated to suit generator socket rating and cable current carrying capacity

FIGURE B1 ISOLATED OUTPUT SINGLE-PHASE GENERATING SET

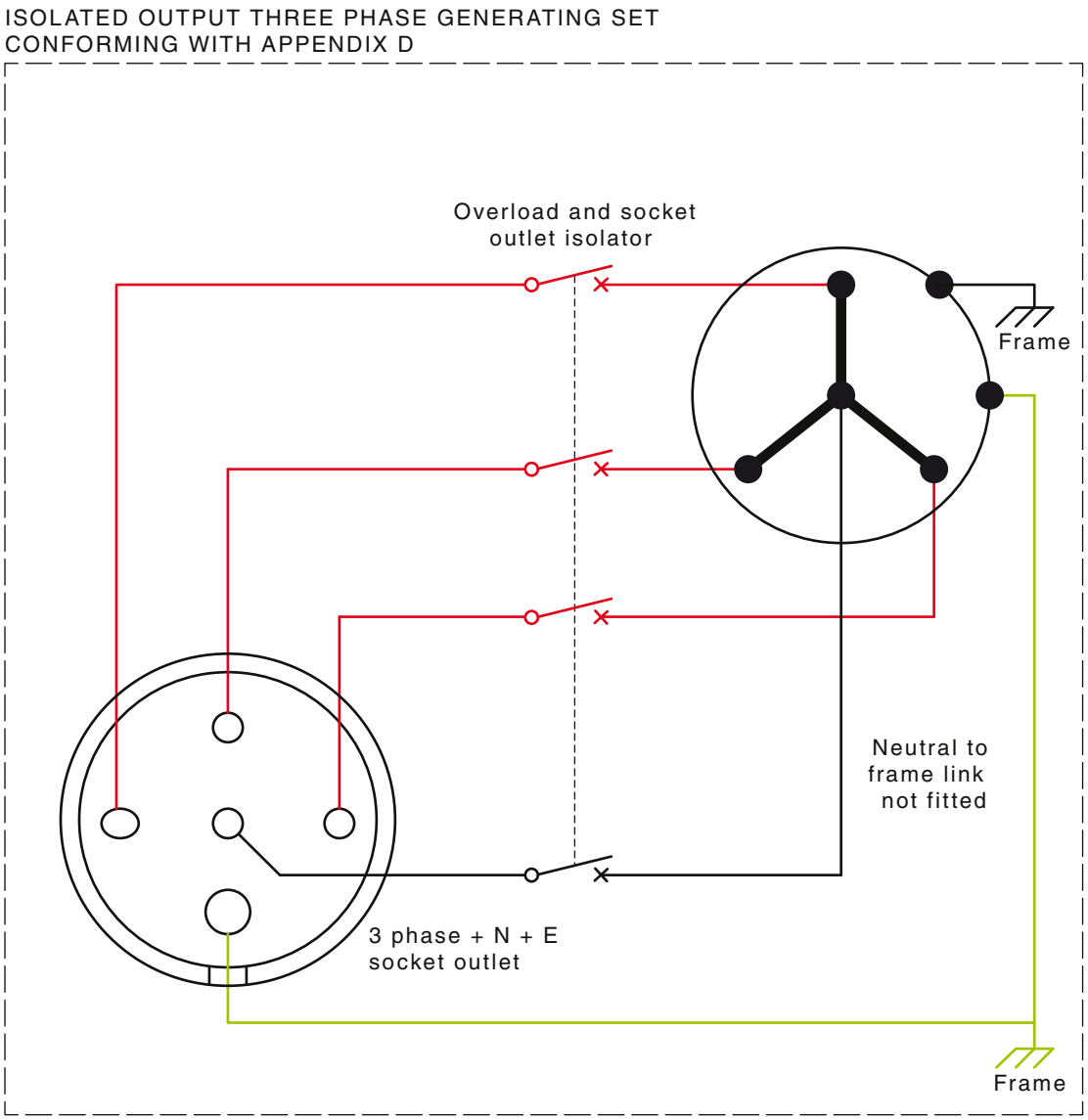


FIGURE B2 ISOLATED OUTPUT THREE-PHASE GENERATING SET

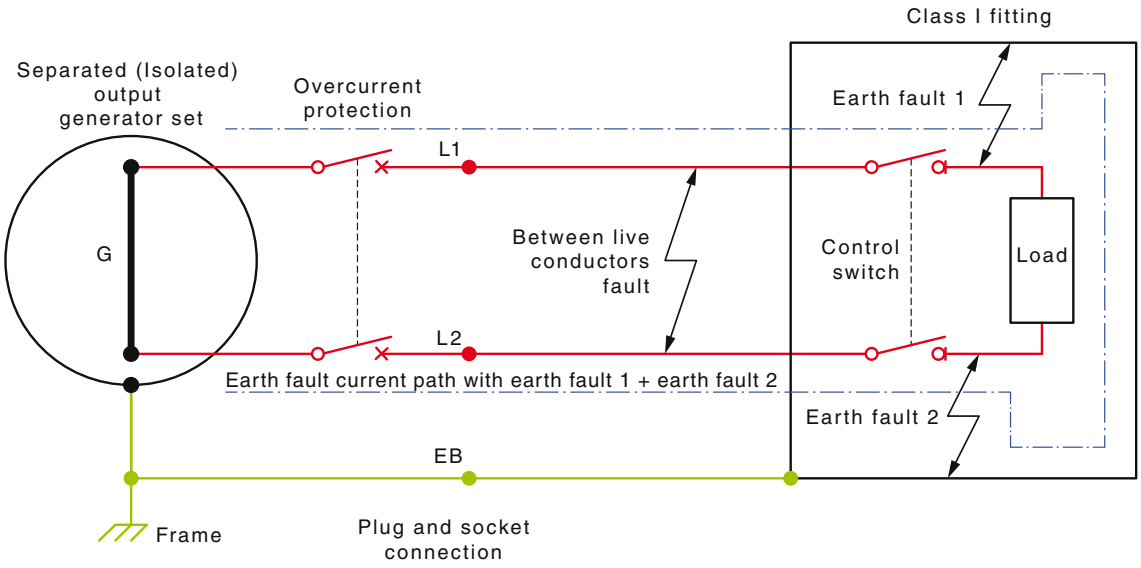


FIGURE B3 SEPARATED (ISOLATED) SUPPLY EARTH FAULT CURRENT PATHS

On the occurrence of earth fault 1 only, or, earth fault 2 only, no fault current will flow, but one side of the generator output will be connected to the external conductive part of the Class I equipment connected to the generating set. As the generator output is isolated with respect to the equipotential bonding system, there is no return path to the generating set output and no earth fault current flows.

On the simultaneous occurrence of earth fault 1 and earth fault 2 together, fault current flows through the earth faults 1 and 2 and would trip the overcurrent device in the generating set. Figure B3 shows the path of earth fault current under fault conditions.

On the occurrence of a fault between the live conductors only (see Figure B3), fault current will flow in the live conductors only and trip the overcurrent protection device in the generating set.

If an earth electrode is connected to the generating set frame, this does not form part of a low impedance earth fault current loop and hence the provision of this connection to the mass of earth is not recommended or required. The main earth fault loop is comprised of the equipotential bonding system and the live conductors.

B2.3.2 *RCD protected supply*

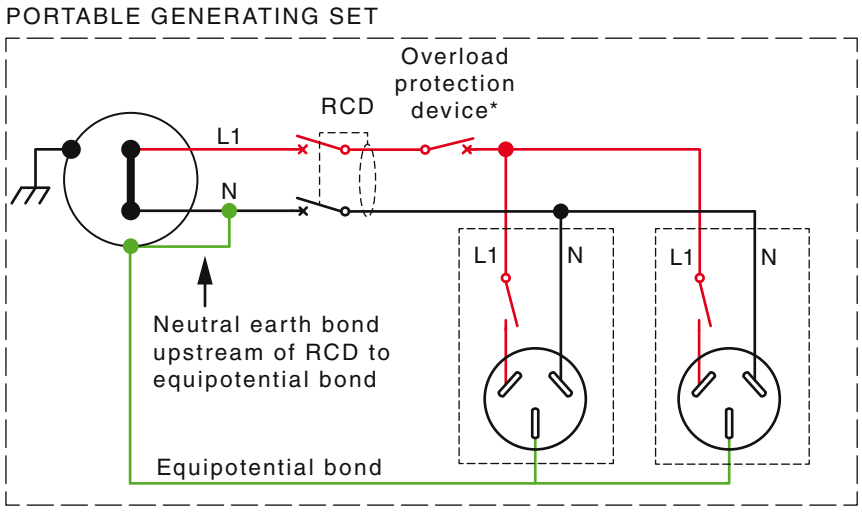
A neutral to frame connection is fitted on RCD protected output generating sets only, to provide the correct operation of an in-built RCD fitted for personal safety purposes.

The RCD Type fitted should correctly operate on the output waveform of the generating set.

The RCD should operate in all live conductors, including the neutral connection.

In New Zealand only, the RCD should be of a type for which tripping is ensured for residual alternating current and residual pulsating direct current.

A typical generating set wiring is given in Figure B4.



* Rated to suit generator socket rating and cable current carrying capacity

FIGURE B4 RCD PROTECTED SINGLE-PHASE GENERATING SET

B2.3.3 *RCD protected generators*

When a RCBO (or RCCB + MCB) is used to detect earth fault or earth leakage current conditions in the equipotential bonding system, the star point of three-phase generators or one side of single-phase generators should be connected to the equipotential bonding system to provide a return path of earth leakage currents to a point upstream of the RCBO in order to operate or trip the RCBO when the earth leakage current rises above the RCBO residual current rating.

On the occurrence of a fault between live conductors (see Figure B5), fault current will flow in the live conductors and trip the overcurrent section of the RCBO (or MCB) in the generating set.

NOTE: Figure B5 details the connections and the path of earth fault current (dotted line) under fault conditions.

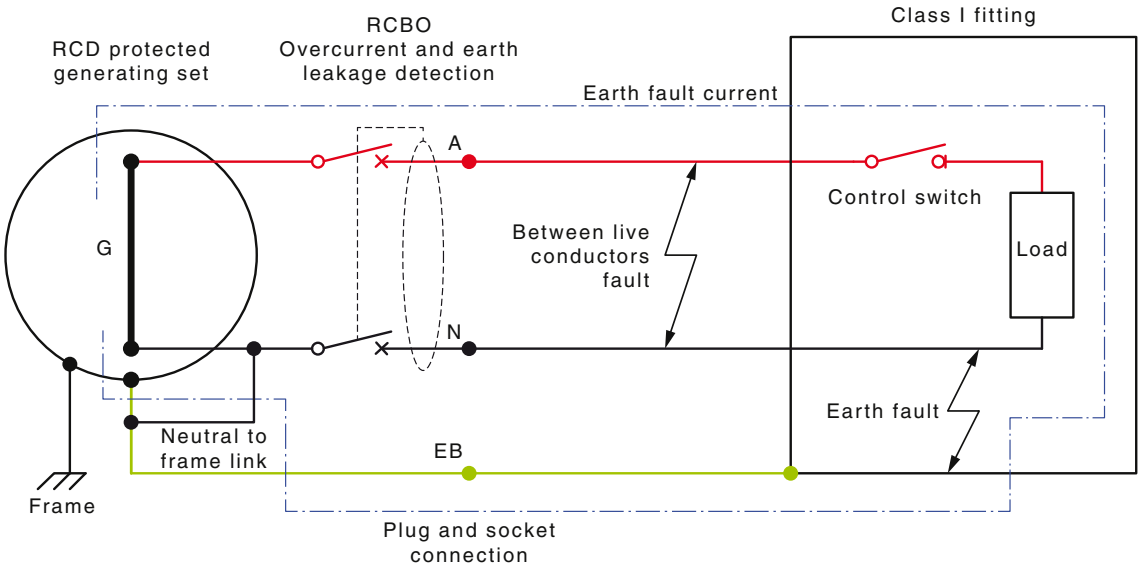


FIGURE B5 RCD PROTECTED SUPPLY EARTH FAULT CURRENT PATH

B2.3.4 *Enhanced personal safety supply*

The fitting of an insulation monitoring device (IMD) in accordance with IEC 61557-8 is required to provide enhanced personal safety and should be connected and installed to the manufacturer's instructions.

The IMD should be located in the generating set or be contained in a detachable outlet box or switchboard.

A typical IMD connection is shown in Figure B6, the IMD should control the output from the generating set by use of a contactor or shunt trip coil fitted to the generating set overcurrent protection MCB.

The generating set output should be isolated from the frame of the generating set to provide electrical separation (isolated) supply to AS/NZS 3000 requirements.

When an IMD is fitted, the generating set should be permanently marked 'Insulation monitoring device fitted. Maximum lead length permitted is 500 m'. If the IMD manufacturer's instructions specify a different maximum length other than 500 m, that maximum length should be used.

An IMD fitted in an isolated output generator or a portable socket outlet assembly are shown in Figures B6 and B7 respectively. The connections shown for the IMD are typical only. The IMD wiring connections to be used should be those detailed in the manufacturer's instructions.

B2.3.5 *Insulation monitor device (IMD) protected generators operation*

When the generating set is running and a output supply is available, the IMD device continuously monitors the insulation resistance between the generating set isolated output live conductors and the equipotential bonding connections of the generating set, connecting cables and the load connected to the generating set output.

If the insulation resistance drops below a pre-set value due to insulation failure, the generating set output should automatically disconnect the supply to the load.

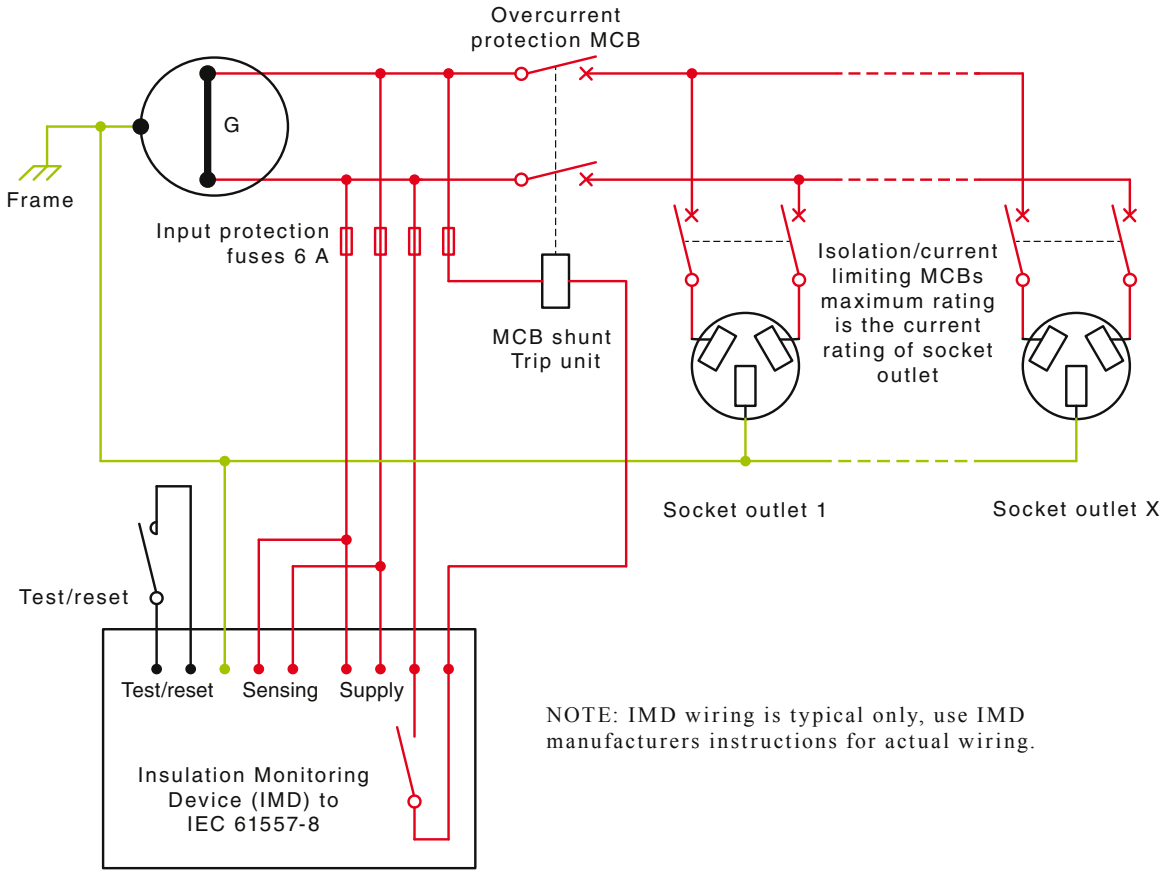


FIGURE B6 ISOLATED OUTPUT GENERATOR WITH BUILT-IN INSULATION MONITORING DEVICE

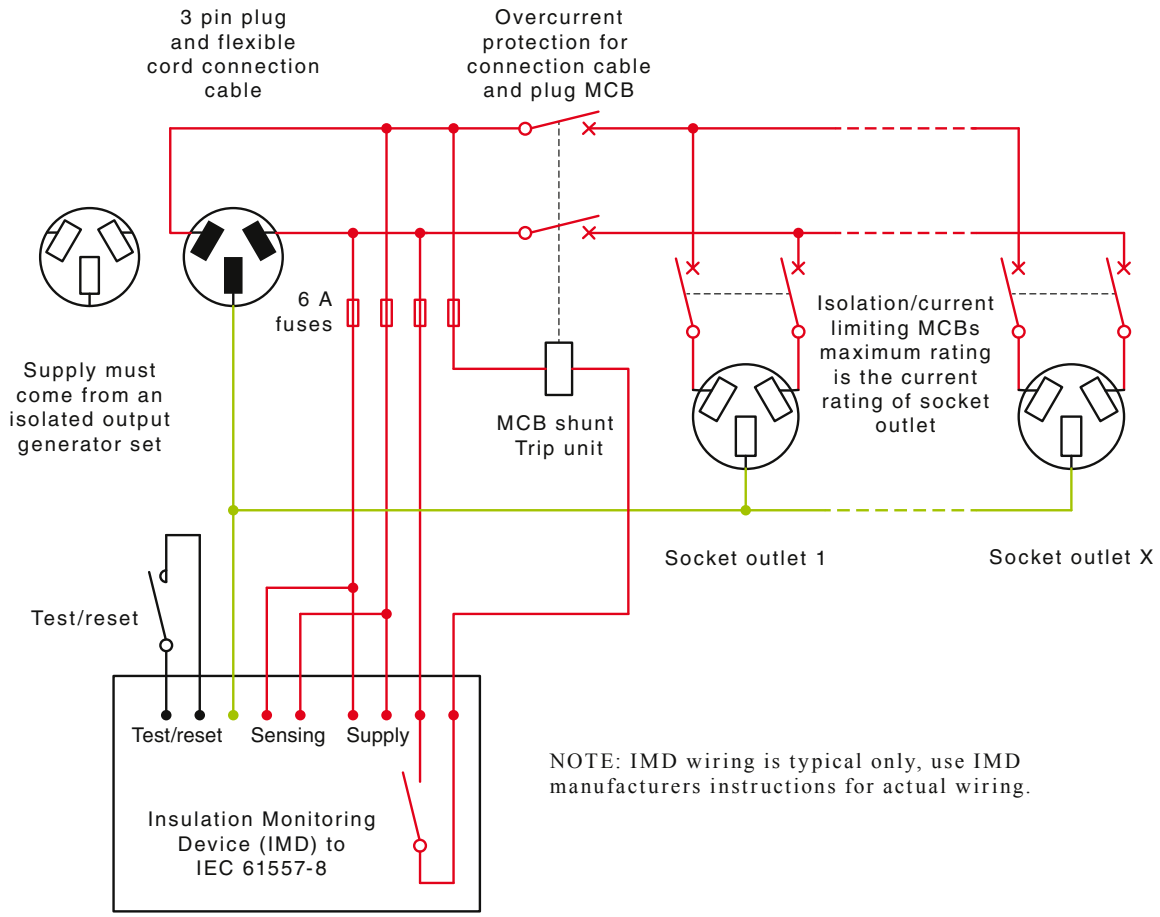


FIGURE B7 PORTABLE SOCKET OUTLET ASSEMBLY WITH INSULATION MONITORING DEVICE

B2.3.6 *Isolated output provided by an electronic inverter module*

For generating sets fitted with an electronic inverter module, the output is isolated from the inverter output and frame of the generating set to provide electrical separation (isolated) supply to AS/NZS 3000 requirements.

NOTE: See Figure B9 for typical details of this type of generating set.

On the occurrence of earth fault in the generating set in the load connected, the earth fault current clearance will be as detailed for an isolated output generating set detailed in Paragraph B2.3.1.

B2.4 Generating set output connections

B2.4.1 *Socket outlet types*

The following socket outlet types are to be used:

(a) AS/NZS 3112 (3-pin flat pin) for single-phase up to 15 A.

(b) IEC 60309 or AS/NZS 3123 (round pins) for single-phase 15 A and above.

(c) IEC 60309 or AS/NZS 3123 (round pins) for three or two-phase + N.

(d) AS/NZS 3120 (3-pin flat pin) for single-phase up to 15 A.

When cord extension socket, cord extension set and socket outlet types exceeding the current ratings available for the above listed Standards are required, the detachable connection fittings should conform with other Australian, Australian/New Zealand or international Standards requirements.

For single-phase generating sets only, with a rated output up 4 kW, the output connection should be made only by socket outlets in accordance with AS/NZS 3112 or AS/NZS 3120.

B2.4.2 *Socket outlet control switching*

The circuit-breaker provided for generating set overcurrent protection may be used for the control for a maximum of two adjacent socket outlets.

If three or more socket outlets are provided on the generating set, or, are contained in a switchboard fixed or adjacent to the generating set, the following requirements apply:

(a) All socket outlets should be individually controlled by an adjacent control switch.

(b) All switches or overcurrent devices should operate in all live poles (including the neutral conductor).

(c) The rating of the overcurrent device should not exceed the rating of the smallest rating socket outlet.

(d) The designated earthing terminals of all socket outlets should be connected to the equipotential bonding conductor and the generating set frame to AS/NZS 3000 requirements for a separated (isolated) supply or RCD protected supply.

(e) For an attached switchboard only, the total loading of the input to switchboard should be limited by a switchboard mounted circuit-breaker; the maximum current rating should be the lesser of the plug rating or the current rating of the connecting cord to the supply source.

B3 LIMITATIONS FOR THE SUPPLY TO MULTIPLE ITEMS OF ELECTRICAL EQUIPMENT FROM A GENERATING SET

B3.1 Isolated supply

The provisions of AS/NZS 3000 for separated (isolated) supply apply to the supply arrangements of multiple items of electrical equipment when operating from an isolated output supply from a generating set.

B3.2 RCD protected supply

The 30 mA RCD provided for the generating set supply output will provide earth leakage protection for all equipment connected to the generating set. There are no limitations to the number of Class I and Class II electrical equipment that can be supplied, other than a limit imposed by the sum of the leakage currents from all operating electrical equipment.

B3.3 IMD protected supply

When the generating set output is available the IMD provides continuous monitoring of the insulation resistance between live parts and equipotential bonding of the generator set and the connected loading will detect any insulation failure and then automatically disconnect the supply.

There are no limitations to the number of Class I and Class II electrical equipment that can be supplied, other than a limit imposed by the sum of the insulation resistance from all electrical equipment when connected in parallel, and the maximum length of 500 m or the IMD manufacturer’s maximum cord length recommendation, whichever is the lesser, for the extension cords connecting the generating set and the connected load.

B3.4 Electronic inverter type supply

The output of an electronic inverter supply has the same limitations as for Paragraph B3.1.

B3.5 Externally connected multiple socket outlet connections

B3.5.1 *Using a distribution switchboard*

With portable or semi-portable generating sets a distribution board or switchboard may be used to provide additional socket outlets; each socket outlet should have overcurrent protection in all live conductors, including the neutral connection. The overcurrent protection rating should not exceed the rating of the socket outlet it is protecting.

NOTE: Figure B8 gives a typical example of a distribution outlet box or switchboard.

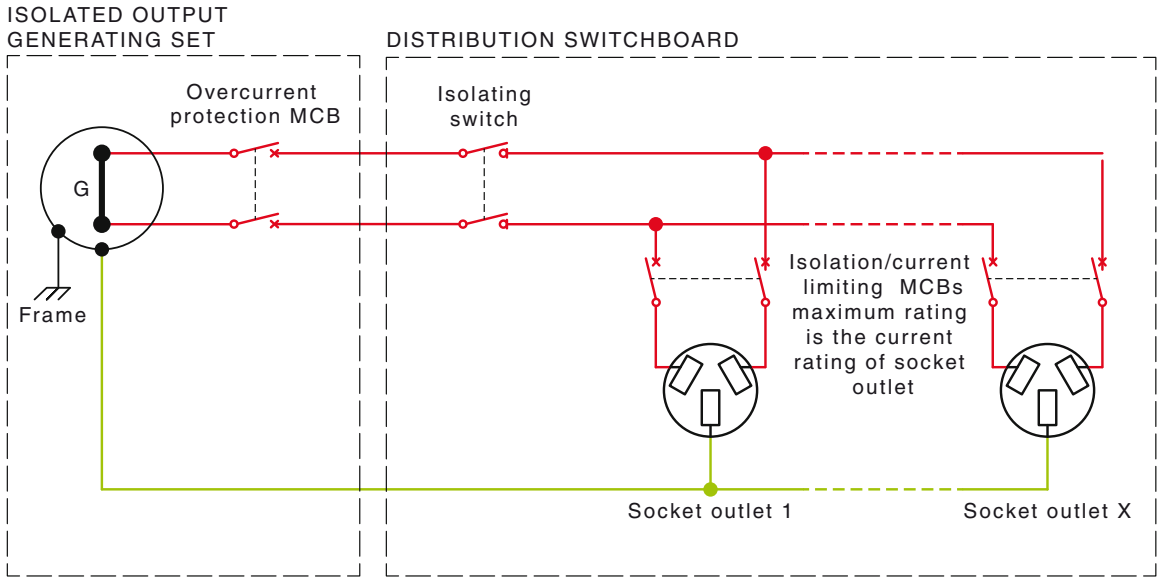


FIGURE B8 GENERATING SET WITH DISTRIBUTION SWITCHBOARD

B3.5.2 *Use of portable socket outlet assembly (PSOA)*

A PSOA in accordance with AS/NZS 3012 or AS/NZS 3190 may be used for the provision of multiple socket outlets when plug connected to portable generating sets with an isolated output or RCD protected system of supply.

B4 ADDITIONAL PROVISIONS FOR GENERATING SETS WITH AN ELECTRONIC INVERTER MODULE

B4.1 General

An electronic inverter module capable of providing a constant frequency sine wave with a closed voltage controlled output with a very low harmonic content may be used in the supply for the operation of computer equipment and other electronic equipment. This allows for some variations of the requirements detailed above in this appendix to be made for this type of generating set.

NOTE: See Paragraphs B4.2 to B4.4 for further information.

B4.2 Engine

In periods of light loading, without loads containing motors, the engine speed may be reduced to lower the a.c. power input to the inverter module. In periods of high loading and when motor starting currents are needed, the engine should run at the normal speed.

B4.3 Engine coupled generator

The engine coupled generator provides for an a.c. supply to the input of the inverter module, the engine speed is able to be varied and hence the input frequency into the inverter module will also vary, but the generating set output frequency will be fixed by the inverter module output.

The engine coupled mounted generator may also provide an ELV input to the inverter module for ELV battery charging.

B4.4 Inverter module

The LV and ELV outputs from the inverter modules may be provided with in-built electronic overcurrent protection. The fitting of external overcurrent protection devices is required and may be used as the output isolation switch.

The LV and the ELV inputs and outputs from the inverter module should be isolated from each other.

NOTE: A typical arrangement is shown in Figure B9.

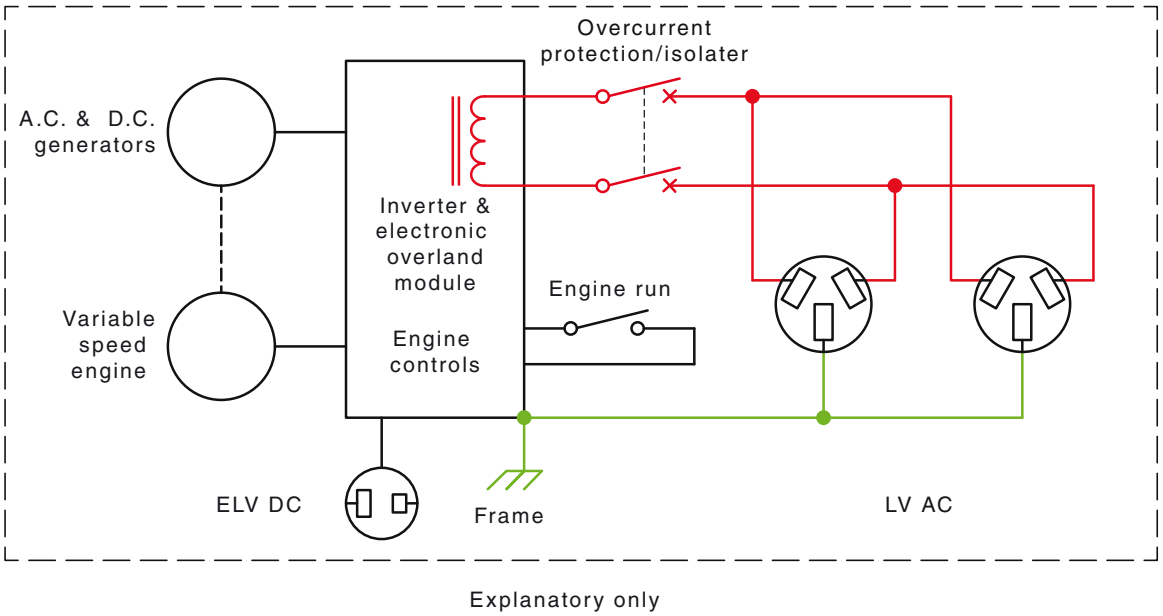


FIGURE B9 GENERATOR SET WITH INVERTER MODULE

B5 REDUCED LOW VOLTAGE GENERATING SETS

B5.1 Use of reduced low voltage generating sets

Generating sets supplying 110 V a.c. tools should conform with Paragraph B5.

B5.2 Output supply configuration

The output supply configuration should be a maximum of 110 V a.c. at 50 Hz with a centre tapped output winding that should be connected to the generating set frame, to form a single-phase output supply in which no live part can exceed 55 V with respect to the engine frame.

B5.3 Output overcurrent protection

The single-phase socket outlet overcurrent protection should be provided by a two pole MCB in the unearthed connections from the generator, the rating should not exceed the maximum rating of the generator set output. Figure B10 gives details of a typical generating set.

B5.4 Socket outlet type

The single-phase socket outlet type should be IEC 60309 with the socket outlet keyway position in the 110 V 50 Hz supply position and should be coloured ‘Yellow’. The earth terminal of the socket outlet should be bonded to the generating set frame.

B5.5 Electrical performance

The single-phase electrical performance, voltage regulation should conform with Paragraph D6.1. With the exception that the output voltage should be 110 V with a centre tap output winding connection to the generating set engine bonding system so that no live part exceeds reduced low voltage.

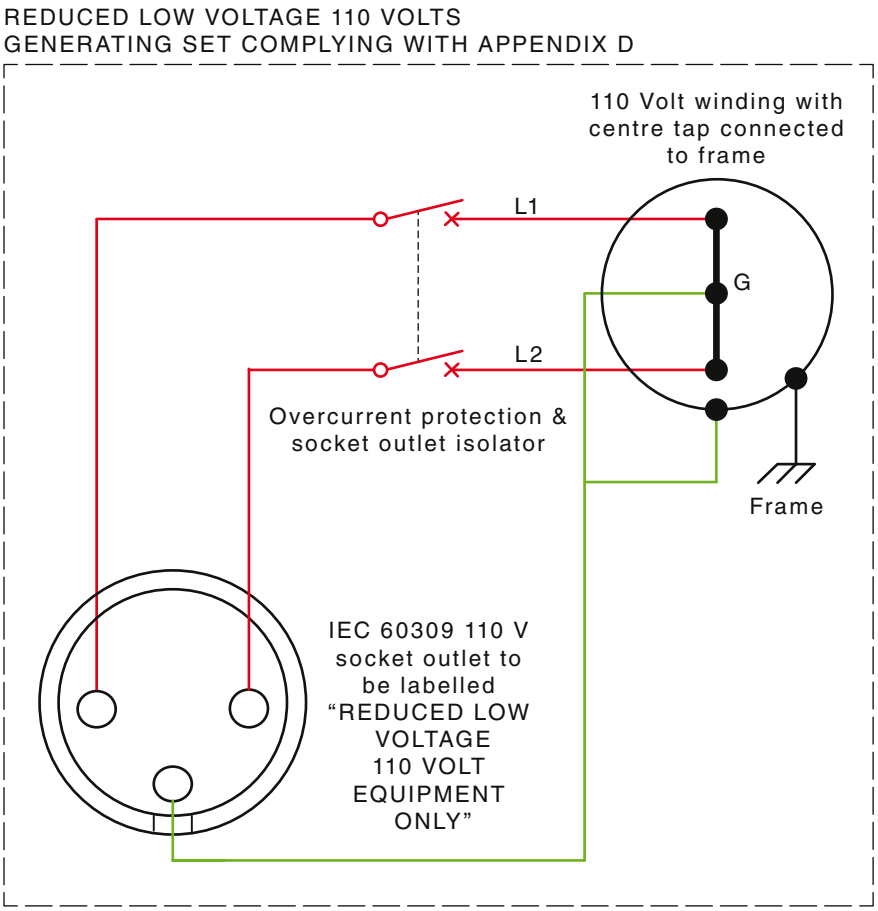


FIGURE B10 REDUCED LOW VOLTAGE SINGLE-PHASE GENERATING SET WITH 110 V IEC 60309 SOCKET OUTLET

B5.6 Three-phase supply

The principles of Paragraphs B5.2 to B5.4 also apply to three-phase sets, excepting that overcurrent protection should be four pole (three-phase + N) and socket outlet should be three-phase + N + E to IEC 60309 for 110 V 50 Hz supply and should be coloured 'Yellow'. The maximum voltage from an active conductor to the generating set frame is 63.5 V and between the active (phase) conductors the maximum voltage should not exceed 110 V.

B5.7 Engine recommendations for tunnelling applications

B5.7.1 *Type*

The type used should be a compression ignition diesel engine. The safety requirements should be accordance with AS/NZS 3584.1. The use of any other of engine type is not permitted.

B5.7.2 *Exhaust gas conditioning/catalytic converter*

The exhaust system should be fitted with exhaust gas conditioning. A catalytic converter should be fitted if possible.

B6 PROVISION OF AN EARTH ELECTRODE FOR THE PORTABLE GENERATING SETS

The provision of an earth electrode for the generating set is not a requirement of this Standard.

The equipotential bonding connections of the generating set output, connecting leads and the earth connections of the electrical equipment connected, ensures that all earth fault currents will operate or trip the overcurrent or earth leakage devices fitted to the generating set to automatically disconnect the supply.

If an earth electrode is connected to the generating set frame, this does not form part of a low impedance earth fault current loop and then the provision of this connection to the mass of earth is not recommended or required. The main earth fault loop is comprised of the equipotential bonding system and the live conductors.

APPENDIX C

NZ

DEDICATED WIRING IN AN ELECTRICAL INSTALLATION FOR CONNECTION OF A PORTABLE GENERATING SET (NEW ZEALAND ONLY)

(Normative)

C1 CONNECTION OF THE DEDICATED WIRING SYSTEM TO A GENERATING SET

C1.1 Design

The dedicated wiring system for the distribution of a portable generating set output within an electrical installation shall conform with the following:

(a) The system shall be single-phase.

(b) The dedicated wiring system shall have a maximum rating of 3.5 kW (15 A at 230 V).

(c) The generating set when connected to the dedicated wiring system shall be located in a well-ventilated position to allow safe escape of engine exhaust fumes and to provide adequate cooling of the generating set when running.

(d) The generating set connection to the dedicated wiring system by a supply lead shall be by one of the following:

(i) When a detachable supply lead is to be used for the connection of the dedicated wiring system to a generating set output, a labelled 10 A or 15 A appliance inlet in accordance with AS/NZS 3112 shall be used. The appliance inlet shall have a minimum degree of protection of IP24.

(ii) When a permanently connected flexible supply lead is to be used for the connection of the dedicated wiring system to a generating set output, a permanent connecting facility (e.g. a junction box) mounted on the building shall be provided for the connection of the flexible supply lead to the installation wiring of the installation. The flexible supply lead shall be fitted with a 10 A or 15 A 3-pin plug in accordance with AS/NZS 3112.

The flexible supply lead shall be securely anchored at the point of connection to the building dedicated wiring system and a suitable means for the storage of the flexible supply lead when not in use shall be provided.

(e) The flexible supply lead used for connecting the generating set and the dedicated wiring system shall be protected from overcurrent by a two pole MCB (for both active and neutral conductors) with a rating of the inlet plug rating or the flexible supply lead current rating, whichever is the lesser value.

(f) The dedicated wiring system shall include a facility for isolation of the inlet fitting from the rest of the system.

NOTE: This function may be performed by the overcurrent protection device.

The connection device shall be suitably protected to provide a minimum degree of protection of IP24.

NOTE: The generating set overcurrent protection system provides the overcurrent protection of the generating set only. It may not provide system overcurrent protection for the dedicated wiring system, which will require a setting suitable for that system.

(g) The dedicated wiring system in the building structure shall be completely isolated (active, neutral and earth) from any other installation wiring in the structure, including any switchboard enclosure, flush boxes provided for the fixing of socket outlets and any connection to the earthing system of the electrical installation.

All cables shall be physically separated to AS/NZS 3000 requirements, as required for a different electrical installation, by a minimum distance of 25 mm.

(h) The dedicated installation wiring system shall be connected to a limited number of permanently marked double pole switched 10 A socket outlets (for both active and neutral conductors) in accordance with AS/NZS 3112, connected for operation from a portable generating set output.

(i) The wiring connections shall conform with Figure C1.

NOTES:

1 The total isolation of the dedicated wiring system is to provide isolation from the earthing system of the electrical installation and to prevent any possibility of back feeding of the portable generating set output into the electricity distributors supply system connected to any switchboard of the electrical installation.

2 The total isolation of the dedicated wiring system enables any configuration of portable generating set conform with Paragraph B2.1 requirements, excepting a reduced low voltage generating set, to be used.

C2 VERIFICATION

To confirm that the requirements of this Appendix have been met, after completion and before use, the dedicated wiring system shall be—

(a) inspected, as far as practical; and

(b) tested as detailed in Section 8 of AS/NZS 3000:2007, and the following additional requirements:

(i) Equipotential earth bonding continuity.

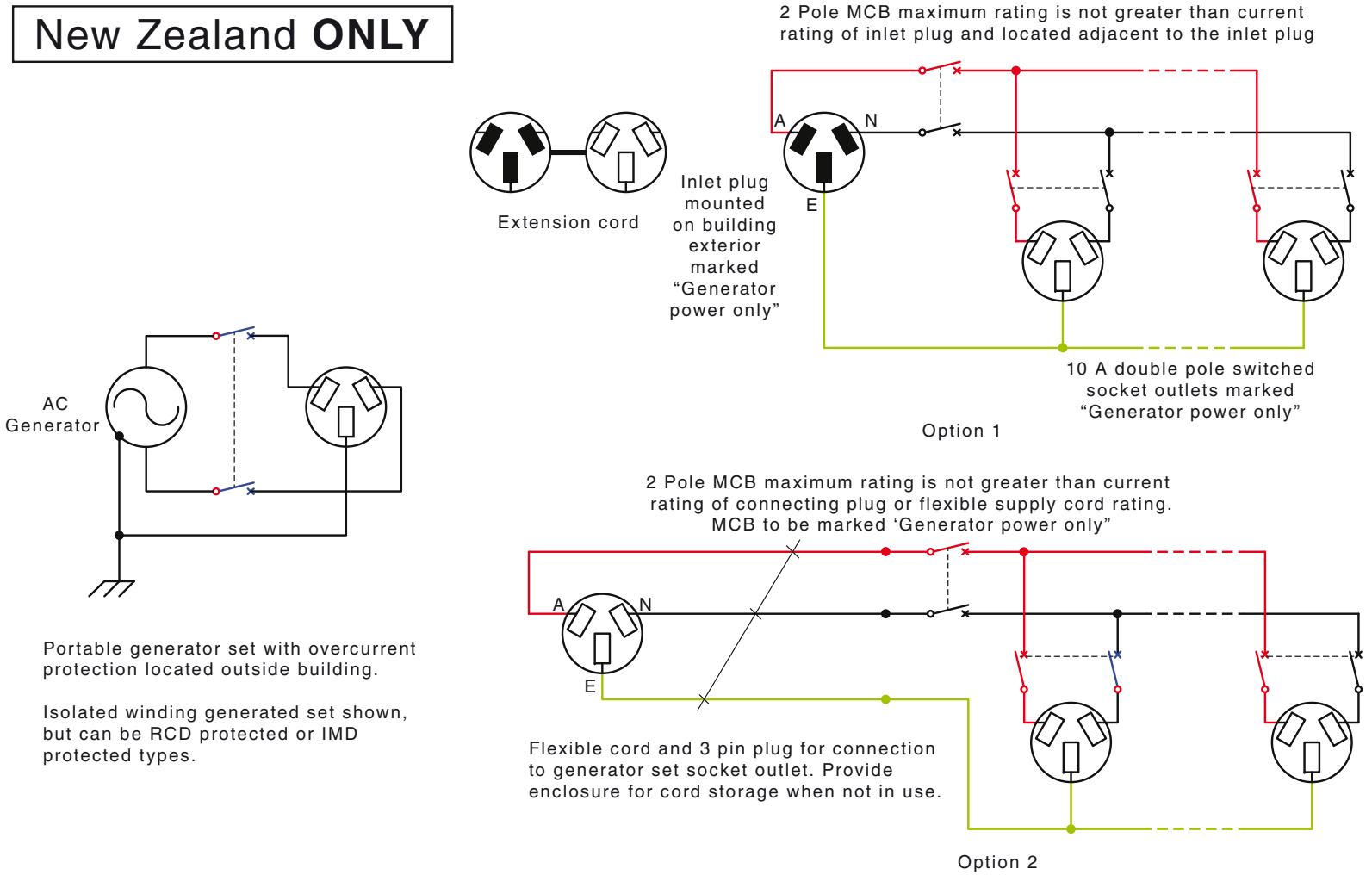
(ii) Correct labelling ‘GENERATING SET POWER ONLY’ on the appliance inlet, overcurrent device and all socket outlets.

(iii) All dedicated wiring is at least 25 mm away from other electrical installation cabling.

(iv) All dedicated wiring does not enter any electrical installation switchboard enclosure, flush boxes or socket outlet fittings that are connected to other sources of normal power.

(v) All switching devices and the overcurrent device operate in all live poles (active and neutral).

New Zealand **ONLY**



NOTES:

1. All wiring for portable generator set output inside the electrical installation to be segregated from electrical installation wiring to AS/NZS 3000 requirements of a different electrical installation.
2. No wiring shall pass through any switchboard enclosure of the electrical installation and includes any flush boxes for the mounting of the electrical fittings in the electrical installation.

FIGURE C1 DEDICATED WIRING SYSTEM IN ELECTRICAL INSTALLATION FOR CONNECTION OF A PORTABLE GENERATING SET

APPENDIX D

REQUIREMENTS FOR THE CONSTRUCTION OF SELF-CONTAINED TRANSPORTABLE GENERATING SETS UP TO 25 KW

(Normative)

D1 SCOPE

This Appendix sets out the requirements for the construction of self-contained transportable electricity generating sets driven by internal combustion engines and intended to provide a 50 Hz a.c. supply, of low voltage, single-phase, two- or three-phase, with a maximum output up to 25 kW.

They may be portable, semi-portable, transportable, or mobile.

The generating sets are typically standard manufactured sets and are often selected from a commercial catalogue or leaflet.

This Appendix does not apply to generating sets intended solely for charging batteries at ELV.

For electrical safety requirements, this Standard shall be read in conjunction with AS/NZS 3000, AS/NZS 3100 and AS/NZS 3820.

NOTES:

1 A generating set may include a separate extra-low voltage d.c. output, e.g. 12 V, for battery-charging purposes.

2 The terms ‘extra-low voltage’ and ‘low voltage’ are as defined in AS/NZS 3000 and AS/NZS 3100.

3 Generating sets conforming with this Appendix are not normally suitable for operation in parallel with other sets or with reticulated supply because of the lack of controls and instrumentation suitable for controlling generating sets running in parallel with the normal supply.

D2 SERVICE CONDITIONS

A generating set shall be suitable for use under the following service conditions:

(a) *Ambient temperature*:

  (i) Maximum 40°C.

  (ii) Minimum −15°C.

(b) *Altitude* Up to 1000 m above sea level.

(c) *Protection against the weather* Either—

  (i) for undercover or weather-protected usage—having no inherent protection against rain; or

  (ii) for outdoor use—without further protection from the weather (see Paragraph D7.3.)

(d) *Fuels and lubricants* Use readily available fuels and lubricants.

D3 SAFETY

D3.1 Electrical safety

D3.1.1 *Design, construction and materials*

The design, construction, materials, equipment and components used, and the workmanship involved, shall be in accordance with the requirements of AS/NZS 3100.

D3.1.2 *Identification of conductors*

Conductors shall be identified as specified in AS/NZS 3100. Conductors which are connected, directly or indirectly, to the frame (see Paragraph D3.1.9) shall be considered to be earthing conductors.

D3.1.3 *Overload protection*

Overload protection shall be by means of circuit-breaker(s) or fuse(s), by inherent circuit regulation, by stalling the engine (for generating sets up to 15 kW), or by other suitable means.

Where circuit-breakers are used, they shall be in accordance with AS/NZS 60898.

Fuses holders shall be in accordance with AS/NZS 3100 and the fuse links with AS/NZS 60269.

NOTE: Small generating sets have very limited overcurrent capability in excess of the full load rating, checking the generator (alternator) and protective device manufacturer's information will be necessary to select the correct current rating and type of protective device to provide adequate protection.

When an electronic module device (EMD) is used to provide a stable voltage and frequency output, the electronic module device may be used for overload protection in addition to any external overcurrent devices.

D3.1.4 *Switching in output circuits*

Switching in output circuits shall be provided by either—

(a) a main switch; or

(b) individual all live pole (active(s) and neutral) switches for each socket outlet.

A circuit-breaker shall be acceptable as a main switch.

The outlet individual switch on socket outlets shall be in accordance with the requirements of AS/NZS 3133 or AS/NZS 60947 (series).

Exception: The main switch in the output circuit may be used as a common switch instead of individual socket outlet switches for up to two adjacent socket outlets.

D3.1.5 *Arrangement of live parts, conductors and cables*

Live parts shall be arranged in accordance with AS/NZS 3100 requirements.

Where a low voltage output and an extra-low voltage output are available simultaneously, accessible extra-low voltage wiring, e.g. battery charging circuits derived from the generator, shall be separated by double insulation from the low voltage circuits, refer to AS/NZS 3100 for details.

Conductors and cables shall be protected as specified in AS/NZS 3100. All unsupported conductors shall be stranded and no strand shall exceed 0.67 mm (nominal) diameter.

D3.1.6 *Joints and connections*

Joints and connections shall be in accordance with AS/NZS 3100 requirements.

D3.1.7 *Guarding and insulation of live parts*

All live parts, including any 'neutral' parts, shall be guarded and insulated in accordance with AS/NZS 3100 requirements.

D3.1.8 *Equipotential bonding (earthing) facilities*

The following parts shall be in effective electrical contact with each other:

(a) The engine frame.

(b) The generator frame.

(c) All external metal enclosing electrical equipment or wiring.

(d) The 'earth' terminals of all socket outlets.

(e) The main frame terminal (marked ⏚ or 'FRAME').

(f) The main winding, as specified in Paragraph D3.1.9.

(g) The 'earth' connection of any electronic circuitry that may need to be connected to the above items.

The connections shall be in accordance with AS/NZS 3100 requirements.

D3.1.9 *Connections between main winding(s) and frame*

Single-phase connections between main winding(s) and the frame shall be as follows:

(a) *Single-phase winding (isolated output)*—the winding shall not be connected to the frame.

(b) *Single-phase winding (RCD protected)*—using a 30 mA RCD in accordance with AS/NZS 3190, AS/NZS 61008.1 or AS/NZS 61009, or a combination socket outlet RCD in accordance with AS/NZS 3190.

The RCD shall be of a type that operates correctly on the output supply of the generating set.

The input neutral terminal of the RCD shall be connected to the earth terminal of the frame, see Figure B4.

In New Zealand, the RCD type shall be of a type for which tripping is ensured for residual alternating current and residual pulsating direct current. NZ

NOTE: This should be the only connection between the winding and the frame.

(c) *Single-phase winding (isolated output) fitted with an insulation monitoring device*

An insulation monitoring device (IMD) in accordance with IEC 61557-8 shall be fitted to control the overcurrent protective device fitted with an undervoltage coil, or, to control a series contactor.

In the event of the insulation resistance of the generator and/or the load connected falling below a pre-set minimum resistance the IMD shall remove the supply from the load connected to the generating set.

The IMD shall be installed to the manufacturer's instructions.

(d) *Single-phase output with an inverter module* The output of the electronic inverter module output shall not be connected to the frame.

(e) *Two-phase winding* The neutral or centre-tap connection shall not be connected to the frame via a removable connection or link, when used to supply an electrical installation connected by installation wiring or a plug and socket arrangement.

The winding connections permitted are—

(i) two-phase 120° electrical (open delta) 230 V phase-to-neutral 400 V between phases; or

(ii) two-phase centre-tapped (180° electrical) 230 V phase-to-neutral 460 V between phases, see Figure D1.

NOTE: The two-phase centre tapped (180° electrical) is the system of supply used for single earth wire return distribution systems.

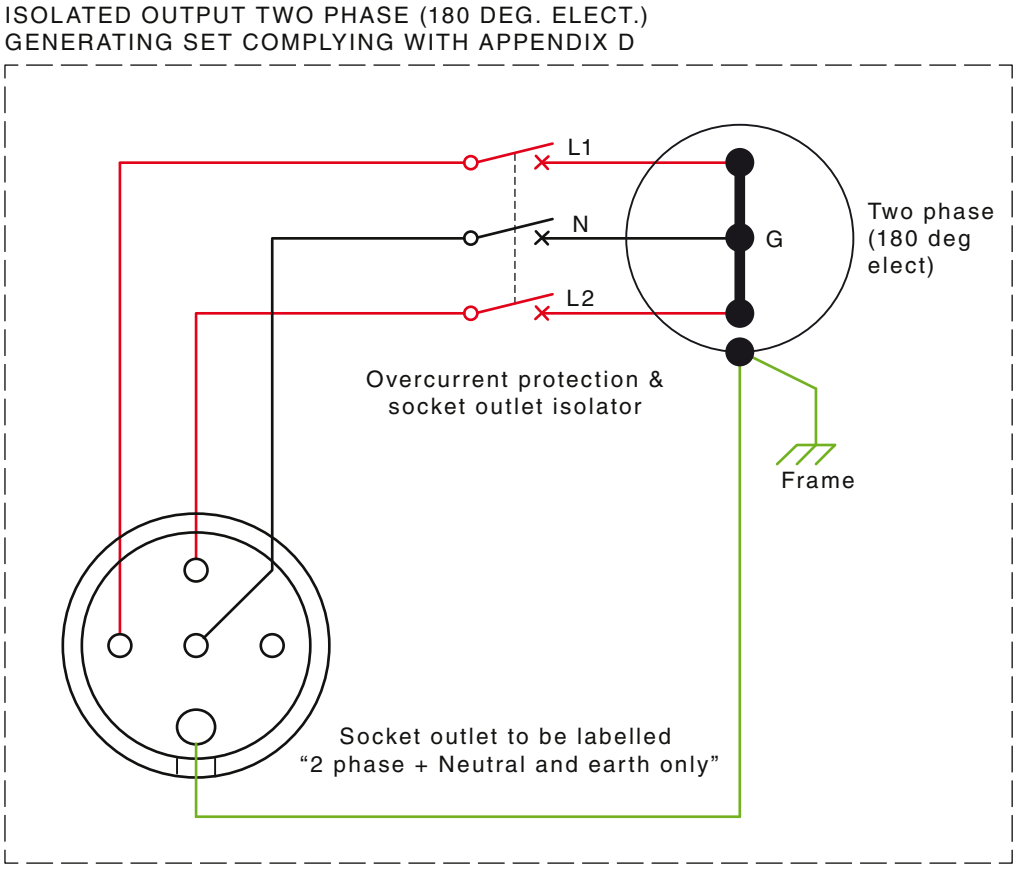


FIGURE D1 ISOLATED OUTPUT TWO-PHASE (180° ELECTRICAL) GENERATING SET WITH TWO-PHASE + N SOCKET OUTLET FOR USE IN SWER DISTRIBUTION AREAS

(f) *Three-phase windings (star-connected)*.

(g) *Three-phase winding (isolated winding)* The star point or neutral connection shall not be connected to the frame.

(h) *Three-phase winding connected to a four pole (three-phase + N)*—30 mA RCD in accordance with AS/NZS 3190, AS/NZS 61008 or AS/NZS 61009.

The input neutral terminal of the RCD shall be connected to the earth terminal of the generating set frame, see Figure B2.

The RCD shall be of a type that operates correctly on the output supply of the generating set.

In New Zealand, the RCD type shall be of a type for which tripping is ensured for residual alternating current and residual pulsating direct current. NZ

NOTE: This should be the only connection between the winding and the frame.

(i) *Three-phase winding (isolated winding)* and connected to a three-phase IMD in accordance with IEC 61557-8 shall be fitted to control the overcurrent protective device fitted with a shunt trip coil, or, to control a series contactor.

In the event of the insulation resistance of the generator and/or the load connected falling below a pre-set minimum resistance shall remove the supply from the load connected to the generating set.

The IMD shall be installed to the manufacturer's instructions.

NOTES:

1 It is considered that, in the absence of 30 mA RCD or IMD protection, a single-phase winding is safer when isolated from the generator set frame, subject to the limitation on the number of Class I appliances or tools on a common generator output with a separated (isolated) output as detailed in AS/NZS 3000.

In the event of a single earth fault to frame, see Paragraph B2.3.1 for details of the clearance of an earth fault condition.

2 Where a RCD is fitted, the connection between winding or RCD neutral input terminal and the generator set frame is required to permit correct operation of the RCD.

If the RCD device were subsequently removed, it is likely (and recommended) that the winding-to the generator set frame connection should also be removed.

The fitting of an RCD is unsuitable for connection of the generator set to a fixed MEN electrical installation (where the neutral and earth are connected together on the load side of the RCD because the RCD would trip on load due to the division of load current between the neutral and earth conductors to the electrical installation.

3 A removable generator set connection or link is specified in Note 2 above, so that it may be easily removed (by an appropriately licensed person) when the set is to be connected to a MEN electrical installation.

D3.1.10 *Limiting temperatures of electrical parts*

The temperatures of insulating materials shall not exceed the relevant values specified in AS/NZS 3100. (See also Paragraph D6.3 concerning the generator.) The temperatures of conductors shall not exceed the relevant values specified in AS/NZS 3100.

D3.1.11 *Output socket outlets*

Output shall be by—

(a) socket outlet(s) in accordance with AS/NZS 3112, (3-pin flat pin) 10 A or 15 A, single-phase only; and

(b) for generating sets over 2.5 kW, single-phase and multi-phase, AS/NZS 3123 or IEC 60309 (round pins) greater than 15 A.

Extra-low voltage socket outlets shall be in accordance with AS/NZS 3112, and shall be of a type that does not permit AS/NZS 3112 low voltage plugs to enter the extra-low voltage socket outlet and vice versa.

D3.1.12 *Cord extension sets*

Where a single-phase cord extension set rated at 10 A, 15 A, or 20 A is provided with a generating set, they shall be in accordance with AS/NZS 3199. The flexible cord shall be ordinary duty or heavy duty in accordance with AS/NZS 3191.

D3.2 Mechanical safety

D3.2.1 *Protection from external damage*

All components of a generating set, including mechanical parts, fuel systems, wiring, switches, instruments, and controls shall be adequately protected against mechanical damage likely to occur in normal use.

D3.2.2 *Protection against moving parts*

All moving parts that may cause injury to persons shall be enclosed by guards to prevent inadvertent personal contact with such parts. A crank handle, if provided, shall be arranged to disengage when the engine starts.

D3.2.3 *Protection against disintegration of rotating parts*

External rotating parts, e.g. the flywheel, shall not disintegrate at runaway speed of the generating set.

D3.2.4 *Accessibility of controls*

Switch(es) or control(s) for stopping and starting the engine shall be readily accessible and their mode of operation obvious and be permanently labelled.

Any automatic-start or remote-start arrangement shall be capable of being disabled and kept in that state for purposes of inspection and maintenance of the generating set.

D3.2.5 *Direction of rotation*

Where the driving shaft or flywheel is accessible or where crank handle starting is provided, the direction of rotation shall be marked on a suitable adjacent surface in an obvious and permanent manner.

D3.3 Thermal safety—Protection against hot parts

All parts that in normal operation reach temperatures in excess of 120°C, e.g. the engine, the muffler, the exhaust, the cooling system and the cooling system vent, shall be arranged to prevent inadvertent personal contact with such parts.

D4 PROTECTION AGAINST FIRE AND EXPLOSION

D4.1 Leakage of fuel and lubricating oil

The fuel tank and pipes shall be compatible with the fuel used and, if a gravity feed system, be provided with a stopcock on the outlet of the fuel tank.

The fuel tank, fuel pipes and lubricating oil pipes shall not be installed in the vicinity of high-temperature surfaces, electrical components or the air intake (to engine or generator). The tank filling arrangement shall ensure that, when overfilled, fuel does not spill over or flow onto hot parts or rotating parts.

D4.2 Prohibited fuel piping

Galvanized steel shall not be used in contact with diesel fuel.

D4.3 Arrangement of the exhaust

The exhaust shall be fitted with a spark arrestor in accordance with AS 1019. Exhaust gases shall be directed away from the fuel supply system, from electrical wiring and from controls.

D5 RATING AND PERFORMANCE

D5.1 General

D5.1.1 *Total rating*

All ratings shall apply to the complete generating set.

The rated power output of the generating set shall be the output available from the generator at rated operating conditions and at standard temperature and air pressure (refer to AS 4594.1 and AS 60034.1 or ISO 8528-8).

D5.1.2 *Noise and vibration*

When determined by the procedure specified in AS 2221.1, the maximum A-weighted sound pressure level of the generating set, under both rated load and no load, shall not exceed that specified in Table D1.

TABLE D1

MAXIMUM SOUND PRESSURE LEVELS OF GENERATING SETS AT 7 m FROM THE REFERENCE SURFACE, dB(A)

Type of engine	Rated output of generating set, kW		
	≤2.5	>2.5 ≤15	>15
Spark-ignition	78	80	83
Compression-ignition	80	85	90

NOTES:

1 The above maximum levels are based on typical manufacturing standards; nevertheless, many generating sets may achieve significantly lower levels.

2 The operation of the generating set shall not be limited by harmful vibration.

D5.1.3 *Fuel consumption*

The fuel consumption in litres per hour, if declared by the manufacturer, shall apply after the nominated run-in period, in normal operation at rated electrical output with all accessories, including battery charger, if any, operational.

When measured in accordance with AS 4594.1, the fuel consumption shall be within 5% of the manufacturer's rated consumption.

D5.2 Mechanical—Governing

A generating set having a rated output exceeding 15 kW shall be provided with Class A1 governing in accordance with AS 4594.4.

A generating set of rating not exceeding 15 kW shall be provided with governing such that, when operating at rated load at governed speed and the full load is removed, the increase in engine speed does not exceed that specified in Table D2.

TABLE D2

GOVERNING REQUIREMENTS FOR GENERATING SETS OF RATING NOT EXCEEDING 15 kW

Type of engine	Maximum increase in engine speed, percentage of governed speed	
	Transient	Steady state
Spark-ignition	15	10
Compression-ignition	12	8

D5.3 Cyclic irregularity of voltage

When the generating set is running at rated load and governed speed, the cyclic irregularity of voltage shall not exceed the limits of AS 4594.5.

NOTE: This Paragraph imposes a maximum cyclic irregularity of voltage so that, under steady-state conditions, light flicker is limited. However, there may be other causes of light flicker.

Cyclic irregularity arises from the combined effects of engine impulses (firing strokes) and the smoothing inertia of the flywheel and generator rotating masses. Cyclic irregularity, which varies from cycle to cycle, is calculated from the ratio:

$$\frac{\text{maximum speed} - \text{minimum speed}}{\text{mean speed}}$$

When a generating set is running at rated load and governed speed, the cyclic irregularity of voltage shall not exceed $\frac{1}{75}$, i.e. 1.33%, when measured as follows:

(a) Plot, by direct or indirect means, the square of the voltage waveform over 10 consecutive half-cycles.

(b) Then measure the area of each half-cycle of the plot, noting the maximum, minimum, and mean areas.

(c) Then calculate the ratio:

$$\frac{\text{maximum speed} - \text{minimum speed}}{\text{mean speed}}$$

D5.4 Over-speed withstand

A generating set shall withstand, without harmful effect, a speed of 120% of the rated speed for 5 min.

D5.5 Shutdown facilities

A generating set having a rated output exceeding 15 kW, shall incorporate automatic shutdown devices for the following engine conditions:

(a) Low lubricating-oil pressure.

(b) High temperature of coolant (air or water).

(c) An over speed of 25%.

D6 ELECTRICAL

D6.1 Rated output

A generating set shall have a maximum continuous rating (S1 rating) in watts (or kilowatts) at a stated power factor and be suitable for continuous running duty.

D6.2 Operation at other than the rating point

A generating set shall operate as follows:

(a) *Without exceeding specified temperature limits*—at rated output, rated speed, rated power factor and at a voltage between 95% and 105% rated voltage.

(b) *Without practical difficulty*—at rated output, rated speed, rated voltage, and at any power factor between 0.8 lagging and unity.

D6.3 Temperature rise

The limits of temperature rise of the various parts of a generator when driven by the engine at rated output, and the methods of measurement shall be as specified in AS 60034.1

NOTE: For other electrical components see Paragraph D3.1.10.

D6.4 Voltage regulation and adjustment

The voltage regulation under steady-state conditions between no load and rated load shall be within ±5% of the rated voltage. No other means for the adjustment of voltage need be provided.

D6.5 Irregularities of voltage waveform

When irregularities of voltage waveform are measured as specified in AS 60034.1, the following limits shall apply:

(a) *Waveform deviation*:

(i) Generating set <2.5 kW. ..... 25% max.

(ii) Generating set >2.5 kW–15 kW. ..... 20% max.

(iii) Generating set >15 kW. ..... 15% max.

NOTE: For some applications, e.g. for supply to electronic equipment, lower limits may be necessary [see Paragraph D9(k)].

D6.6 Electromagnetic interference

The limits for electromagnetic interference shall be as follows:

(a) From spark-ignition engines as specified in AS/NZS CISPR 12.

(b) From generator and electrical circuitry as specified in AS/NZS CISPR 14.1.

D6.7 Under-speed withstand

A generator shall withstand, without overheating, normal operation at rated output at speeds down to 95% of rated speed.

D6.8 Momentary overload

A generator should be capable of withstanding, for not less than 15 s a current of 150% rated current, the voltage being maintained as near the rated value as possible consistent with the maximum capacity of the engine.

NOTE: The exact value of the voltage is not important.

D6.9 Short-circuit withstand

A generator shall be capable of withstanding a sudden short-circuit as specified below, on all phases or on any combination of phases, at the terminals of the generator without harmful deformation of the windings or other parts of the generator.

The peak value of the short-circuit current shall not exceed 15 times the peak value or 21 times the RMS value of the rated current.

Conformance may be checked by calculation or by test. In the latter case, the test shall be carried out on a machine running on open-circuit at rated speed with excitation constant at a value that will produce a generator terminal voltage not greater than the rated voltage.

A generator shall be deemed to satisfy the requirements of the test if no harmful deformation occurs and if the windings withstand the high-voltage test specified in AS 60034.1, after the short-circuit test.

D7 DESIGN AND CONSTRUCTION

D7.1 General

D7.1.1 *Unitary construction*

The generating set shall be constructed as a unit. All parts, including the fuel tank and engine-cooling means, e.g. radiator, shall be common mounted.

Adequate means shall be provided for lifting the set, special requirements will be included in the information to be supplied when placing an order for the supply of the generating set (see Paragraph D9).

D7.1.2 *Location of components*

Components shall be grouped according to safe practice to avoid any hazard, e.g. due to proximity of the fuel tank and the hot exhaust parts, while providing reasonable access for routine service, e.g. cleaning of filters and changing of fuses.

In particular, electrical wiring shall be kept clear of the exhaust, the muffler and other hot parts.

D7.1.3 *Vibration isolation*

Means for minimizing transmission of vibration shall be provided as follows:

(a) Between the engine-generator combination and the chassis; alternatively underneath the chassis.

(b) For instruments and controls where these might be affected by vibration.

D7.1.4 *Accessibility of parts*

Parts of a generating set requiring routine service, e.g. air and oil filters, shall have unobstructed access and be readily accessible and serviceable without major dismantling or the use of special tools.

D7.1.5 *Weather protection*

A generating set intended for undercover use should be suitable for use in light mist without interruption of operation.

A generating set intended for outdoor use without further protection from the weather shall conform with Paragraph D7.3.

NOTE: For protection of electrical components, see Paragraph D7.3.

D7.2 Mechanical

D7.2.1 *Fuel system*

The fuel tank capacity shall be sufficient for normal operation at rated output for at least 3 h.

D7.2.2 *Cooling system*

The cooling system shall be suitable for continuous operation at rated output.

D7.2.3 *Lubricating system*

Means shall be provided for collecting drained oil into a suitable container.

D7.3 Electrical—Protection of electrical equipment against ingress of objects, dust, and water

Electrical components, accessories and wiring shall be protected against ingress of objects, dust, and water insofar as such might occur in normal use.

The enclosure of electrical equipment of a generating set shall have a minimum degree of protection of not less than IP22 in accordance with AS 60529 or, for the generator, with AS 60034.1.

The enclosure of electrical equipment of a generating set intended for outdoor use without further protection from the weather shall have a minimum degree of protection of not less than IP23.

NOTE: Additional protection may involve considerable additional cost (see Paragraph D9).

D8 INFORMATION

D8.1 Marking on set

The following information shall be permanently and legibly marked on a generating set:

(a) The name of the manufacturer of the set.

(b) The model number and serial number of the set.

(c) The type of fuel or fuel-oil mixture.

(d) Rated output in watts or kilowatts at a stated power factor.

(e) The voltage and frequency.

(f) Output terminal markings (unless all outputs are -socket outlets).

(g) The frame terminal: Symbol  or 'FRAME'.

(h) On a set intended for undercover or weather-protected usage, the words 'NOT WEATHERPROOF'.

(i) On a set intended for outdoor use without further protection, the IP classification of its electrical equipment.

(j) A warning as follows:

WARNING: THE OUTPUT OF THIS GENERATING SET IS POTENTIALLY LETHAL. THE SET SHALL NOT BE CONNECTED TO A FIXED ELECTRICAL INSTALLATION BY FIXED WIRING EXCEPT BY AN APPROPRIATELY LICENSED PERSON. SEE INSTRUCTION MANUAL.

D8.2 Warning notices

In addition to the warning detailed in Paragraph D8.1(j), the following warnings shall be either—

(a) marked on a generating set in accordance with Paragraph D8.1; or

(b) provided in documents supplied with a generating set.

The warnings need not be phrased as set out below but should convey the same sense:

(i) DO NOT OPERATE IN A HAZARDOUS LOCATION, E.G. WHERE THERE MAY BE A RISK OF EXPLOSION OF PETROL FUMES, LEAKING GAS OR EXPLOSIVE DUSTS.

(ii) DO NOT OPERATE IN A CONFINED AREA WHERE EXHAUST GASES, SMOKE OR FUMES COULD REACH DANGEROUS CONCENTRATIONS

(iii) DO NOT REFUEL WHILE ENGINE IS RUNNING FOR PETROL DRIVEN ENGINES.

Warnings shall also be provided, where necessary, dealing with methods of lifting the generating set and any operating restrictions, e.g. concerning operation for long periods at low load.

D8.3 Technical manual

A generating set shall be supplied with a technical manual that provides comprehensive instructions concerning installation, operation and maintenance procedures. The connection of the generating set to a fixed electrical installation should also be detailed [see Paragraph D8.1(j)].

D9 INFORMATION TO BE PROVIDED WITH ENQUIRY AND ORDER

The following information should be supplied by intending purchasers with enquiries and orders for generating sets in accordance with this Appendix:

(a) The intended usage, or dominant load, e.g.:

(i) Leisure, sports, camping—lights, cooking appliances, refrigeration.

(ii) Light industrial—portable tools.

(iii) Domestic household—mains-failure back-up.

(iv) Industrial, construction and building trades: tools.

(v) Marine applications.

(vi) Special requirements, e.g. high ambient temperature, high altitude, or both.

(b) If the set is to drive electric motors, e.g. refrigerators, grinders, pumps, fans, air conditioners.

(c) The intended operating periods, e.g.:

(i) Number of hours per day, week, or month, as appropriate.

(ii) Maximum usage on one occasion, in hours.

(iii) Expected usage before engine overhaul, in years.

NOTE: The specification of a lengthy period before overhaul may involve considerable additional cost.

(d) The fuel to be used, e.g. grade of petrol; petrol-oil mixture (2-stroke); diesel; other, e.g. LPG.

(e) Voltage, frequency, phases, e.g. 230 V 50 Hz, single-phase.

(f) The output required, in watts or kilowatts and load power factor.

NOTES:

1 Note the marked load of each item intended for use simultaneously and add them. Make allowance for motor-operated appliances like air conditioners, refrigerators and freezers that briefly, on starting, take five times rated load.

2 Consider a larger output if it requires reduced variations in voltage and frequency due to load changes, e.g. with sensitive electronic equipment.

(g) Details of the number, type and rating of the socket outlets to be provided.

(h) If a lower noise level is required.

(i) If manual setting of voltage or closer automatic control of voltage than specified in Paragraph D6.4 is required.

(j) If a voltmeter or ammeter is required.

(k) If a better voltage waveform is required (see Paragraph D6.5).

(l) If a special lifting arrangement, e.g. single-point lifting, is required (see Paragraph D7.1.1).

(m) Any special protection of the ignition system, if any, from the ingress or deposition of moisture, or of the engine intake from ingress of water (see Paragraph D7.3).

(n) Any special protection against fungus growth (in the tropics), salty atmospheres (in coastal areas), or corrosion (in industrial environments).

(o) If a larger capacity fuel tank is required (see Paragraph D7.2.1).

Any special protection of electrical equipment against ingress of objects, dust, or water (see Paragraph D7.3).

D10 INSTRUCTION MANUAL

The instruction manual shall include the following information:

(a) Read instructions and note warnings on the set.

(b) Locate set in convenient place, avoiding long extension leads and possible damage to leads by pedestrian or vehicular traffic.

(c) Stop engine, when adding fuel to tank.

(d) Maintain normal safety precautions with appliances and accessories as for use on normal reticulated normal supply.

NOTES:

1 Extension leads should be ordinary or heavy duty depending on the application, of appropriate current rating, and in any case not less than 1 mm^2 cross-section of conductor for 10 A fittings, or 1.5 mm^2 when 15 A fitting are used, and incorporates an earthing conductor to ensure that there is no voltage difference between the generating set and any equipment powered by the generating set.

2 The electrical continuity of the 'earthing' core should be checked periodically from pin to socket to ensure continued electrical safety.

3 Some electrical appliances, e.g. portable drills, are marked ⧈ or 'double insulated', in which case there will not be an earthing conductor in its mains lead (even though it may have a 3-pin plug).

NOTES

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GPO Box 476 Sydney NSW 2001
Phone (02) 9237 6000
Email mail@standards.org.au
Internet www.standards.org.au
SAI Global Customer Service
Phone 13 12 42
Email sales@saiglobal.com

PO Box 1473 Wellington 6140
Freephone 0800 782 632
Phone (04) 498 5990
Email enquiries@standards.govt.nz
Website www.standards.govt.nz

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