

Australian/New Zealand Standard™

Electrical installations—Generating sets



AS/NZS 3010:2017

This Joint Australian/New Zealand Standard was prepared by Joint Technical Committee EL-001, Wiring Rules. It was approved on behalf of the Council of Standards Australia on 13 March 2017 and by the New Zealand Standards Approval Board on 5 April 2017.

This Standard was published on 8 May 2017.

The following are represented on Committee EL-001:

Australian Building Codes Board
Australian Industry Group
Communications, Electrical and Plumbing Union—Electrical Division
Consumers Federation of Australia
Electrical Contractors Association of New Zealand
Electrical Regulatory Authorities Council
Electrical Safety Organisation, New Zealand
ElectroComms and Energy Utilities Industries Skills Council
Energy Networks Association
Engineers Australia
Institute of Electrical Inspectors
Master Electricians Australia
Ministry of Business, Innovation and Employment, New Zealand
National Electrical and Communications Association
National Electrical Switchboard Manufacturers Association
New Zealand Council of Elders
New Zealand Electrical Institute
New Zealand Manufacturers and Exporters Association

Keeping Standards up-to-date

Standards are living documents which reflect progress in science, technology and systems. To maintain their currency, all Standards are periodically reviewed, and new editions are published. Between editions, amendments may be issued. Standards may also be withdrawn. It is important that readers assure themselves they are using a current Standard, which should include any amendments which may have been published since the Standard was purchased.

Detailed information about joint Australian/New Zealand Standards can be found by visiting the Standards Web Shop at www.saiglobal.com or Standards New Zealand web site at www.standards.govt.nz and looking up the relevant Standard in the on-line catalogue.

For more frequent listings or notification of revisions, amendments and withdrawals, Standards Australia and Standards New Zealand offer a number of update options. For information about these services, users should contact their respective national Standards organization.

We also welcome suggestions for improvement in our Standards, and especially encourage readers to notify us immediately of any apparent inaccuracies or ambiguities. Please address your comments to the Chief Executive of Standards Australia or the New Zealand Standards Executive at the address shown on the back cover.

This Standard was issued in draft form for comment as DR AS/NZS 3010:2015.

Australian/New Zealand Standard™

Electrical installations—Generating sets

First published as AS 3010.1—1987.
Revised and redesignated AS/NZS 3010:2005.
Second edition 2017.

COPYRIGHT

© Standards Australia Limited

© The Crown in right of New Zealand, administered by the New Zealand Standards Executive

All rights are reserved. No part of this work may be reproduced or copied in any form or by any means, electronic or mechanical, including photocopying, without the written permission of the publisher, unless otherwise permitted under the Copyright Act 1968 (Australia) or the Copyright Act 1994 (New Zealand).

Jointly published by SAI Global Limited under licence from Standards Australia Limited, GPO Box 476, Sydney, NSW 2001 and by Standards New Zealand, PO Box 1473, Wellington 6140.

ISBN 978 1 76035 745 0

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.

CONTENTS

	<i>Page</i>
SECTION 1 SCOPE AND GENERAL	
1.1 SCOPE.....	4
1.2 APPLICATION	4
1.3 REFERENCED DOCUMENTS.....	5
1.4 DEFINITIONS.....	7
1.5 SYMBOLS	9
SECTION 2 GENERAL REQUIREMENTS FOR THE INSTALLATION OF GENERATING SETS	
2.1 GENERAL.....	10
2.2 LOCATION.....	11
2.3 MECHANICAL AND THERMAL PROTECTION.....	11
2.4 CONTROL OF GENERATING SET.....	12
2.5 EARTHING ARRANGEMENTS	14
2.6 ELECTRICAL INSTALLATION.....	15
2.7 ALTERNATIVE SUPPLY (STANDBY)	16
2.8 EARTHING AND BONDING REQUIREMENTS.....	31
2.9 GENERATOR SWITCHBOARDS.....	34
2.10 LIGHTNING PROTECTION SYSTEMS.....	34
2.11 GENERATING SETS CONNECTED AS NORMAL SUPPLY TO A MAIN SWITCHBOARD IN A PERMANENT ELECTRICAL INSTALLATION.....	34
2.12 GENERATING SETS CONNECTED TO AN ELECTRICAL INSTALLATION CONNECTED AS AN ALTERNATIVE SUPPLY	35
SECTION 3 ADDITIONAL REQUIREMENTS FOR PERMANENTLY CONNECTED GENERATING SETS	
3.1 GENERAL.....	44
3.2 LOCATION.....	44
3.3 GUARDING OF LIVE PARTS	45
3.4 TRANSFORMERS.....	45
3.5 GENERATING SETS SUPPLYING SAFETY AND ESSENTIAL SERVICES	46
SECTION 4 ADDITIONAL REQUIREMENTS FOR PORTABLE GENERATORS	
4.1 GENERAL.....	52
4.2 CONNECTION TO AN ELECTRICAL INSTALLATION	52
4.3 EARTHING AND BONDING.....	53
4.4 CONNECTION OF A PORTABLE GENERATING SET TO A DEDICATED WIRING SYSTEM—NEW ZEALAND ONLY	54
APPENDICES	
A EARTHING REQUIREMENTS FOR GENERATING SETS CONNECTED TO FIXED ELECTRICAL INSTALLATIONS	58
B RECOMMENDATIONS FOR PORTABLE GENERATING SETS SUPPLYING ELECTRICAL EQUIPMENT (NEW ZEALAND ONLY)	60
C DEDICATED WIRING IN AN ELECTRICAL INSTALLATION FOR CONNECTION OF A PORTABLE GENERATING SET (NEW ZEALAND ONLY).....	72
D REQUIREMENTS FOR THE CONSTRUCTION OF SELF-CONTAINED TRANSPORTABLE GENERATING SETS UP TO 25 KW.....	75

STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

Australian/New Zealand Standard
Electrical installations—Generating sets

SECTION 1 SCOPE AND GENERAL

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
3112	Approval and test specification—Plugs and socket-outlets
3120	Approval and test specification—Cord extension sockets
3123	Approval and test specification—Plugs, socket-outlets and couplers for general industrial application
3133	Approval and test specification—Air-break switches
3190	Approval and test specification—Residual current devices (current-operated earth-leakage devices)
3439	Low-voltage switchgear and controlgear assemblies (series)
3584	Diesel engine systems for underground coal mines
3584.1	Part 1: Fire protected—Heavy duty
3820	Essential safety requirements for electrical equipment
3947	Low-voltage switchgear and controlgear
3947.6.1	Part 6.1: Multiple function equipment—Automatic transfer switching equipment
4024	Safety of machinery
4024.1601	Part 1601: Design of controls, interlocks and guarding—Guards—General requirements for the design and construction of fixed movable guards
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)

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

NZ

- (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.
- 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.

A

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.

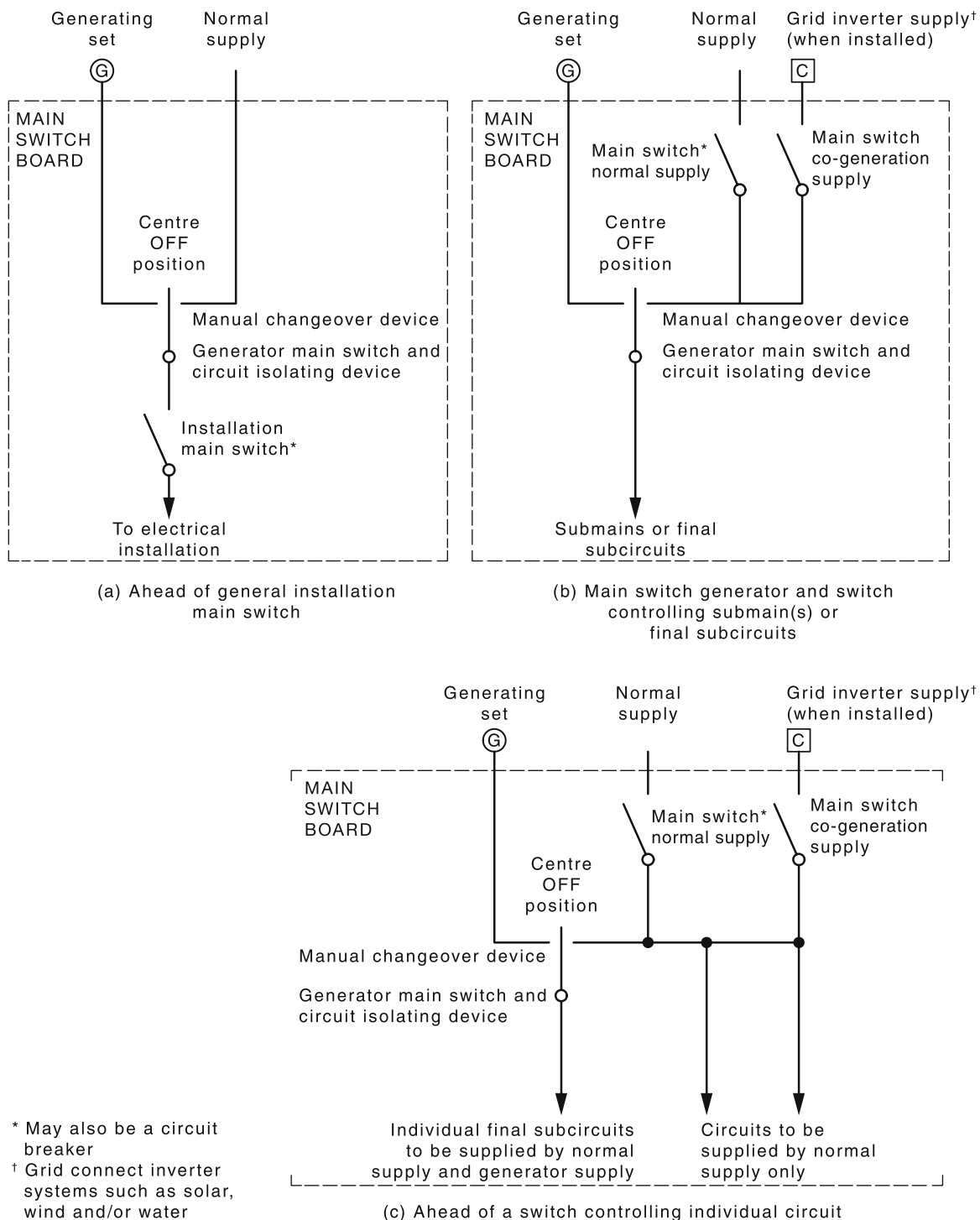
2.7.7 Access

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.

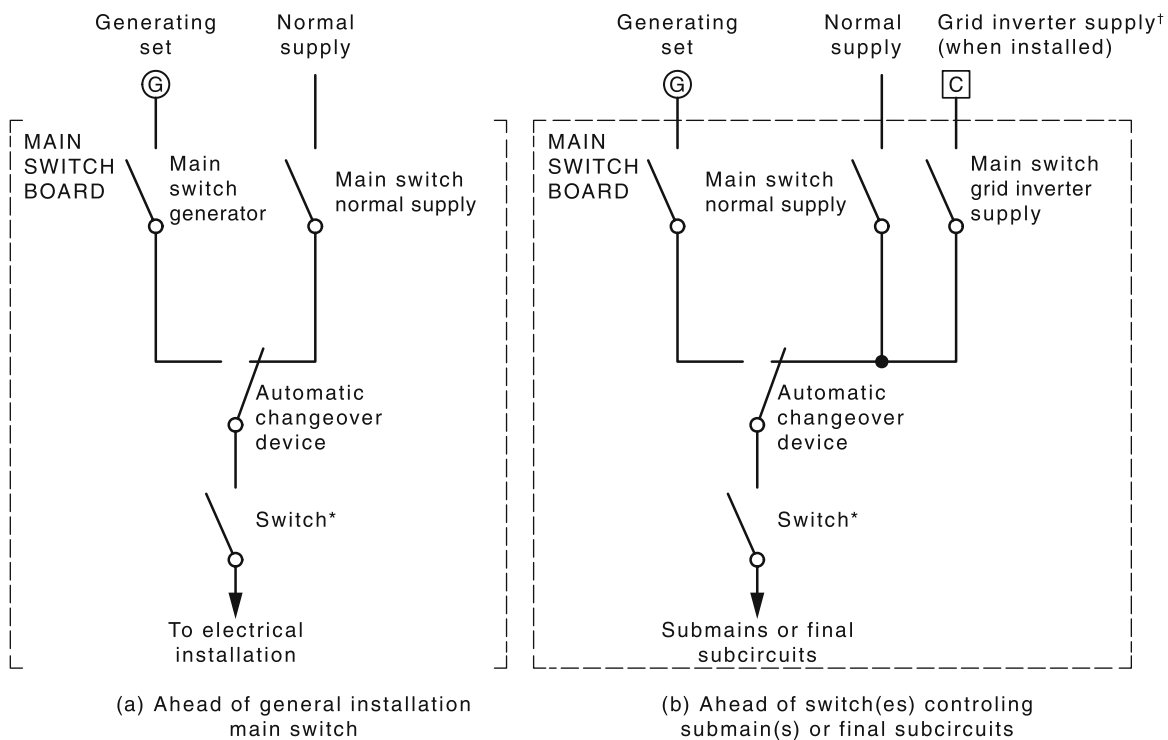
Where the operation of a changeover device automatically brings into service an alternative supply, the purpose of the device shall be permanently marked accordingly.



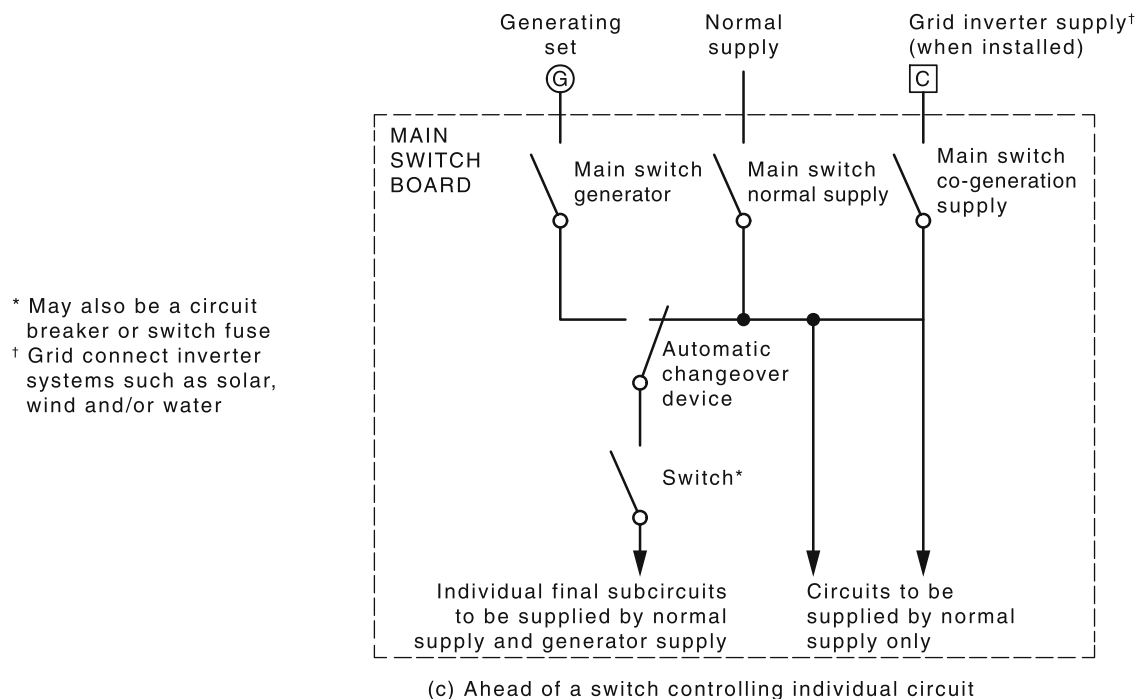
NOTES:

- 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



NOTE: Co-generation not permitted with this arrangement



* 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

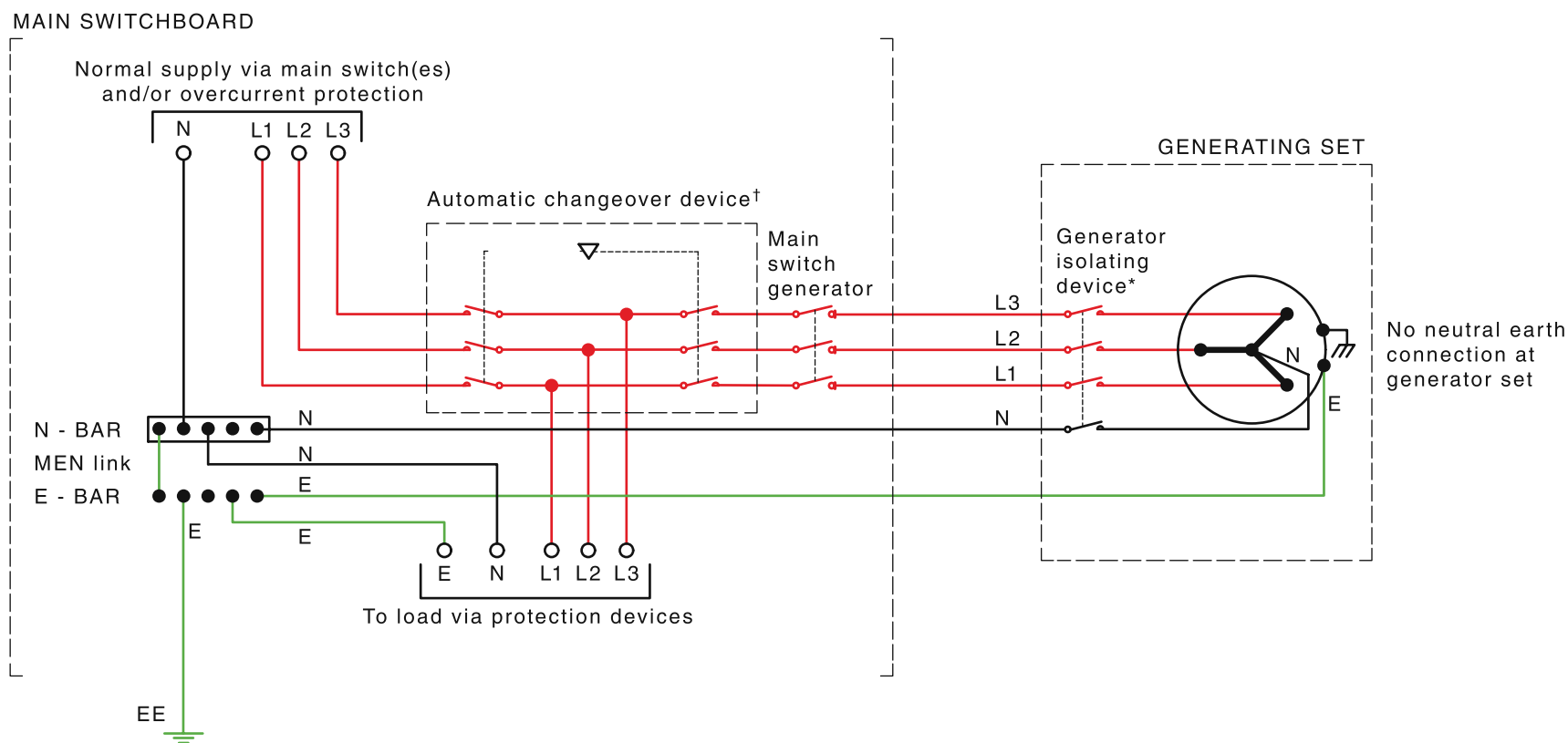
When a four pole/four pole changeover device is used in a main switchboard, the normal supply neutral conductor to the switchboard shall not be switched prior to MEN link.

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
	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

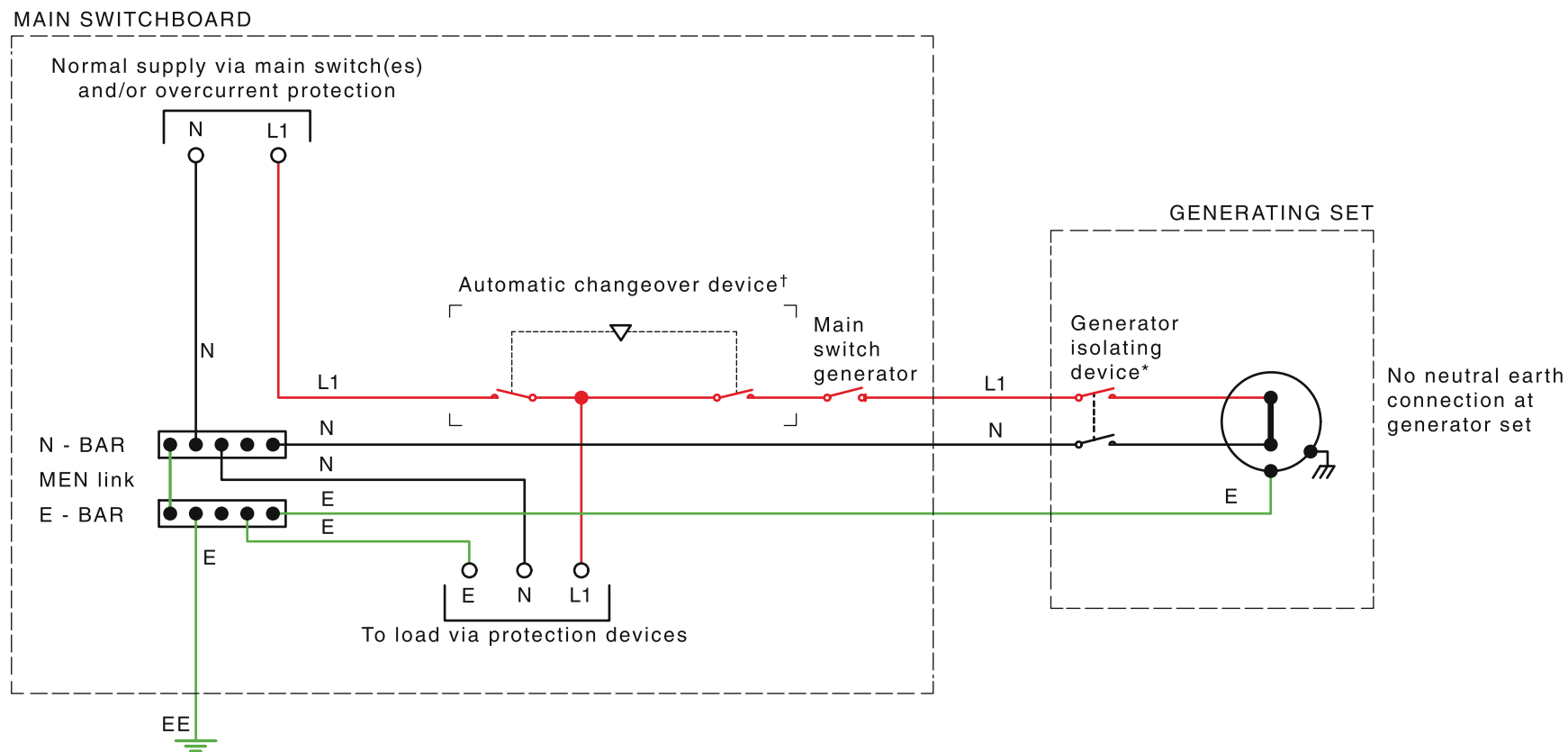


* May include overcurrent protection

† 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



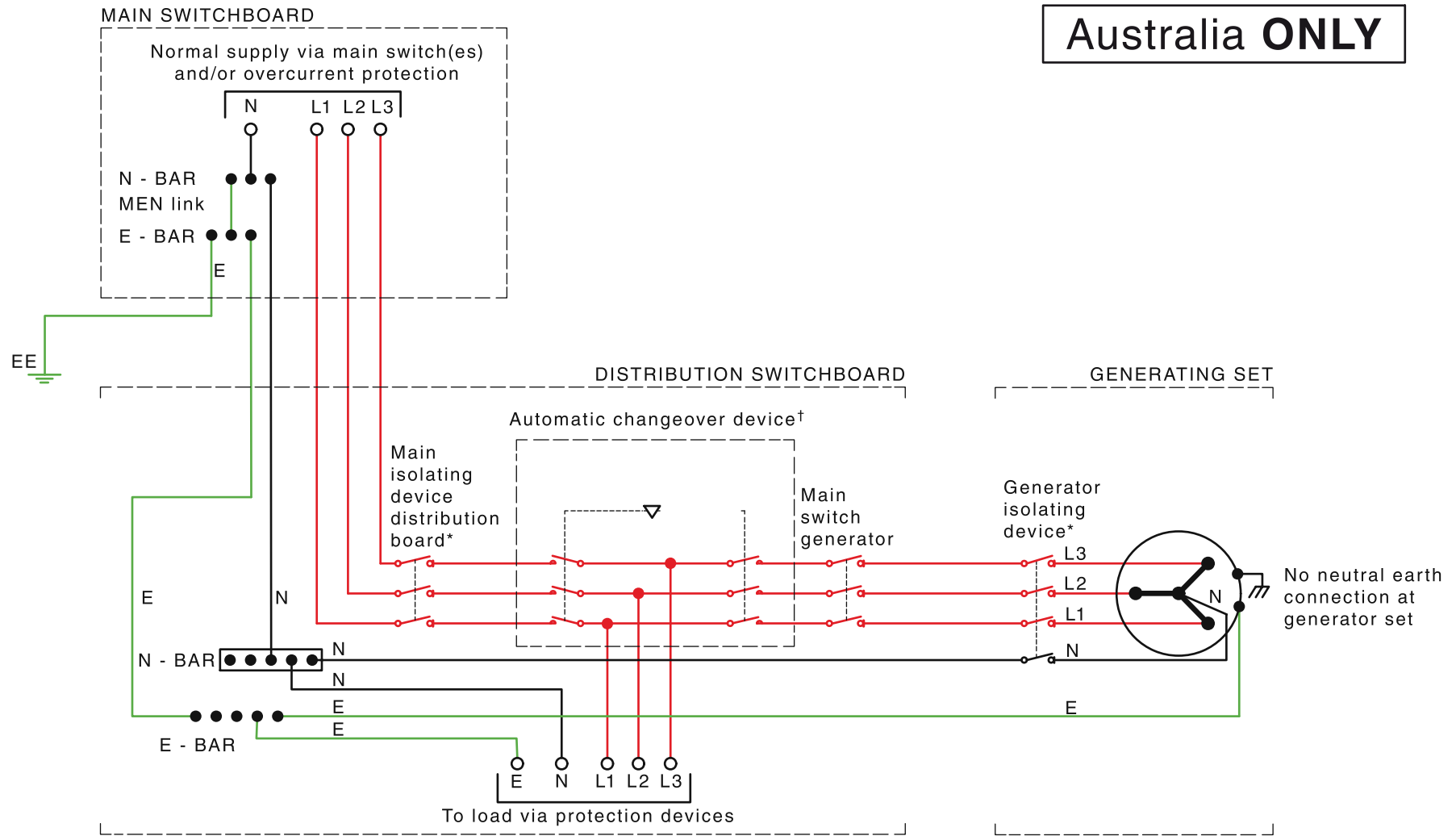
* May include overcurrent protection

† 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

Australia ONLY



* May include overcurrent protection

† Synchronisation and control equipment not shown

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