



PNWP 030

**THE INSTALLATION, CONNECTION
AND OPERATION OF
THREE PHASE MOBILE GENERATORS**

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Authorised by:	Owned by:	Issue Date: 02/02/11	Status: Approved
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2 Scope

This document covers the procedures, general safety rules and technical aspects relating to the installation connection and operation of Three Phase Mobile Generators. Mobile Generators are used in PWC to provide temporary supply to isolated sections of the LV distribution system and maintain the voltage within prescribed limits during emergency and maintenance periods.

3 References

Australian Standards AS 2790 -1989 Electricity Generating Sets –
(Transportable up to 25 KW)

AS/NZS 3010:2005 Electrical Installations – Generating Sets

Australian Standard AS 3000 – Wiring Rules

Australian Standard AS 1742 – Manual of Uniform Traffic Control Devices

Power and Water Field Guide for Traffic Control

NP003 Power Network Policy Installation Rules

NP007 Power Networks Service Rules

4 Responsibility

All PWC staff as well as the external Generator Providers involved in the installation, connection and operation of a Generator are responsible for the adherence of this procedure.

4.1 Hired Generators

The requirements for installation, connection, operation etc of a Mobile Generator, as described in this document, apply irrespective of whether a Generator is owned by PWC or hired from an external supplier.

However, for hired units, the allocation of responsibilities between the Generator provider and PWC staff may differ according to various contractual arrangements with different Generator providers.

PWC Procurement shall ensure that all relevant staff of PWC and the Generator provider are made aware of their responsibilities in relation to both contractual arrangements and the requirements defined herein.

The following responsibilities of PWC are to be restricted to competent and appropriately trained staff: The interactions with customers (e.g. negotiate Generator sites, power outages, etc), connection of the generator to the network, and the investigation and resolution of any issues relating to the network or customer installation energised by the generator.

Responsibilities assigned to any external Generator provider are usually limited to the provision, and operation of the Generator.

5 Definitions

Customer	An individual or entity who is an end user of electricity
MEN	Multiple Earthed Neutral
Generator	Mobile Generator
RCD	Residual Current Device
JSEA	Job Safety and Environmental Analysis
Low Voltage (LV)	Voltage exceeding 50 volts a.c./120 volts d.c. but not exceeding 1000 volts a.c./1500 volts d.c.
Shall	Mandatory
Should	Not Mandatory but recommended
Established Earth	Existing earthing arrangement of PWC network

6 General

6.1 Personnel Requirements

All staff involved in the installation, connection and operation of a Generator shall be appropriately competent and qualified to perform their assigned duties with PWC authorisation.

6.2 Location Arrangements

Permission/ agreement should be sought from the owner/responsible authority before proceeding to place a Generator on public or private land. Prior to placing a Generator, the relevant Local Council and customers who are directly affected, should be consulted, wherever practicable.

6.3 Access to LV Equipment

All work associated with this procedure shall be carried out in accordance with the requirements of PWC safety rules.

6.4 Connection of portable generators

The connection of electricity supply, by Generator, to installation must be carried out by licensed electrical installation workers and is deemed to be 'Prescribed Electrical Installation Work'. The PWC authorisation to install and connect the generator is also required in the form of approved permits and associated switching programs.

6.5 Prevention of unauthorised access to Generator site

Care shall be taken to prevent the unauthorised access to Generators, Generator switchboards, and associated overhead mains, substations, customer switchboards, etc. Care shall be taken to prevent unauthorised access or operation of the emergency shutdown device.

To ensure the security of the site, the following measures as appropriate, should be implemented, particularly in locations frequented by the general public:

- Locking the access doors/gates
- Warning signs and Notification signs
- Temporary fencing around the site
- Monitoring / Supervision around-the-clock for duration of the Generator operation.

6.6 Night time operation

Sufficient lighting and appropriate type of signage are to be provided for security and to make the Generator site noticeable for pedestrian and vehicular traffic.

6.7 Traffic Management Plan

Consideration should be given to the impact on motor vehicle and pedestrian traffic and if relevant, a suitable traffic management plan in accordance with the relevant "Field Guide for Traffic Control" and AS 1742 shall be developed and implemented.

6.8 Interruption of Supply to Customers

Arrangements should be made for an interruption to connect a Generator, where the duration of disconnection of supply to customers shall be minimised. For planned operations it is generally required to give a minimum of one week notice to all customers thus affected.

7 Installation

7.1 JSEA

A JSEA shall be completed before any work is undertaken at the work site

7.2 Location

The selection of location for installing a Generator should be such that minimum inconvenience is caused to local residents, the general public, and PWC personnel working nearby. Locating a Generator at the same location within a month should be avoided as far as possible.

Placing of Generators in sensitive locations such as areas near schools, kindergartens, hospitals etc, should be avoided. Also residential areas should be avoided, particularly where it is intended to operate the Generator throughout the night which is likely to disturb the sleep of residents. Sites should be managed in accordance to the relevant Environmental Procedures as outlined in Network Standards.

7.3 Access for Refuelling

When selecting a site for generator, consideration shall be given to accessibility for refuelling.

7.4 Cables

The cables used to connect a Generator shall be rated to at least match the rated output of the Generator.

Cables shall be suitably supported and protected from mechanical damage on the ground, up poles, and as they enter substations and switchboards, etc. Suitable measures shall be taken to ensure that cables do not pose a trip-hazard to the public or PWC employees.

7.5 Noise

The noise generated by a Generator shall be minimised. Appropriate control measures may be carried out to mitigate or manage the noise within acceptable limits. (Standard limits Spark ignition engine – 83 db (A); Compression ignition – 90 db (A) at distance of 7 metres)

7.6 Exhaust

It shall be ensured that the exhaust be vented to open air space. Under no circumstances should the Generator be placed such that exhaust gases smoke or fumes could reach dangerous concentrations or enter rooms occupied by persons or otherwise cause damage or nuisance to the adjacent environment.

8 Generator Connection

8.1 Equipotential Earthing and Bonding

The Generator should have the following parts electrically bonded together to form the Generator frame bonding system: the engine frame, the Generator frame, all exposed metal enclosing electrical equipment or wiring, the "earth" terminal of all socket outlets and any residual current device, and the main frame terminal.

The Generator has a winding neutral or star point which is normally connected to the frame bonding system through a removable connection or link.

Where a residual current device is fitted, the connection between the frame bonding system and the winding neutral or star point is necessary to permit correct operation of the device. However this device is unsuitable for connection to a fixed MEN connection (where the neutral and earth are connected together on the load side of the device) because the device would trip on load due to the diversion of current between the neutral and earth connections to the installation. To alleviate this problem the residual current device should be made "Disable" when connected to an MEN system. This process should be done in the secondary wiring of the residual current device/earth leakage relay circuit. To facilitate this, a switch should be available to make the device "Disable" (i.e. turn the device off).

8.2 Generator RCD Protection

The generators supplied are normally fixed with a Residual current device (RCD) to protect against Earth faults. The types of the RCD used are:

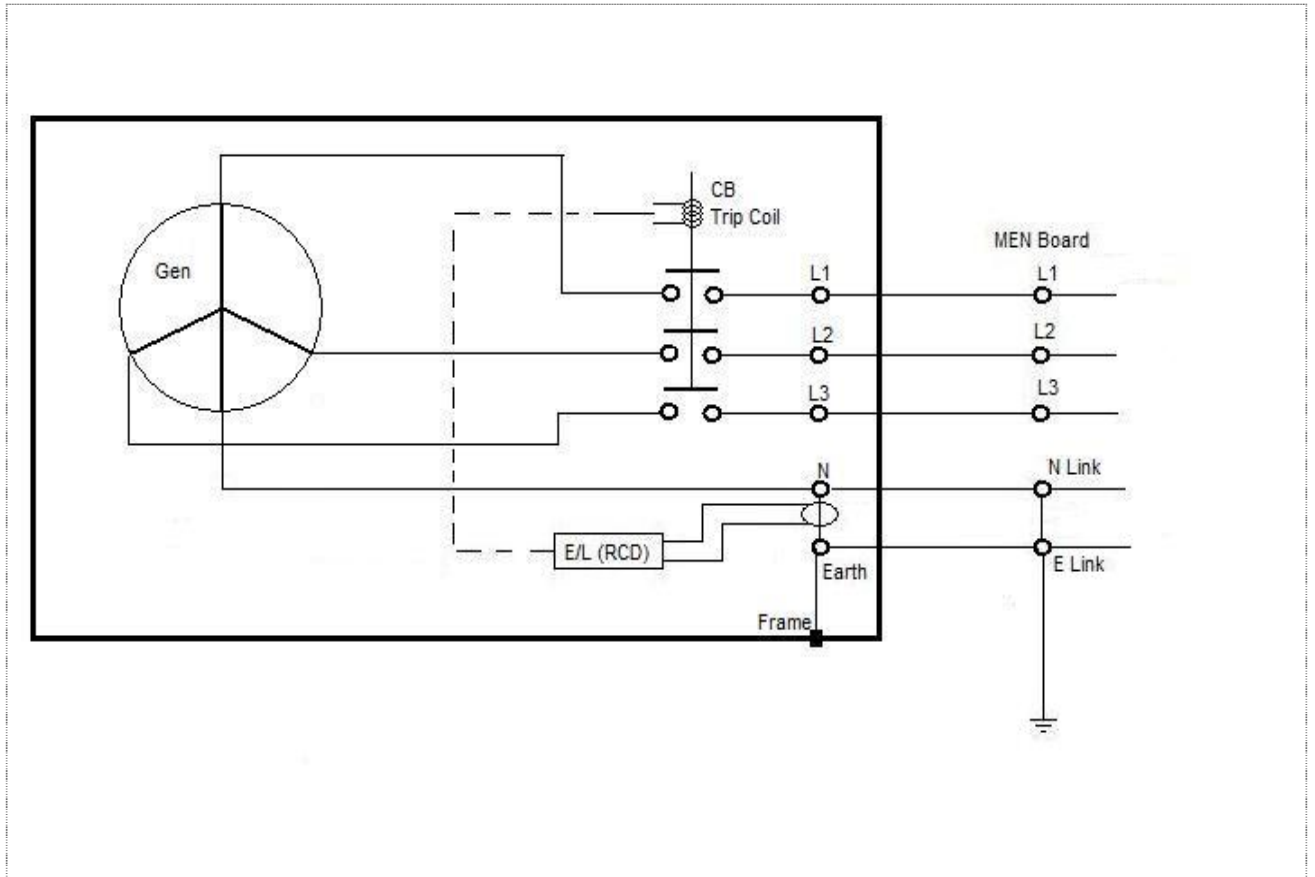
8.2.1 Earth leakage type Residual Current Protection

The schematic diagram shown below illustrates the connection of a Generator with Earth Leakage RCD protection to the PWC LV network with MEN connection.

As discussed above the Earth leakage type Residual Current device is not suitable for connection to an MEN system and hence this has to be disabled for the generator connection to function. Normally a switch is provided in the generator for RCD protection "Disable". This shall be kept in "Disable" position when the generator is connected to the PWC LV network with MEN connection.

If no switch is provided, alternate arrangement is to be done to interrupt the RCD tripping circuit wiring to disable the RCD protection.

Alternately the primary connection from the neutral to the earth through the earth leakage CT can be removed to bypass the CT and the leads reconnected back directly.



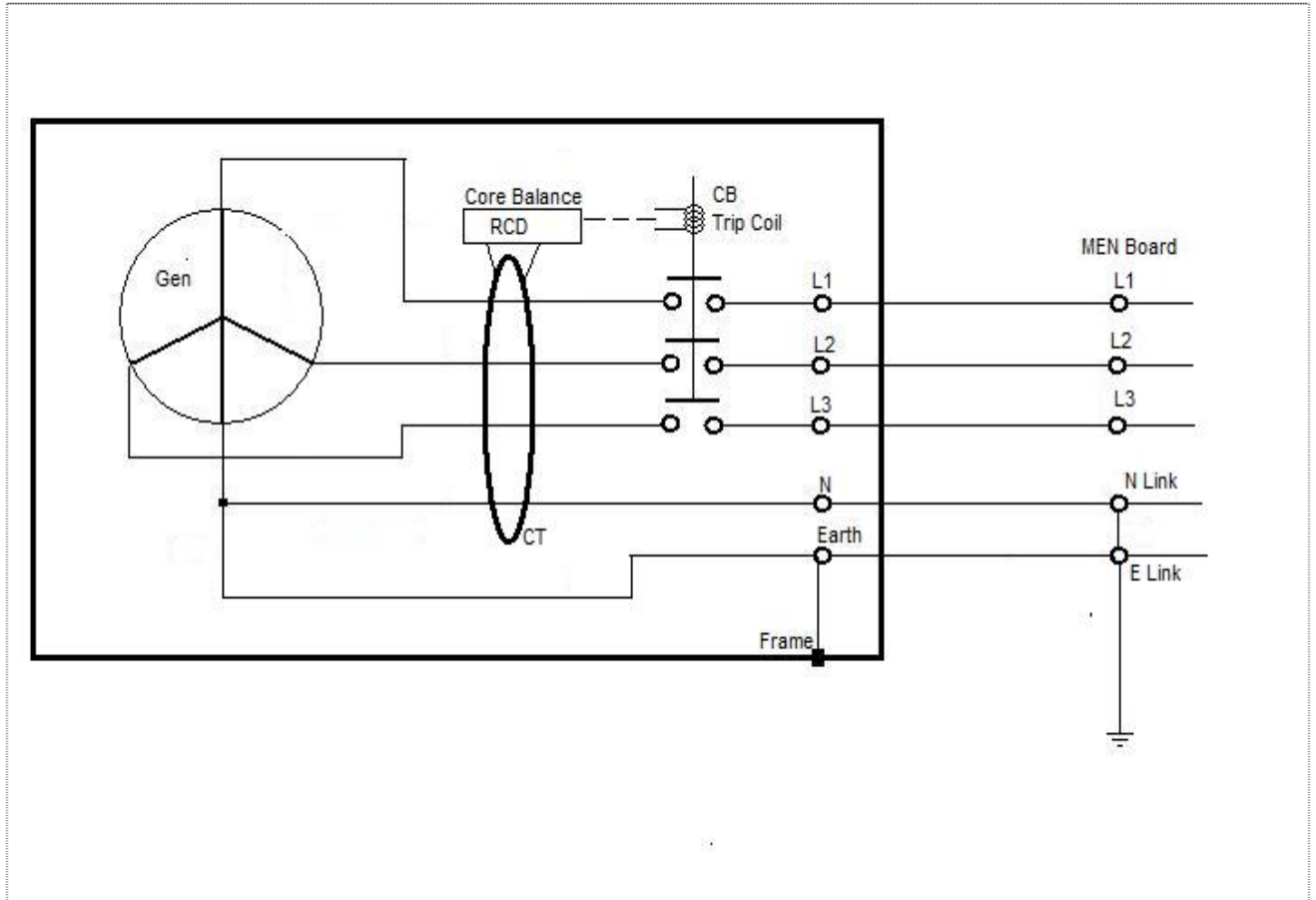
Schematic Diagram for Generator (with Earth leakage relay RCD protection) connection to PWC Network

8.2.2 Core balance type Residual Current Protection

The schematic diagram shown below illustrates the connection of a Generator with Core Balance RCD protection to the PWC LV network with MEN connection.

As discussed above the Core balance type Residual Current device also is not suitable for connection to an MEN system and hence this has to be disabled for the generator connection to function. Normally a switch is provided in the generator for RCD protection "Disable". This shall be kept in "Disable" position when the generator is connected to the PWC LV network with MEN connection.

If no switch is provided, alternate arrangement is to be done to interrupt the RCD tripping circuit wiring to disable the RCD protection.



Schematic Diagram for Generator (with Core Balance RCD protection) connection to PWC Network

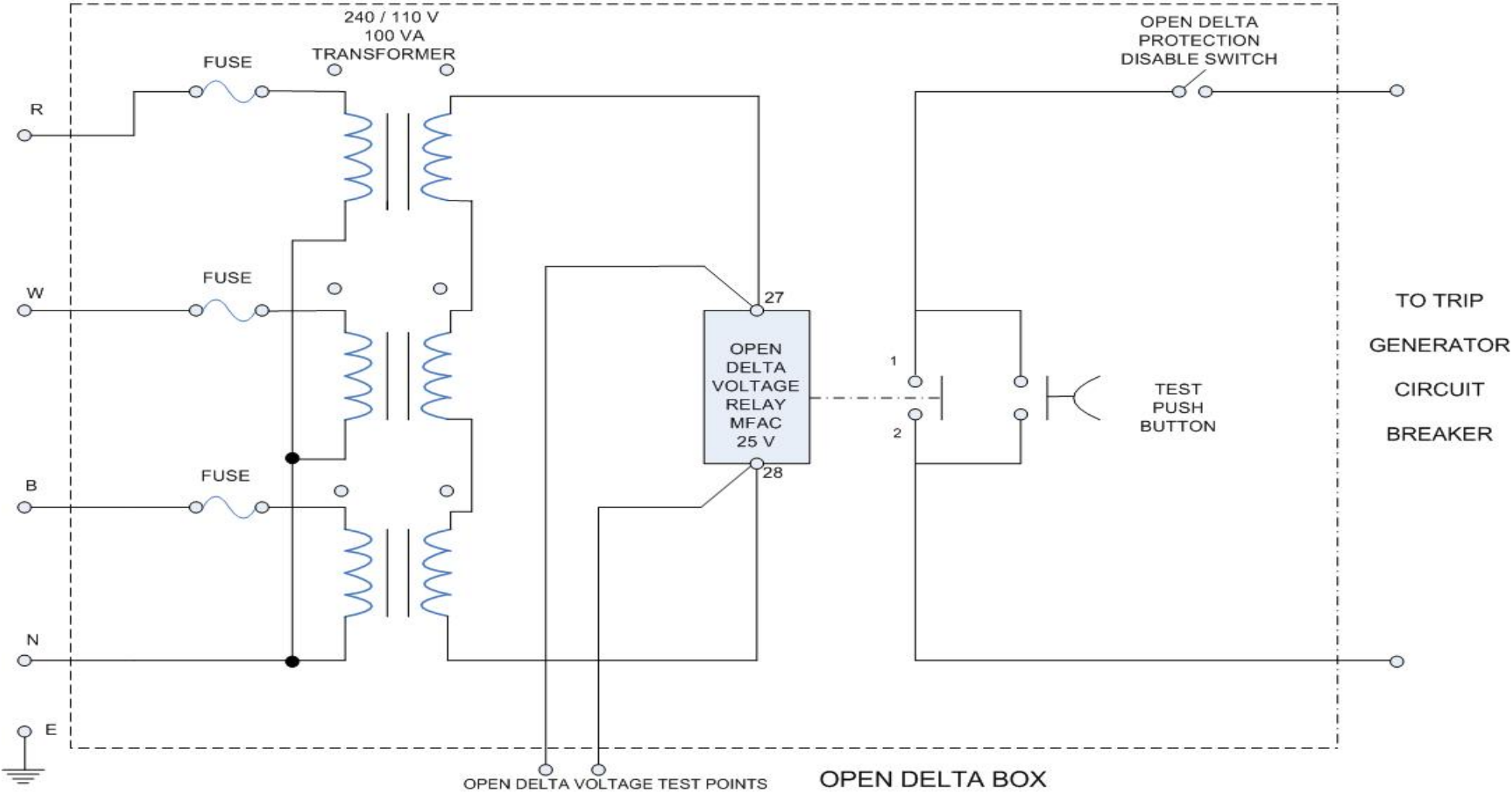
8.2.3 Alternate Open Delta Voltage relay Protection

The Generator connection to the PWC LV network with the MEN connection is functional once the RCD is disabled as above, but there is now no effective earth fault protection and therefore PWC requires that an alternate called an "Open Delta Box" shall be used for providing some level of earth fault protection.

The schematic of the Open Delta Voltage scheme is shown below. The three phase input to the Open Delta voltage box shall be connected to the generator supply for measuring the open delta voltage which is used to sense an earth fault and produce a trip pulse to the generator. The trip contacts of the open delta voltage relay are connected to the generator trip

circuit. The generators are to normally have provisions for connection of the power and trip circuit cables of the Open delta voltage relay Box.

MOBILE GENERATOR EARTH FAULT PROTECTION USING OPEN DELTA VOLTAGE RELAY PROTECTION



9 Generator Connection Direct to PWC Network

The Generator frame bonding system shall be earthed by means of a suitable earth lead connected to the established Low Voltage earthing system of the PWC network.

9.1 Connection procedure for a PWC Package / Kiosk substation

- Check and record the phase rotation of the LV incomer.
- Confirm that the PWC Package substation / Kiosk substation is de-energised and the HV section is electrically isolated from the energised section of the network and Permit is issued.
- Ensure the LV incomer is de-energised and isolated.
- The LV incomer switch is opened and LV isolator links removed on all phases to isolate the circuit to the transformer LV bushings, or alternately disconnect the incomer cables from the Transformer bushings.
- The neutral lead of the generator is connected to the neutral busbar of the Package /Kiosk substation.
- The phase leads of the generator are connected to the load side of LV isolator generator terminals. Care should be taken to ensure the correct phase sequence of the existing network.
- The Generator earthing shall be connected to the established LV earth bus bar arrangement. **Where this is not possible the generator shall not be connected and the situation referred to the appropriate supervisor**

9.2 Connection Procedure for a UG Mains Pillar

- Check and record the phase rotation.
- Confirm that the UG Mains Pillar is de-energised and the Incoming and Outgoing feeder LV supply is electrically isolated from the energised section of the PWC network.
- The LV incomer feeder phase cables are disconnected and isolated.
- The Generator neutral cable is connected to the neutral busbar of the Pillar.
- The Generator LV feeder phase cables are connected to the Pillar mains confirming the correct phase sequence.
- Similarly the Generator earthing shall be connected to the established LV earth bar/ earthing arrangement of the pillar. **Where this is not possible the generator shall not be connected and the situation referred to the appropriate supervisor.**

9.3 Generator Connection Direct to PWC LV OH Mains

Where a Generator is connected directly to PWC LV OH mains network, the Generator earth can be connected to the overhead network earth available at an Overhead pole which has dedicated earthing arrangement.

Connection procedure:

- Check and record the phase rotation of the LV OH conductors to which the generator is to be connected
- Confirm that the overhead network is de-energised and the section of connection is electrically and physically isolated from the energised section of the network.
- The neutral lead of the generator is connected to the neutral lead of the network.
- The phase leads of the generator are connected confirming the correct phase sequence.
- The Generator earth can be connected to the overhead network earth available at an Overhead pole which has dedicated earthing arrangement. **Where this is not possible the generator shall not be connected and the situation referred to the appropriate supervisor.**

Note:

During the connection and removal of the generator cables it should be ensured that the neutral cables should be first to be connected and last to be disconnected.

9.4 Generator Connection Direct to Customer Installation with Earthing System

At the existing Customer Electrical Installation:

- Conduct a visual inspection of the electrical installation.
- Check and record the phase sequence of the incoming supply conductors.
- Ensure that the PWC power supply has been disconnected and there is no power supply available at the existing incoming supply terminals.
- Remove the existing PWC phase cable connections and the neutral cable connections on the customer's mains switchboard.
- Connect the neutral and the three phase cables from the generator to the appropriate points on the customer's mains switchboard.
- Connect the generator earth to the switchboard main earth link or the established earth point.

10 Protection requirements

10.1 Ingress Protection of the Mobile generator

As a minimum, an ingress degree of protection of IP 24 should be achieved (i.e. protection of fingers against access to hazardous parts and protection against splashing and spraying of water from all possible directions). Care shall be taken to prevent contact with live parts of the Generator installation. Erecting temporary barriers, warning and notification signs shall be installed wherever necessary. Care should also be taken to prevent the ingress of water that could cause supply failure.

10.2 Electrical Protection

10.2.1 Over-current and Short Circuit Protection

As a minimum a Generator should be provided with a circuit breaker with over-current and short circuit protection.

10.2.2 Over/ Under Frequency Protection

Generator should be equipped with frequency based protection systems that isolate the Generator in case of the output frequency going beyond the prescribed limits.

10.2.3 Residual Current Device

Where a residual current device (RCD) or Earth Leakage Relay is fitted, the connection between the frame and the winding neutral or star point is necessary to permit correct operation of the device. This arrangement is unsuitable for connection to a fixed MEN connection (where the neutral and earth are connected together on the load side of the device) because the device would trip on load due to the diversion of current between the neutral and earth connections to the installation. To alleviate this problem the device status should be made "Disable" when connected to an MEN system. To do this the process should be done in the secondary wiring of the residual current device/ Earth Leakage Relay circuit. To facilitate this, a switch should be available to make the device "Disable" (i.e. turn the device off).

10.2.4 Anti-islanding

This procedure is not suitable and should not be used for the connection of generators to operate in parallel with the PWC network.

11 Operation

11.1 Voltage and Frequency

Adjustment of frequency and voltage may be required after the Generator has taken load. Generators with automatic speed and voltage regulation should not vary greatly with moderate changes in load. Large load fluctuations caused by lift motors, welding machines; etc will require adjustments of frequency and voltage.

The single phase voltage level must be checked and recorded to be as close to 240 V as possible. The load current should not exceed the Generator rating. If the load exceeds this value, the customer should be requested to reduce their load. But it is better to ensure that the generator is suitably rated to meet the customer load.

The Generator voltages & currents should be monitored and recorded at regular intervals. The records should be returned to the relevant supervisor for future reference.

11.2 Refuelling the Generator

Where a Generator is to be installed and operated for an extended period of time, consideration should be given to preparing a refuelling schedule to ensure continuous operation. The frequency of refuelling would depend on the size of the Generator's fuel tank and rate of fuel consumption.

11.3 Shutting Down a Generator

When shutting down a Generator, the load is first isolated by operating the circuit breaker without reducing the load and then the Generator should be shut down in accordance with the Manufacturer's instruction.