

Section 8
**Alternative Sources
of Supply**

Service and Installation Rules of New South Wales
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8 Alternative Sources of Supply

8.1 INTRODUCTION

All privately owned generating installations (whether stand-by or parallel generation) connected to the distribution system must comply with all statutory and regulatory requirements, including:

- (a) AS/NZS 3000.
- (b) AS/NZS 3010.1 'Electrical installations - supply by generating set Part 1: Internal combustion engine driven set'.
- (c) These Rules.
- (d) The electricity distributor's customer connection contract.
- (e) The National Electricity Rules.

The electricity distributor may disconnect your generating equipment from their distribution system if:

- (a) The equipment is dangerous to the electricity distributor's staff or representatives.
- (b) The continued operation of the equipment is dangerous to the integrity of the electricity distributor's distribution system.
- (c) The equipment adversely affects other customers.

All enquires regarding alternative sources of supply must be directed to the electricity distributor.

8.2 COSTS

Subject to the relevant determinations of IPART and/or the provisions of the National Electricity Rules, the customer may be required to pay for all costs incurred by the electricity distributor resulting from the installation of private generating plant. These may include the provision of equipment to:

- (a) Record the operation of the plant.
- (b) Control and protect the electricity distributor's distribution system.

The customer should not spend any money on the proposed generating plant or its installation until:

- (a) The conditions under which the electricity distributor agrees to the connection and intended use of the plant have been received, or
 - (b) The electricity distributor's conditions of use and connection have been received.
-

8.3 STAND-BY GENERATING PLANT - GENERAL

For the purpose of this section, the terms STAND-BY GENERATING PLANT or STAND-BY GENERATOR mean private generating equipment installed to supply or partly supply an electrical installation which is normally supplied from the electricity distributor's distribution system.

8.3.1 Conditions of Use

Stand-by generating equipment must only be used under the conditions agreed to by the electricity distributor.

In general, stand-by generating equipment must not be used to operate in parallel with the electricity distributor's distribution system unless it complies with the requirements of Clauses 8.4 or 8.5.

Applications to connect generating systems intended to operate in parallel with the distribution system will be individually assessed. Connection of these systems must be approved by the electricity distributor and meet the requirements of Clauses 8.4, 8.5 and 8.6.

Inquiries or proposals for generation and sale of electricity into the network shall be directed to the electricity distributor.

8.3.2 Spacing for Conductors

Conductors must be suitably spaced from all the other conductors of the installation, to limit the damage to the customer's electrical installation if an internal generator fault occurs.

8.3.3 Changeover Equipment for Non-Parallel Operation

The connection of the stand-by plant to the electrical installation should normally be made on the load side of the electricity distributor's metering equipment. This is so the electricity distributor's metering will not meter the generated energy. However, this may be unavoidable where an installation has multiple customer metering. Typical arrangements are shown in Figures 8.1 and 8.2.

Switchgear to facilitate manual or automatic changeover in the event of interruption to the electricity supply should be located on or adjacent to the switchboard controlling that part of the electrical installation to be supplied from the private generating plant.

If automatic changeover uses contactors or circuit breakers, arrange them so that opening any switch that controls that part of the installation is safe. Do not create a situation where the opening of any switch controlling that part of the electrical installation intended to be supplied from the stand-by generating plant could be unsafe. Contactors or circuit breakers for automatic changeover must meet the requirements of AS/NZS 3010.1. Provide a switch to isolate the stand-by generating plant from the installation.

Figure 8.1: Suitably interlocked switches
(phase connections only shown)

i.e., break before make type, where there is a definite period when both switches are open.

This interlocking may be electrical and/or mechanical (with fail safe non-parallel state) or by keying.

Refer AS/NZS 3010.

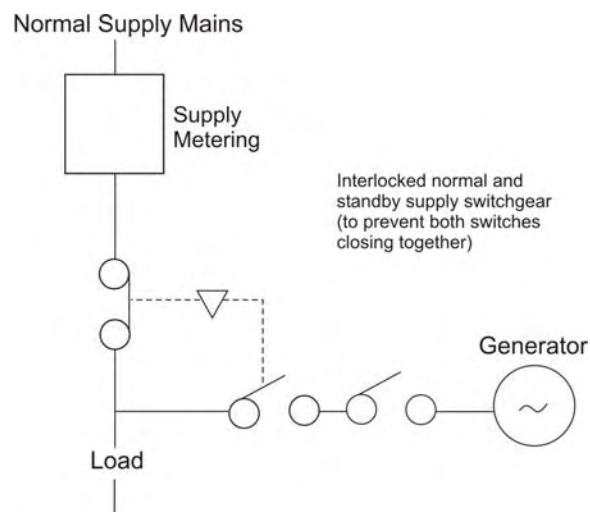
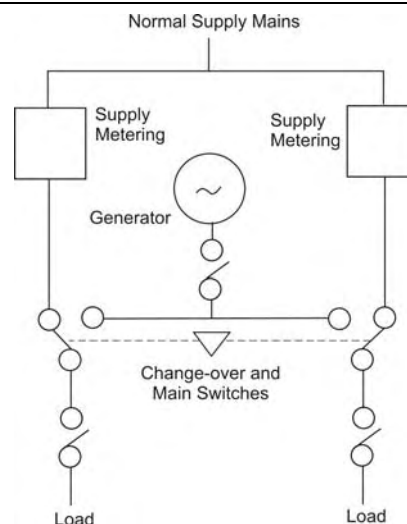


Figure 8.2: Changeover switches
(phase connections only shown)

Refer to AS/NZS 3010 for methods of connecting and switching neutral conductors.



8.3.4 Switching the Neutral

8.3.4.1 Principles

The switching of the generator neutral may be required to avoid multiple MEN connections.

The normal supply neutral must not be switched.

Correct sizing of the earth and neutral conductors for a permanently connected generator set is essential as these conductors form the loop that carries the earth fault currents. Refer to Table 8.1 for correct sizing of these conductors.

Table 8.1: Neutral and Earthing Conductors

Size of Active Conductors	Minimum Size of Connecting Conductors
Not larger than 120mm ² copper or 185mm ² aluminium	Not smaller than half the largest active conductor, and in any case, not smaller than 25mm ² copper or 35mm ² aluminium.
Exceeding 120mm ² copper or 185mm ² aluminium	Not smaller than one quarter of the largest active conductor and in any case not less than 70mm ² copper or 95mm ² aluminium.

Note: The minimum size of connecting conductors may be reduced from 25mm² copper and 35mm² aluminium to 10mm² copper and 16mm² aluminium respectively for generating units up to and including 5kVA.

8.3.5 Multiple Generators

The customer must discuss the method of interconnection with the electricity distributor if multiple generators are to be connected in parallel.

The methods for interconnection will vary with the size of the site and whether or not all the generators are to be connected at the same switchboard. Larger sites may have generation at multiple locations, whereas smaller sites may have their generators located at the one

position. Refer to AS 3010 for various changeover requirements.

The harmonic current produced by the generator will flow through the neutral under normal operating conditions. Where dissimilar generators are operated in parallel, steps shall be taken to limit the circulating current in the neutral connection between the generators. The circulating current must be taken into account when determining the size of the neutral conductor.

8.4 REQUIREMENTS FOR STAND-BY GENERATOR SYNCHRONISE CLOSE TRANSFER TRIP

Generator Synchronise Close Transfer Trip (SCTT) allows transfer to generator supply without complete disconnection of the load.

Customers who wish to use SCTT operation with their stand-by generation must also provide a letter stating the operating conditions of the generator. The operating conditions must specify that the generator will be used as a stand-by supply and will only run in parallel with the electricity distributor's supply system for extended periods if the conditions of Clause 8.5 are met.

The customer must provide the electricity distributor with the following details of the equipment:

- i) Site electrical drawings.
- ii) The protection settings of circuit breaker transfer switches and interlocking arrangements.
- iii) Earthing provisions.
- iv) The proposed installation date.
- v) The size of the generator.

Note: All sources of supply, at the time of synchronisation, must be considered when designing the fault capacity of the system.

8.4.1 SCTT Operating Procedure

The time period for operating in parallel with the distribution system during the disconnection or reconnection function of the SCTT for any occurrence should not be longer than 1 second for each operation. The short transfer period eliminates the need for protection against reverse power flow and vector shift. This time period includes:

- (a) Closing the generator isolating device to the distribution system once generator and mains supply are synchronised.
- (b) Isolation from the distribution system and transfer of the load to the generator.
- (c) Transferring the load from the generator to the distribution system once generator and mains supply are synchronised.
- (d) Disconnecting the generator.

8.4.2 Additional Protection

Apart from the protection requirements in AS/NZS 3010, the only additional protection required is a check synchronisation relay.

An indicator on the main switchboard must clearly show the generator and electricity distributor's supply system status.

The electricity distributor will approve and inspect the installation before the generator is commissioned. A test operation may be necessary.

When it is necessary for the electricity distributor's System Operator to be informed of a stand-by generator run period, a minimum of one hours notice is desirable advising of the starting time and duration before commencing each run period. The customer representative must provide a contact number and be available for the duration of the run period.

The customer must provide details of the maintenance schedule of the generator protection devices if requested. The customer must keep records; they must be available upon request.

Manual synchronisation is prohibited, unless monitored by a check synchronisation relay.

8.5 REQUIREMENTS FOR GENERATOR PARALLEL OPERATION

This clause covers the use of a generator for extended parallel operation.

Customers must provide a statement of the operating condition of the generator. This will specify that the generator may be run in parallel with the electricity distributor's supply system for extended periods as agreed with the electricity distributor.

The customer must provide the electricity distributor with the following details of the equipment:

- i) Site electrical drawings.
- ii) The protection settings of circuit breaker transfer switches and interlocking arrangements.
- iii) Earthing provisions.
- iv) The proposed installation date.
- v) The size of the generator.

8.5.1 Operating Procedure

The procedure for operating in parallel with the electricity distributor's distribution system for any occurrence will include:

- (a) Closing the generator isolating device to the distribution system once in synchronism.
- (b) Increasing the generator load to the desired level.
- (c) Run for period arranged.
- (d) Decrease the generator load and isolate generator from the distribution system.

8.5.2 Additional Protection

The minimum interconnection protection requirements to allow parallel operation are:

- (a) Over and under voltage protection relays with appropriate time delays (under voltage protection to prevent generator load being transferred to the electricity distributor's distribution system in the event of low or no supply system voltage).
- (b) Manually initiated, fully automatic synchronising equipment.
- (c) Overcurrent and earth fault protection. The protection setting must be suitable for the rating of the machine, the method of earthing and the current capability of the affected circuits.
- (d) A supervised battery supply for relays and tripping.

Note: Settings on these devices should be approved by the electricity distributor prior to the generator being used in parallel mode.

You must also provide devices to protect the generator from abnormal operating conditions. Devices shall include (as a minimum) protection against:

- i) Reverse Power (Failure of Prime Mover).
- ii) Loss of Excitation (Pole Slipping).
- iii) Loss of Mains (Anti-Islanding)

Further protection may be installed as required by the generator manufacturer or consultant. Typical examples are listed as follows:

- i) Negative phase sequence.
- ii) Rotor earth fault.
- iii) Differential protection.
- iv) Thermal overload.

Switchboards must be labelled as in clause 8.7.

An indicator on the main switchboard must clearly show the generator and electricity distributor's supply system status.

The electricity distributor will approve and inspect the installation before the generator is commissioned. A test operation may be necessary.

When it is necessary for the electricity distributor's System Operator to be informed of a stand-by generator run period, a minimum of one hours notice is desirable advising of the starting time and duration before commencing each run period. The customer representative must provide a contact number and be available for the duration of the run period.

If the paralleling adversely affects the quality of supply to other customers, correct the operation of the generator before any further parallel operation.

The customer must provide details of the maintenance schedule of the generator protection devices if requested. The customer must keep records; they must be available upon request.

Manual synchronisation is prohibited, unless monitored by a check synchronisation relay.

8.6 SMALL SCALE PARALLEL CUSTOMER GENERATION (VIA INVERTERS)

8.6.1 Introduction

This clause outlines requirements for the installation of small scale generation facilities on a customer's premises that are connected to the electricity distributor's distribution system (grid) via an inverter. The generation source is most commonly solar photovoltaic (PV) arrays, but other sources are applicable.

These Rules apply to single and three phase generators rated at 10 kVA per phase maximum, larger generators will require special negotiation and approval by the electricity distributor, refer to clauses 8.6.11 and 1.10.13.

These installations allow customers to either:

- (a) have all the electricity generated supplied to the distribution network and for metering to measure the amount of electricity so supplied (gross metering), or
- (b) have some or all of the electricity generated used by the customer rather than being supplied to the distribution network (net metering).

8.6.2 Responsibilities

The customer is responsible for the design, installation and maintenance of private generation facilities. The installation must comply with all relevant Australian Standards, including:

- (a) AS 4777.1 'Grid connection of energy systems via inverters - Installation requirements'.
- (b) AS 4777.2 'Grid connection of energy systems via inverters - Inverter requirements'.
- (c) AS 4777.3 'Grid connection of energy systems via inverters - Grid protection requirements'.
- (d) AS/NZS 3000.
- (e) AS/NZS5033, Installation of Photovoltaic Arrays.
- (f) These Rules.
- (g) Any requirements of the electricity distributor.

Customers must not connect generation facilities until the electricity distributor gives approval in writing. The electricity distributor will advise its requirements upon receipt of application for connection and all supporting documentation.

The associated Application for Connection and relevant notice of electrical work form must include full details of the inverter rating and its Certificate of Suitability certification number.

8.6.3 Buy Back Tariffs

Availability of buy back tariffs should be discussed with the electricity retailer.

8.6.4 Metering Requirements

The electricity distributor will outline its metering requirements for the installation.

Possible metering options include:

8.6.4.1 Time of Use (TOU)

The customer must arrange to install bi-directional electronic metering capable of separately registering TOU imported and exported energy.

8.6.4.2 Standard

The customer must arrange to install either:

- (a) Separate back to back, non electronic, detented metering, or
- (b) Bi-directional electronic metering capable of separately registering imported energy and flat rate exported energy.

8.6.4.3 Deleted

8.6.5 Construction Permits

The customer must obtain any authorisation or permits required for the connection and operation of the generating equipment and interconnection facilities. This may include local government rezoning or building permits.

8.6.6 Islanding Prevention

The customer must prevent the intentional or unintentional 'islanding' of generator-installations. Islanding is a situation where one or more inverters maintain a supply to the distribution system after the distribution system supply has been isolated. Isolation of grid supply may be unplanned (blackout) or planned (for work on the street mains).

Islanding creates serious safety issues, quality of supply problems for other customers and the possibility of equipment damage.

The protection equipment associated with the generation source must be designed, installed and tested to ensure that islanding does not occur, refer to clause 8.6.12 Protection Equipment.

8.6.7 Generation System Wiring

All wiring must be installed in accordance with the AS/NZS 3000. Figure 8.3 shows an example installation, single line diagram.

8.6.8 DC Circuit Breaker

A double pole DC circuit breaker must be installed either close to the inverter or internal to the inverter, to isolate the DC source from the inverter. It must operate simultaneously in both the positive and negative legs of the DC cable.

8.6.9 Connection Point

It is preferable for the generation source to be connected to the main switchboard. If this is not possible due to distance (cost) considerations, the nearest distribution board should be used and all up stream switchboards labelled. Refer to Section 8.7 Labelling.

The generation system must be connected to a dedicated circuit. The rating of the inverter circuit cables and all the cables between any distribution boards and the main switchboard which carry inverter output must be rated for at least the full output of the inverter, refer to the AS/NZS 3000.

8.6.10 Switching Requirements

The following installation main switches must be of the lockable or sealable form for safe isolation:

- (a) The installation main switch(s) on the main switchboard.
- (b) The generator supply main switch, refer to clause 8.6.19 Generator Supply Main Switch.

8.6.11 Approvals Documentation

The inverter and protection equipment must be approved by the electricity distributor prior to connection. The customer must provide all appropriate documentation at the time of application for connection, including:

- (a) Single line diagram of the Alternating Current (AC) side of the inverter, showing the connection point, refer to clause 8.6.9.
- (b) Full description of all protection equipment installed, including test results verification. The electricity distributor may also require ongoing periodic verification tests.
- (c) Approved by the Business Council for Sustainable Energy or equivalent.

8.6.12 Protection Equipment

Protection must consist of both active (anti-islanding) and passive systems. All protection equipment must be type tested for compliance to the requirements of these Rules and the electricity distributor. Refer also to AS 4777.3.

8.6.13 Active (Anti-islanding) Protection

Active anti-islanding protection isolates the generation source from the distribution system in the event of a distribution system supply outage.

An example of this method is frequency drift. In this system the inverter is designed to lock to the distribution system frequency as a reference. The inverter frequency generator must then shift away from the nominal 50 Hz if the distribution system supply is not present, thereby, tripping the Over/Under frequency protection. It is recommended that the direction of frequency shift be downwards.

If the inverter does not have the above frequency drift system the manufacturer must demonstrate an alternate anti-islanding protection feature that is acceptable to the electricity distributor.

8.6.14 Passive Protection

In addition to the above anti-islanding protection the customer's generation facilities must have the following minimum protection (in the inverter):

- (a) Over/under frequency.
- (b) Over/under voltage.
- (c) Over current and short circuit protection.

Where the inverter protection is not considered adequate, the electricity distributor may require the installation of backup protection. Where required the backup protection is generally installed in an interconnection protection panel (outside the inverter) and must include:

- (d) Over/under frequency.
- (e) Over/under voltage.
- (f) Circuit opening device.

The over/under voltage and frequency protection settings should be negotiated with the electricity distributor within the limits specified in the AS 4777.3 and summarised below in Table 8.2.

Table 8.2: Over/Under Protection Setting Limits

	Minimum	Maximum
Frequency	48-50Hz	50-52Hz
Voltage	200V	270V

Relays must be set and calibrated by a recognised relay calibration laboratory to the satisfaction of the electricity distributor. Settings may be either factory set or site programmable.

8.6.15 Security of Protection Settings

Where the inverter energy system has protection settings that may be changed via a keypad or switches, adequate security must be employed to prevent any tampering or inadvertent/unauthorised changing of these settings. A suitable lock or password system should be used. The electricity distributor must approve any setting changes.

8.6.16 Isolation Time

The maximum combined operation time of both the passive and active protection systems is 2 seconds after loss of the distribution system supply under all load conditions. The inverter must remain disconnected from the distribution system until the reconnection conditions have been met, refer to clause 8.6.18 Reconnection Procedure.

Disconnection, due to the operation of any of the above protection must be via two separate methods, one of which must be by normally open contacts.

8.6.17 Functional In Service Test of Inverter Protection

The following in service tests should be carried out by the installing contractor to the satisfaction of the electricity distributor.

Test Method

Remove all loads in the installation, for example, remove all circuit fuses except for the inverter circuit. Isolate normal supply main switch. The inverter should trip by its own internal protection in less than 2 seconds following disconnection from the distribution system supply. Then close the main switch. The inverter should re-connect after a time delay as per clause 8.6.18. Follow a similar procedure to test the backup protection (where installed).

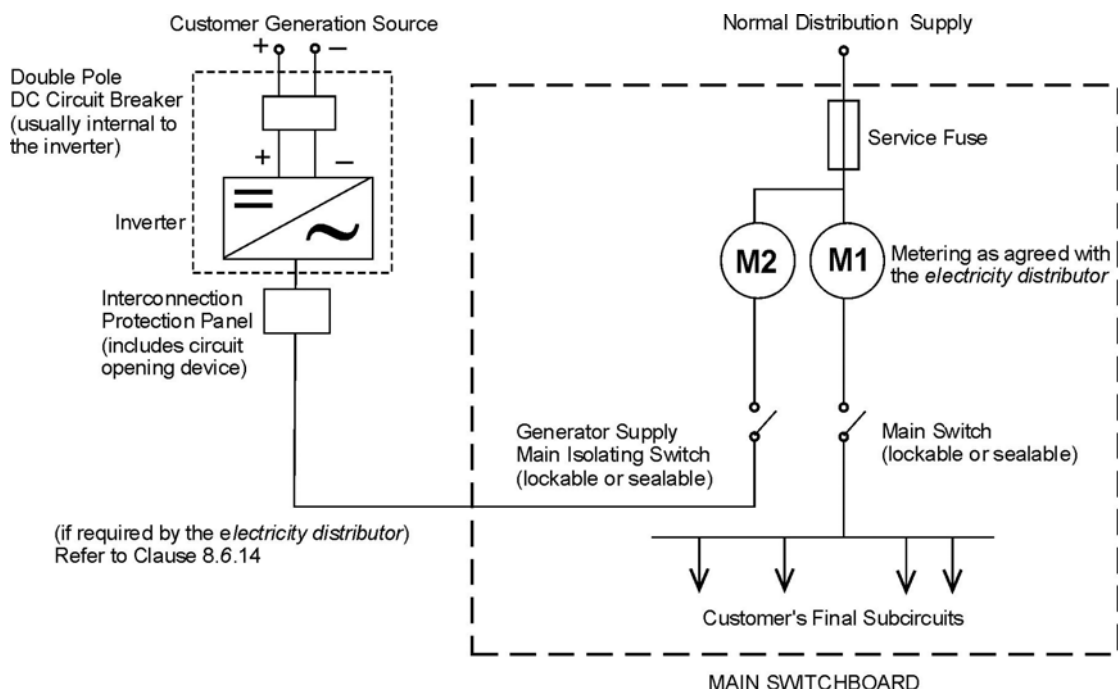
8.6.18 Reconnection Procedure

Automatic reconnection of the generation system onto the distribution system must only occur if the distribution system voltage and frequency are within the protection limits in clause 8.6.14 and these conditions have been maintained for a minimum of 1 minute, or as agreed with the electricity distributor.

8.6.19 Generator Supply Main Switch

The generator supply main isolating switch must be located on the switchboard at which the generation source is connected.

Figure 8.3: Example Single Line Diagram (parallel generation source connected at the main switchboard)



8.7 LABELLING

The customer must supply and install clear and indelible labelling on the installation. As a minimum, labelling should be placed:

- (a) On the switchboard or distribution board that has private generation facilities connected to it.
- (b) On all switchboards including the main switchboard and distribution board(s) upstream of the board that has the private generation facilities connected to it.

Labels should indicate:

- i) The existence of an alternative source of supply.
- ii) The sections of the electrical installation it can supply.

- iii) The point of control.
- iv) The conditions under which the alternative source may be operated.
- v) The conditions of connection and suitable operating arrangements.
- vi) The actual **type** of generation source installed, as particular generation sources have varied electrical characteristics.

The following sample labels are considered acceptable.

Note: Words in *italic* would change to describe the type of generation (eg photovoltaic, induction generator, synchronous generator, etc)

Main switchboard and distribution board(s) upstream of distribution board where private generation plant is connected.

Qty: 1
Lettering height: 4mm, 8mm "WARNING"
Colour: Red, white letters
Size: **120 x 60 mm**

WARNING
SOLAR GENERATION PLANT
CONNECTED
ISOLATE SOLAR GENERATION
PLANT AT (*appropriate distribution board*)

Main switchboard or distribution board where private generation plant is connected.

Qty: 1
Lettering: 4mm, 8mm
"WARNING"
Colour: Red, white letters
Size: **120 x 60 mm**

WARNING
DUAL SUPPLY
ISOLATE BOTH NORMAL AND SOLAR SUPPLIES
BEFORE WORKING ON THIS SWITCHBOARD

NORMAL SUPPLY MAIN SWITCH

Qty: 1
Lettering: 5mm
Colour: White, black letters
Size: **75 x 30 mm**

NORMAL SUPPLY MAIN SWITCH

SOLAR GENERATOR MAIN SWITCH

Qty: 1
Lettering: Title 5mm, Words 4mm
Colour: White, black letters
Size: **75 x 30 mm**

SOLAR SUPPLY MAIN SWITCH
SOLAR GENERATOR LOCATED IN
(*location of solar generator*)

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