Work Procedure - Low Voltage Testing

IMS-WPP-00-15

Overview

This work procedure sets out the methodology for testing of low voltage overhead and underground electricity supply services to the consumer meter isolation point and switchboard.

Authorisation

Version	Document no.	Reviewed by	Approved by	Date
6.1	R0000431790	James Lord, Secondary Asset Engineering Dakota Wolf, Training & Audit Officer Tony Purton, Training & Audit Officer		Oct./Nov. 2017
7.0	R0000431790	James Lord, Secondary Asset Engineering	Leader HSE & Technical Competence Group	14/11/2017
8.0	R0000431790	D. Riley, D.Barrett, TAG Ground Services	Leader Technical Capability, PC&C	06/11/2019

History

Version	Document no.	Date	Comments
2	NS#40050994	01-03-2010	Approved version for field use
2A	NS#40050994	28-01-2014	Added in, doc. Control page in and, changed wording and, links to add in link to new generic testing check list for both line worker and electrician. All new changes shown in grey colour.
2.0	R0000084694	17/11/2014	Updated with tasnetworks logos etc. Technical content unchanged.
2.0	R0000084694	14/04/2015	Added comment on front page to show link back to old title te-wp-001 testing. Removed ref. To test form for linewokrer as now replaced with single test form for both electricians & lineworkers
3.0	R0000431790	26/04/2016	Sections 4.2.1, 4.2.2 and 5.1 strengthened to confirm when testing is required.
4.0	R0000431790	06/09/2016	Section 4.8 steel service poles removed. Section 9.2 refer to all Construction manuals instead of just OH Manual.
5.0	R0000431790	30/01/2017	Section 12.4 added in to provide safe process for testing LV ABC boxes.
6.0	R0000431790	02/02/2017	Option 12.4.8.3 removed from Section 12.4 as testing live at cable terminations not permitted under any circumstance.
6.1	R0000431790	14/09/2017	Review and revise changes to work practices arising from Power of Choice.
8.0	R0000431790	06/11/2019	Added in section 3.6 to cover alternative supplies.

Contents

1 Preface

1.1 Purpose

These instructions are intended to minimise critical electrical risks to TasNetworks employees, consumers and equipment, and ensure compliance with AS/NZS 3000 and AS/NZS 4741.

1.2 Audience

This work procedure applies to all persons working for or on behalf of TasNetworks Pty Ltd who are authorised and accredited to perform this type of work.

1.3 Scope

This work procedure sets out the requirements for low voltage (LV) testing of TasNetworks overhead and underground electricity supply assets and the consumer meter isolation point and switchboard.

1.4 Definitions

Term	Description
TET	TasNetworks Energy Training School
Accredited Contractor	An electrical contractor who has accreditation and authorisation from TasNetworks to work on TasNetworks electrical infrastructure.
Barrier	A part providing basic protection from any usual and basic direction of access.
Cable Jointer	A cable jointer authorised to work on TasNetworks electrical infrastructure.
Conductor	The medium by which electricity is transferred between two points.
Consumer mains	The customer's mains wiring between TasNetworks Point of Supply and the customer's main switch.
De-energised	Separated from all sources of supply but not necessarily isolated, earthed or out of commission.
Disconnected	Physically separated from any source of electrical energy, insulated where necessary and secured in a position clear of any electrical equipment that is capable of being energised.

Earthed	Connected to the general mass of earth. If protective devices are fitted, in a manner that ensures the electrical isolation of any defective equipment through the operation of the protective devices; or In a manner that ensures the removal of any charge.
Earth reference	Proven to be separate from the neutral conductor for testing purposes.
Electrical Installation Notice (EIN)	The electrical certificate of compliance that must be submitted to certify that work undertaken on private infrastructure has been performed in accordance with relevant legislation and standards.
Electrical Practitioner – Cable Jointer	See *Cable Jointer*.
Electrical Practitioner – Electrician	See *Electrical Technician*.
Electrical Practitioner – Line Worker	See *Line Worker*.
Electrical Technician	An electrical technician authorised to work on TasNetworks electrical infrastructure.
Energised	Connected to a source of electrical supply or subject to hazardous induced or capacitive voltages.
Equipment (electrical)	Wiring systems, switchgear, control gear, accessories, appliances, luminaries and fittings used for such purposes as generation, conversion, storage, transmission, distribution or utilisation of electrical energy.
Electrical Standards and Safety (ESS)	Tasmanian regulatory authority for all electrical wiring rules and regulations relevant but not restricted to AS/NZS3000.
Electrical Work Certification (EWC)	Test form that is to be submitted by Electrical Practitioners to confirm electrical work has been “certified” as electrically correct and performed in accordance with relevant standards.
Exposed conductors	Any exposed energised, or the potential to be energised, low voltage conductors that can be touched with standard finger and the approach to which is not prevented by a barrier of rigid material in good order or by insulation that is adequate for the voltage concerned and that is in sound condition.
Insulated	Separated from adjacent conducting material by a non-conducting substance or airspace permanently providing resistance to the passage of current, or to disruptive discharges through or over the surface of the substance or

	space, to obviate danger of shock or injurious leakage of current.
Isolated	Separated from all possible sources of electrical energy by the opening of switches, withdrawal of circuit breakers, removal of fuses, links, connections and the like and rendered incapable of being energised unintentionally.
Isolator	A device which for reasons of safety, provides in the open position, breaks appropriate to the voltage and the insulating medium.
Job Risk Analysis (JRA)	Safety risk questionnaire and assessment
Line Worker	A line worker authorised to work on TasNetworks overhead electrical infrastructure.
Low Voltage (LV)	A voltage greater than 50 volts AC, not exceeding 1000 volts AC.
Multiple Earthed Neutral (MEN)	
Point Of Attachment (POA)	The junction and mechanical attachment, of the overhead service (private or TasNetworks) and the consumer mains on a building or structure. The point of attachment may also be the point of supply in most situations.
Point Of Supply (POS)	The junction of the service provider's conductors with the consumer mains, and is usually the location of the service fuse(s).
Personal Protective Equipment (PPE)	Equipment as set out in TasNetworks PPE Procedure and SAA HB9 & AS/NZS4836 Australian New Zealand Standard Safe Working on Low Voltage Electrical Installations.
Practitioner	A person who is the holder of a license authorising him or her to carry out any electrical work.
Submains	A circuit originating at a switchboard to supply another switchboard.
Testing	Implementation of measures in an electrical installation by means of which its effectiveness is proved.
Voltage	Differences of potential existing between conductors and between conductors and earth as follows: 1) Extra-low voltage not exceeding 50 V AC 2) Low voltage exceeding 50V AC, but not exceeding 1000 V AC 3) High voltage exceeding 1000V AC

Working Near	Where there is a possibility of either of the following coming in contact with exposed energised conductors :- A person's body, extremities when extended, i.e. within reach. Any object, which a person may be carrying or touching during the course of the work, that is not, designed for use on energised conductors operating at that voltage.

1.5 Interpretation

The following words have specific meanings :-

Term	Meaning
Approved	Having the endorsement of a relevant organisation for a specified function.
Competent	Having acquired through training, qualification and experience, the knowledge and skills to correctly perform the task required.
Might or May	The behaviour is optional.
Must	There is an absolute requirement to observe the behaviour.
Must Not	There is an absolute prohibition on the behaviour.
Required	To place under an obligation or necessity.
Should	The behaviour is recommended or encouraged but there might be valid circumstances for adopting a different behaviour.
Should Not	The behaviour is not recommended or is discouraged but there might be valid circumstances for adopting the behaviour.

1.6 Compliance

The Tasmanian Electricity Standards and Safety Group administers the *Electricity Industry Safety and Administration Act* 1997, *Electricity Industry Safety and Administration Regulations 1999*, *Occupational Licensing Act* 2005, and the *Electricity Supply Industry Act* 1995, and compliance with AS/NZS 3000 Wiring Rules and associated standards.

1.7 Related Documents

TasNetworks rules, standards and manuals

Metering Asset Management Framework

Service and Installation Rules

Metering Field Manual

TasNetworks guidelines and work practices

SWMS Metering & Servicing Site Safety & Inspection Requirements

Power System Safety Rules

AS/NZS 3000 Minimum Inspection Guideline

Metering Accuracy Testing

Working on Low Voltage Equipment

Low Voltage Testing Procedure

Testing Multiple Tenancies and Difficult Installations

Working with Live Metering Connections

Isolation of LV Supply

HV Contact with LV Conductors and Lightning Strike

Dealing with Low and Substandard LV Services and Fittings

LV Overhead Service Replacement Requirements

Certification of Electrical Work Procedure

Forms and notices

Notice of Disconnection of Electrical Supply

Electrical Work Certification (EWC) Form

New Electrical Work Certification Sheet – Electrician/Line Worker

Testing Check List For Multiple Installations

Electrical standards

AS/NZS 3000 Wiring rules

AS/NZS 3017 Electrical installations :-Verification guidelines

AS/NZS 3019 Electrical Installations - Periodic Testing

AS/NZS 4741 Testing of connections to low voltage electricity networks

Line Worker Polarity Test at POS

Line Worker Network Analyser Test at POS

Polarity Testing at Customer Switchboard

Network Analyser Test at Switchboard

2 Prerequisites

2.1 Safety And Inspection Requirements

You must comply with the requirements set out in the relevant work procedure :-

- **New Connection**
- **Meter Relocation**
- **Meter Bypass and Fault Response**

You must ensure any site safety or electrical compliance issues found are properly rectified before you can proceed with the work.

Where any of the following issues apply, you must not proceed with the work; if in doubt, contact your Team Leader :-

- You are unable to comply with the safe working requirements in the SWMS Metering & Servicing Site Safety & Inspection Requirements (e.g. a risk assessment requires a Safety Assistant on site but you are there on your own).
- An electrical non-compliance (e.g. unsafe customer wiring found) or site inspection non-compliance (e.g. aggressive customer) makes it unsafe for you to continue or may cause you to contravene your responsibilities as an Electrical Practitioner under current electrical legislation and occupational licensing requirements.

2.2 Requirement To Test

It is a requirement of AS/NZS 3000 Wiring Rules, associated standards and government legislation that electrical tests are conducted to confirm low voltage installations are safe and electrically compliant.

Due to the inherent safety risks, all personnel qualified to carry out electrical testing must show a duty of care to conduct all electrical tests as detailed in this document to ensure installations are electrically compliant.

IMPORTANT :-Failure to comply with testing requirements or maintain competency level or, falsification of test results, could result in :-

- The employee affected having to undergo remedial training to restore competency level or;
- Disciplinary action being taken, depending on the severity of the non-compliance incident or;
- Loss of licence and/or prosecution from Electrical Standards and Safety.

2.3 Accreditation

2.3.1 Electrical Technicians

To carry out low voltage electrical tests, Electrical Technicians working for or on behalf of TasNetworks must :-

- Hold and carry a current Practitioners Licence - Electrician.
- Have passed an annual testing competency assessment/refresher training at TasNetworks Training Centre.
- Hold verification of training records.

2.3.2 Line Workers

To carry out low voltage electrical tests, Line Workers working for or on behalf of TasNetworks must :-

- Hold and carry a current Practitioners Licence - Line Worker.
- Have passed an annual testing competency assessment/refresher training at TasNetworks Training Centre.
- Hold verification of training records.
- Except as provided below, not perform any testing on the consumer side of the POS including TasNetworks metering assets. The only exceptions to this rule are if the Line Worker:
    - Also holds an Electrical Practitioner – Electrician Licence.
    - Has been trained and accredited under an Electrical Safety Management Scheme (ESMS) approved by the Tasmanian State Government Department, Building Standard & Occupational Licensing (BSOL).

2.3.3 Cable Jointers

To carry out low voltage electrical tests, Cable Jointers working for or on behalf of TasNetworks must :-

- Hold and carry a current Practitioners Licence – Cable Jointer.
- Have passed an annual testing competency assessment/refresher training at TasNetworks Training Centre.
- Hold verification of training records.
- Not perform any testing on the consumer side of the POS including TasNetworks metering assets. The only exceptions to this are the same as described under 2.3.2 above for Line Workers.

2.3.4 Apprentices

- Must work in accordance with the TasNetworks Apprentice Supervision Standard.

2.4 Test Instruments

All test equipment must be maintained in good operating condition and stored so as to minimise movement, which may affect sensitivity and calibration.

Note. If a test instrument fails, remove it from service, affix a Danger Tag, and return it to your Team Leader/Supervisor.

Only equipment approved by TasNetworks HSE & Technical Competence Group can be used to carry out electrical testing on electricity supply infrastructure. The test equipment must be category rated to suit the testing environment.

Contractors accredited by TasNetworks must use test equipment specified by TasNetworks that is category rated to suit the testing environment.

2.5 Personal Protective Equipment

The following personal protective equipment (PPE) must be TasNetworks approved, inspected, within test date and used correctly when carrying out electrical tests in accordance with the TasNetworks **PPE Procedure** :-

- LV insulated gloves.
- LV insulated mats.
- Safety eye wear.
- Safety belts and harnesses.
- Footwear – steel cap safety footwear.
- Safety helmet.
- Clothing.
- Other PPE as required for the specific job.

3 LV Testing Requirements

3.1 General

As a number of different personnel may be involved in the connection process, each person performing low voltage electrical tests is required to ensure their section of the work performed is electrically compliant.

If an individual leaves a work site, and the equipment being worked on has not been isolated then all tests to prove it has been de-energised must be conducted again before commencing work.

3.2 When To Test

The following sections identify where LV testing is required.

Examples of when to test

- Service upgrade.
- Transformer replacement.
- Prior to connection of new underground cables.
- Pole bond.

Conditions where checks and tests must be done

- Connecting any low voltage electrical conductors or equipment after fault or repair.
- When fault finding due to e.g. Cable PI fault attendance.
- Disconnecting and reconnecting any conductors (includes earth conductors).
- Connecting any new conductors (including earth conductors).
- Installing or changing conductors that could result in a structure being energised (e.g. steel cross over or service pole with neutral bond).
- When any structures are encountered that support connections (e.g. steel cross over or service pole with neutral bond) a “Test For Energised Exposed Parts” (as per Section 4.1 below) must be conducted to ensure the structures are at zero-volt potential prior to leaving the site.

Testing after private electrical work

Where private work has been performed at the POS or after repairs have been made to private assets, an Electrical Technician must be on site to test at the consumer main switchboard.

3.3 Where To Test

This includes, but is not limited to, any work in the following areas :-

- The distribution system.
- Consumer mains.

- Unmetered sub mains.
- Meter exchanges.
- Metered tariff load cables.

3.4 Customer Notification

- Personal identification (i.e. an Electricity Officer ID Card) must be carried at all times as required by Part 5 of the *Electricity Supply Industry Act* 1995.
- Testing performed on TasNetworks and private assets may require access to private property. When accessing private property the customer must be notified and provided with identification on request.
- If the customer is not present, leave an approved calling card at site stating the reason for the visit.

3.5 Visual Inspection

IMPORTANT Carry out a visual inspection before commencing any electrical testing and before the installation is energised.

Electrical Technicians, Line workers and Cable Jointers check for :-

- Exposed energised parts.
- General condition of the network :-
  - Cables and supports.
  - Required clearances.
  - Pole condition.
  - Connections and fittings at the pole and POS.
  - Turrets and street furniture.
- Condition of the earth electrode and that the earth conductor is connected.

Electrical Technicians check :-

- Conductors for :-
  - General condition.
  - Overloading.
  - Installation method.
  - Mechanical protection.
- Switchboard for :-
  - General condition.
  - Labelling of circuits.
  - Compliance with AS/NZS 3000.

- Wiring Systems for :-
  - Compliance with AS/NZS 3000.
  - Correct circuit connections.
  - Conductor size and current carrying capacity.
  - Conductor Identification – numbering or colour coding.
  - Mechanical protection.
  - Installation method.
- Earthing for :-
  - Compliance with AS/NZS 3000.
  - Earth electrode and cable condition.
  - Fixings secure.
  - Connections in switchboard.
  - MEN.
  - Correct sized conductor for installation.

3.6 Embedded Generation - Solar / Batteries

3.6.1 General Guidelines

We need to be aware of solar and battery backed ups when working in a switchboard or testing. The battery backup may switch in when the grid is isolated. These systems could supply electricity to the whole installation or more commonly only several backed up circuits.

There are a lot of different systems so, to cover all scenarios, the following needs to be taken into consideration:

- Isolate all supplies at the switchboard and battery/inverter if accessible.
- Check and follow the shut down procedure that should be located at the switchboard or inverter.
- Note the original position of all switches and then turn them all off, following the shut down procedure (generally reduce all load , turn off AC, Turn off DC).
- If the inverter is not accessable to isolate, there may be load and voltage present on the neutral and possibly still an energised conductor to the bottom of the backed up circuits main switch.
- **Note**: When working with exposed conductors and connections, use live LV work method and treat all conductors as energised at all times as some systems can take several minutes to change over.
- When the Main Neutral is removed from the neutral bar, be aware there may be voltage present on the neutral bar, even with no load.

- Leave the Earth and MEN connected as this may be required to keep the installation safe were earthing is required.
- You can do your polarity and network analyser tests as normal but connect the earth lead to the earth bar, or use an independent earth.
- When finished, return all switches to the original position as found and follow the shut down procedure (in general DC on, AC on , then load back on).

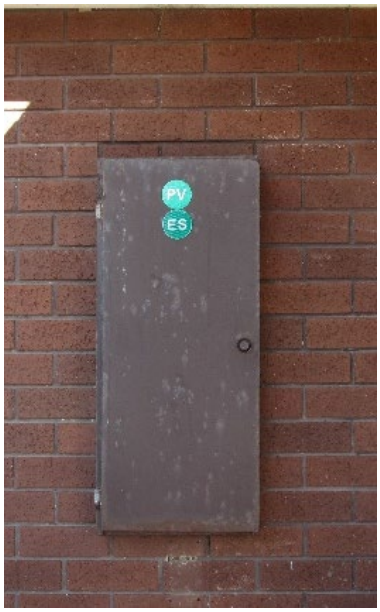
Some of the things to look for that will indicate there is an alternate supply are:

- The presence of solar panels, inverters, batteries.
- Signage indicating solar or bateries.

Below are some examples of what might indicate the presence of an alternate supply:

3.6.2 Examples Of Likely Presence Of Alternate Supply:

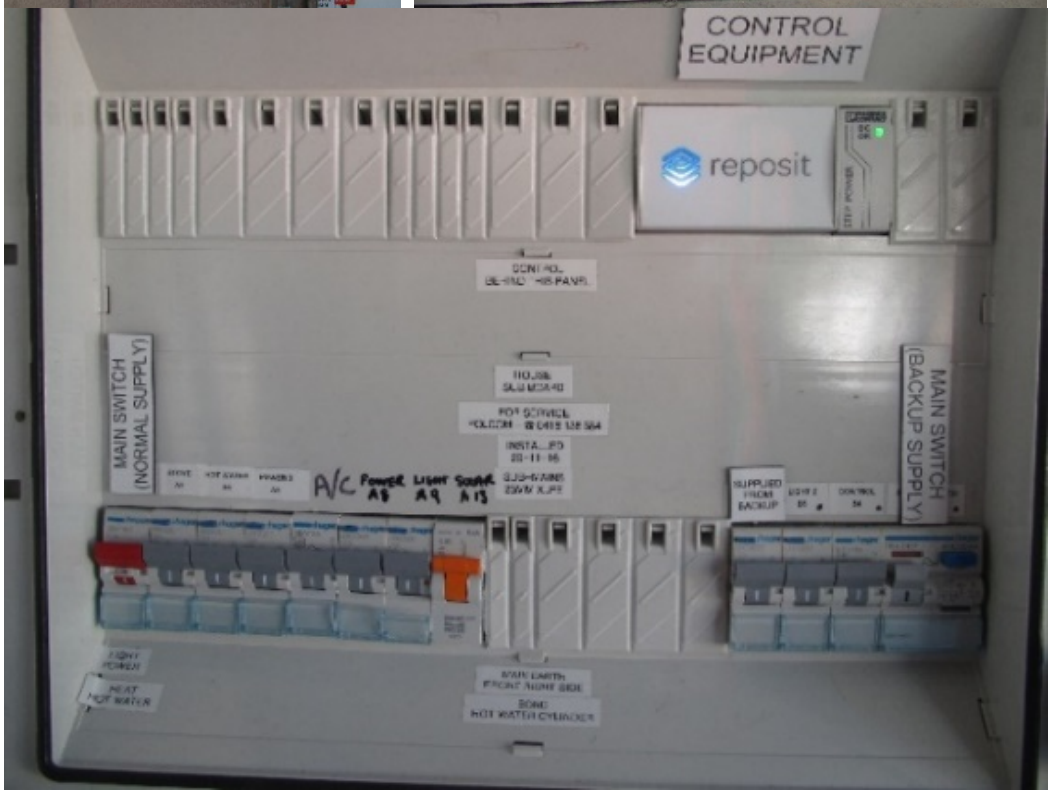
1) External sinage



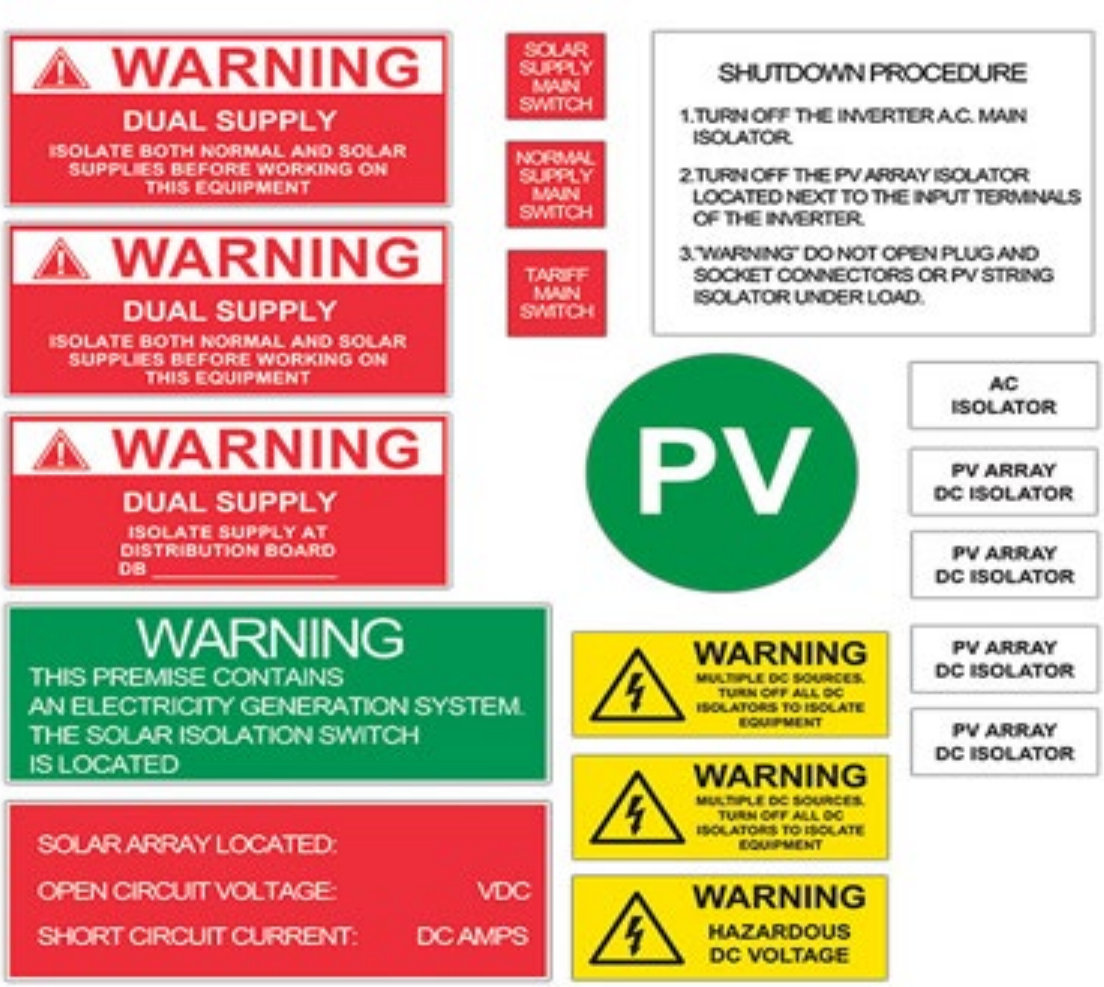
2) Solar panels

3.6.3 Internal Signage Examples

Open circuit voltage / Short circuit current / PV Aray location / Battery location / Backed up circuits / Shut down procedure.



Labels warning that the neutral may be alive, a shut down procedure and other warning labling that may be pressent.

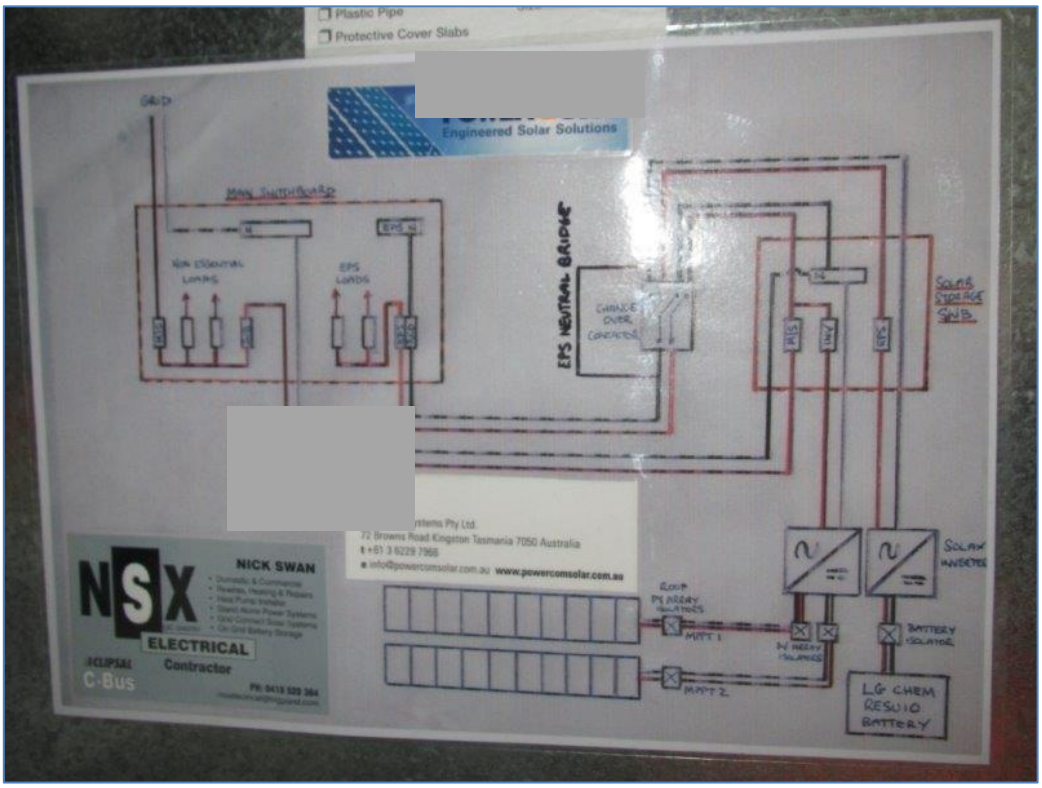


3.6.4 Examples Of Wall Mounted Solar And Batteries

3.6.5 Examples Of A Cabinet Type Solar And Battery

3.6.6 Examples Of Alternate Supply Wiring Diagrams

1) Solar With Battery Back Up



2) AS/NZS 3000 Wiring Rules – Wiring Arrangements and Rules

- Section 7.3.8.1 (page 389) Alternative Supplies – Rules.
- Section 7.3.8.2 Grid-connected Inverter Systems.
- Three Phase Alternative Supply With Change Over Switch & Direct Connection.
- Three Phase Alternative Supply With Change Over Switch & Plug & Socket Connection.
- Stand Alone (Island) Thee Phase System With Local MEN Connection.
- Single Phase Alternative Supply By Means Of Plug & Socket Connection.

3.7 Test The Test Equipment

Check that all test equipment is functioning correctly after a zero reading:

- Voltage tester is checked for correct operation against, a known voltage (e.g. at service fuse, consumer fuses, main switch etc.) or, insulation resistance tester if no other voltage source available.
- Continuity tester for audible, and or, visual indication.
- Independent earth and test equipment circuit operates as one continuous unit.
- Correct operation of insulation resistance tester.
- Correct operation of phase sequence tester to confirm both standard and non-standard readings.

IMPORTANT When any piece of testing equipment fails one of the above tests you must stop work and not proceeed until it is fixed or replaced.

3.8 Earth Reference

When testing street light standards, service cabinets, wall boxes etc. ensure the earth reference is physically disconnected from the main neutral.

4 General Testing Procedures

4.1 Test For Energised Exposed Parts

4.1.1 Purpose Of Test

Installation, switchboards and enclosures can be hazardous environments. Any work site that has a conductive structure supporting electrical connections (e.g. metal crossover or service pole) must be tested for exposed energised exposed before any work commences.

This includes testing any structures that support connections, such as poles being worked on that form part of the direct supply to that installation.

IMPORTANT Steel cross over or services poles that have a neutral bond connection to them must be tested to ensure there is zero-volt potential on the metallic structure of the pole prior to leaving the site.

4.1.2 Test Procedure

Warning. Testers that detect an electric field surrounding an energised conductor may not be suitable for cables surrounded by a metallic screen, cables carrying direct current and in some other cases like AC inverters.

Step	Instruction
⚠	Treat the installation as “energised” until proven otherwise.If solar or bateries are installed, always treat as energised.
1	Test electrical test equipment on a known voltage source after each recorded “0 Volts” reading.
2	When using an independent earth lead, confirm continuity of test lead and equipment. The independent earth must be installed at least 2 metres away from the consumer main earth electrode.

Step	Instruction

3	Test all metallic parts (steel poles, sheds, metal meter box, metallic facias, raisers, etc.).
	Acceptable methods include:
	• Voltage Tester - required results :-0 Volts.
	  ○ Before testing test the voltage tester on a known voltage source (9 V DC battery, cordless drill battery, Insulation Resistance Tester, 230 V supply from service fuses etc.) and check that it is giving the expected reading.
	  ○ Test using an independent earth to conductive parts.
	• Voltage Indicator - required result :-NO red glow and NO audible tone.
	  ○ Before testing test the voltage indicator on a known voltage source (230 V supply from service fuses etc.). Alternatively move tester back and forth vigorously against clothing to activate the red indication light and audible tone.
	  ○ Move plastic tip along and around conductive parts. If the reading is over 48V the red indication light and audible tone will activate.

4.1.3 If Testing Detects A Problem

Step	Instruction
1	Isolate the supply.
2	Fix the problem. If it was a pre-existing problem notify the TasNetworks Fault Centre for follow up action.
3	If it is not possible to isolate the supply: • Make it safe. Place a barrier around the installation to prevent other people coming into contact with energised parts. • Inform the TasNetworks Fault Centre that follow up action is required and remain on site until help arrives.
4	Fill out a safety incident report.

4.2 Conductor Identification And Test

4.2.1 Purpose Of Test

To identify conductors prior to connection and minimise rework following electrical confirmation tests.

4.2.2 Test Procedure

Conductor identification

Conductor	Identification
XLPE	• XLPE is double insulated single core cable with black outer sleeve and clear inner sleeve. • All installed cables must have permanent colour identification on the end of each core conductor.
Overhead LV ABC mains	The phase(s) in Aerial Bundled Cable (ABC) are identified by a number of longitudinal, continuous raised ribs aligning with the phase identification number indicated on the core as follows: • Phase 1 has 1 rib plus the number one (1) applied. • Phase 2 has 2 ribs plus the number two (2) applied. • Phase 3 has 3 ribs plus the number three (3) applied. • The neutral is identified by a series of longitudinal continuous raised ribs. Note. Some older installations may be coloured striped insulation and not have ribbed identification.
Underground service mains	Underground (UG) cables may be colour coded and / or numbered depending on age, make and type. Refer to UG Work Practices for identification of underground cables.

Consumer mains	• The neutral in a consumer mains cable is coloured black.
	  ○ AS/NZS 3000 requires that the neutral shall be black or light blue.
	  ○ Older installations may have a neutral screened cable; in which case, the “screen” is the neutral.
	• Actives can be any colour except:
	  ○ Green/yellow
	  ○ Green
	  ○ Yellow
	  ○ Light blue
	  ○ Black
	Note. Any exceptions must be in accordance with AS/NZS 3000. Some older installations may have yellow as white phase or active conductors.

Open wire conductor identification test

For any service that is disconnected and reconnected, an identification test is to be performed to clearly indicate correct circuit connections.

Single phase test and required results :-

Step	Instruction	Required result
1	Test between neutral and independent earth	0 volts
2	Test between active and independent earth	230 volts
3	Test between neutral and active conductors	230 volts

Three phase test and required results :-

Step	Instruction	Required result
1	Neutral to each and every active	230 volts
2	Test between actives	Red + White - 400 volts Red + Blue - 400 volts White + Blue - 400 volts

UV protection

- Any sleeving used to protect/identify consumer mains that are exposed to sunlight must be UV rated.
- Check manufacturer's specifications to ensure UV compliant :-"UV stabilised" normally printed on sleeving.

5 Line Worker LV Testing Procedures

5.1 Neutral Continuity Test – Line Worker

5.1.1 Purpose Of Test

This test proves continuity between the Consumer Main Neutral at the POS and the Consumer Main Earth Electrode (which can include the metal water pipe).

Note :-Whereas this can indicate neutral connection through the MEN system, and a continuity of the installation circuit, it may not indicate correct circuit connections.

Allows the Line worker to confirm that the consumer neutral conductor, at the POS, is connected through the MEN connection to the earth electrode without working on the switchboard.

5.1.2 Preparing For Test

Step	Instruction
1	Complete JRA.
2	Positively locate consumer Main Earth Electrode (which can include the metal water pipe).
3	Carry out visual inspection and test for energised parts.
4	Turn off consumer main switches, do not proceed if access not possible.
5	Remove service fuses.
6	Disconnect service neutral and tie back.

5.1.3 Test Procedure

Test between consumer neutral at POS and consumer Main Earth Electrode for an audible tone to confirm continuity.

5.1.4 If Testing Is Correct

If Neutral Continuity is confirmed continue on to Polarity Test.

5.1.5 If Testing Detects A Problem

- If no audible tone detected, check all connections and re-do tests.
- If fault still exists, isolate supply (affix a hazardous caution tag) and contact the Fault Centre for an Electrical Technician.

5.2 Polarity Test – Line Worker

5.2.1 Purpose Of Test

This test is to ensure the correct connection of active, neutral and earthing conductors and that no shock hazard exists.

5.2.2 Preparing For Test

- Ensure any preparation work and preceding tests have been carried out correctly.
- Install independent earth a minimum of two metres from consumer main earth electrode or metal water pipe.
- Connect voltage tester to independent earth and test as one continuous unit against a known source to confirm tester.
- Ensure supply is isolated and the service neutral is tied back.

5.2.3 Test Procedure

A diagram of the test connections can be found in the Polarity Test at Switchboard Diagram. **Note.** Voltages listed are approximates.

Single Phase Test

Step	Instruction	Required result
1	Voltage tester/Independent earth to service neutral	No voltage indication - 0 volts
2	Voltage tester/Independent earth to service active	Voltage indication - 230 volts
3	Service neutral to service active	Voltage indication - 230 volts

Multi-Phase Test

Step	Instruction	Required result
1	Voltage tester/Independent earth to service neutral	No voltage indication - 0 volts
2	Voltage tester/Independent earth to service actives	Voltage indication - 230 volts
3	Service neutral to service actives	Voltage indication 230 volts
4	Test between all actives:	Red + White - 400 volts Red + Blue - 400 volts White + Blue - 400 volts

5.2.4 If Testing Is Correct

- Record all readings on the testing checklist.
- Perform other required tests.

5.2.5 If Testing Detects A Problem

- Check all connections, carry out any necessary repairs and re-do tests.
- If fault still exists, Isolate supply (affix a hazardous caution tag) and contact the Fault Centre for an Electrical Technician.

5.3 Phase Sequence Test – Line Worker

5.3.1 Purpose Of Test

A phase sequence test must be performed on all new three (3) phase installations and, before and after works on existing three (3) phase installations.

Phase sequence testing is necessary to ensure that multi-phase metering and installed equipment, such as motors, operate correctly.

5.3.2 Preparing For Test

Step	Instruction
1	Ensure any preparation work and preceding tests have been carried out correctly before testing.
2	Phase sequence tests to be performed at POS before disconnecting conductors and record results.
3	Ensure consumer main switches are off during testing.

5.3.3 Test Procedures

Test 1 – mains box present

Step	Instruction
1	Remove mains box cover.
2	Connect leads to consumer mains in a clockwise direction from consumer neutral.
3	Carry out a phase sequence test and record existing phase sequence.
4	Carry out any work required.

Step	Instruction
5	Carry out: • Polarity • Network Analyser • Check test
6	Carry out the phase sequence test and record final phase sequence. Confirm the final sequence is the same as the original sequence.

Test 2 – no mains box present (consumer mains colour coded)

Step	Instruction
1	Attach the leads as per the wire colours of consumer mains.
2	Carry out a phase sequence test and record existing phase sequence.
3	Carry out any work required.
5	Carry out: • Polarity • Network Analyser • Check test
6	Carry out the phase sequence test and record final phase sequence. Confirm the final sequence is the same as the original sequence.

Test 3 – no mains box present (consumer mains not colour coded)

Step	Instruction
1	Apply phase sequence tester to consumer active mains and record sequence as found.
2	Apply red insulation tape to wire connected to the red lead of the phase sequence tester followed by white to the white and blue to the blue or use 1, 2 and 3 tape stripes respectively.
3	Carry out any work required.
5	Carry out: • Polarity • Network Analyser • Check test
6	Carry out the phase sequence test and record final phase sequence. Confirm the final sequence is the same as the original sequence.

Note. If final phase sequence does not match the original recorded phase sequence, and the service connections were required to be altered to rectify to the original sequence, complete a full polarity test again.

5.3.4 If Testing Is Correct

Record all readings on the testing checklist.

5.3.5 If Testing Detects A Problem

Where the existing phase sequence was not confirmed prior to disconnection, three-phase equipment must be checked for correct rotation with the consumer, prior to leaving the installation connected.

If you still have any doubt about the phase sequence being correct, isolate supply (affix a hazardous caution tag).

Contact the Fault Centre for an Electrical Technician to confirm phase sequence.

5.4 Testing NGK Stanger LV ABC boxes

5.4.1 Purpose Of Test

Due to the narrow gap between each phase terminal, where tinning can flake off or dust etc. can build up under the lift up covers, there is a high risk of an arc flash occurring (and an incident of this nature has occurred already) when lifting the cover lids to conduct testing.

IMPORTANT Where an ABC box has been de-energised the terminals shall be inspected and cleaned of all foreign material and dirt prior to re-energisation.

5.4.2 Live Testing That Is Not Permitted

IMPORTANT You are NOT permitted under any circumstance to perform live testing at the cable termination points.

The cases listed under 5.4.4 “Safe Testing Options” are the only situations where live testing at NGK Stanger type LV ABC boxes is allowed. If this ruling causes a practical issue out in the field then you must follow this up with your Team Leader for resolution.

Live Testing Not Permitted

5.4.3 Identifying NGK LV ABC boxes

NGK Stanger type LV ABC boxes can be identified as follows:

Maker details partly obscured underneath connection bracket.

5.4.4 Safe Testing Options

The following safe testing options can be implemented :-

5.4.4.1 Induction Phase Sequence Tester

5.4.4.2 LV Piercing Connectors

Using LV piercing connectors with tester probes allows safe use of the standard phase sequence tester away from the LV ABC box live terminals.

Note :-Care must be used not to overtighten the piercing connector as too much pressure may cause the cable end hook to crack. Also, if the test probes are to stay connected for a lengthy time period use a rubber band or electrical tape to ensure the probe stays connected into the piercing connector, especially in windy weather.

Rubber bands or tape can be used to keep the test probe connected.

Piercing connectors can also be used to enable safe temporary connection of a data logger without needing to access the LV ABC box live terminals.

Tape must be applied over the effected area once piercing connectors are removed.

5.4.4.3 Other Tests Away From LV ABC box

When testing for voltage levels or energised state, the following options need to be considered and implemented where practical :-

- Trace the ABC box conductors back to the nearest access point and test there.
- If this is not practical, use LV piercing connectors.

5.4.4.4 Other Tests At LV ABC box

If the above options 5.4.4.1 through 5.4.4.3 for testing for energised state or for voltage values are not practical, testing at the LV ABC box is allowed as a last resort.

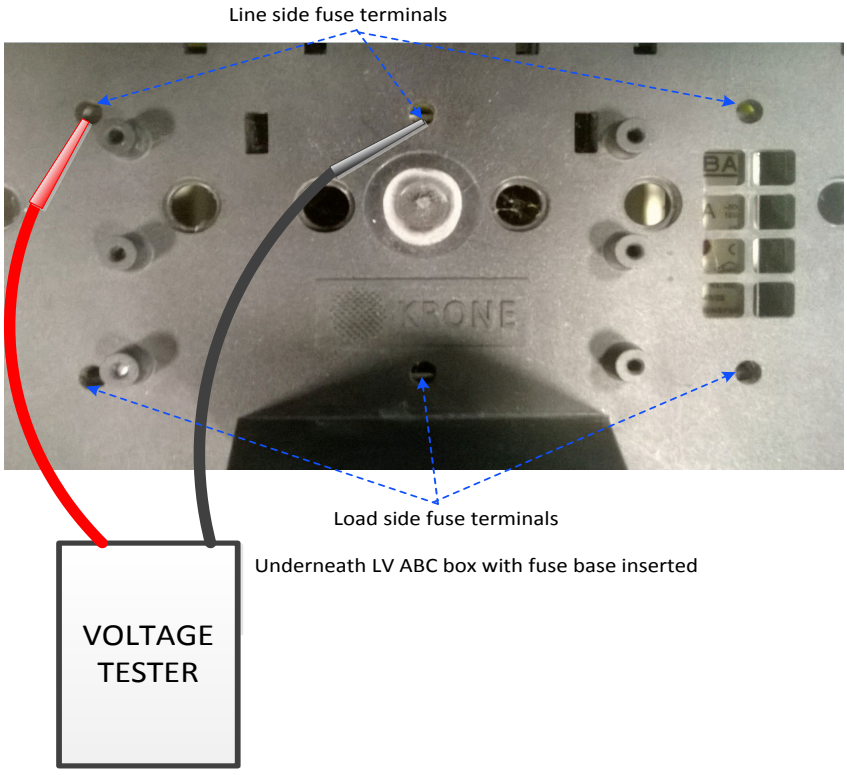
Based on the tests planned assess the need for :-

- A nearby Safety Assistant.
- PPE to protect from electric shock or arc flash.

The following options are available to you :-

Option 1 – test underneath LV ABC box

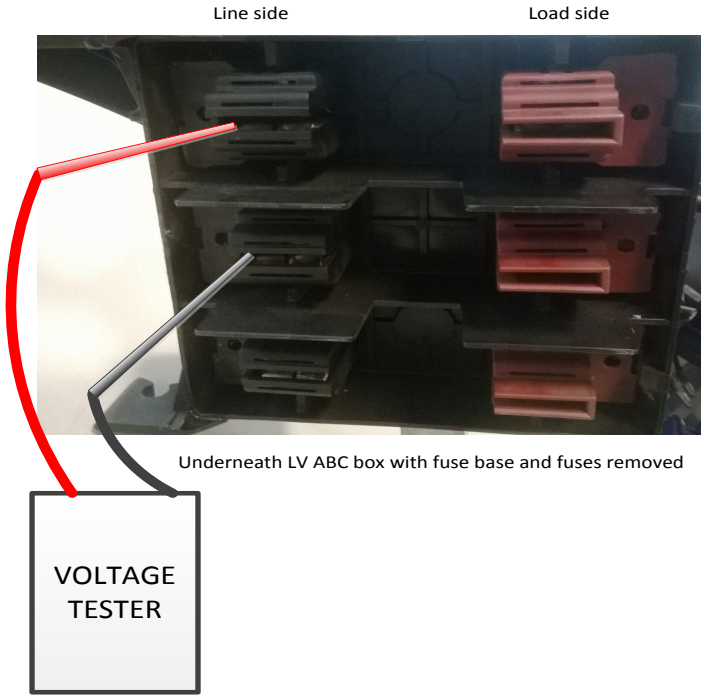
The preferred option is to test underneath the LV ABC box. Insert test probes in the insertion holes as shown below for the line and load sides of the fuses inside.



Underneath LV ABC box with fuse base inserted

Option 2 – Test At The Fuse terminals

If you are removing the fuse base to inspect the fuses you can test directly at the fuse terminals.



Underneath LV ABC box with fuse base and fuses removed

5.5 Network Analyser Test – Line Worker

5.5.1 Purpose Of Test

- The Network Analyser tests voltages, impedances, and prospective short circuit currents between neutral and earth.
- To test the integrity of the earthing system and supply conductors from the circuit transformer to the POS.

5.5.2 Preparing For Test

IMPORTANT A polarity test and associated tests must be conducted before a network analyser test.

5.5.3 Test Procedure

A diagram of the network analyser connections can be found in the **Network Analyser Test at Switchboard Diagram**.

Step	Instruction	Required result
1	Ensure the service neutral is disconnected from the consumer neutral.	
2	Connect the neutral lead to the service neutral.	
3	Connect the earth lead to the consumer main neutral.	
4	Connect the active lead to the active phase.	2 green LED lights
5	Press the TEST button to bring up the V line neutral screen.	Between 225 volts and 253 volts
6	Press the TEST button to bring up the V line earth screen.	Between 225 volts and 253 volts
7	Press the TEST button to bring up the Z line earth screen.	Impedance less than 2000 ohms
8	Press the TEST button to bring up the Z line neutral screen.	Impedance less than 1 ohm
9	Repeat for each phase on multi-phase installations.	

5.5.4 If Testing Is Successful

Leave the installation active if:

- The polarity light is green.
- The the tests all returned results in the required ranges.
- V Line neutral does not vary from V Line earth by more than 5 volts on any given phase.

Record all readings on the testing checklist.

5.5.5 If Testing Detects A Problem

If any of the tests returned results outside the required ranges :-

- Recheck the connections.
- Carry out any necessary repairs.
- Retest.

If V line neutral does vary from the V line earth by more than 5 volts on any phase it may indicate that :-

- A pole bond is connected to an active conductor.

- There is a reverse polarity nearby.
- A faulty/loose neutral connection is causing a floating voltage.

If a fault still exists isolate the supply (affix a hazardous caution tag) and contact the Fault Centre for an Electrical Technician.

5.6 Check Test – Line Worker

5.6.1 Purpose Of Test

- The check test is a final check after performing all other electrical tests.
- To ensure that there is no energised voltage present on the consumer earthing system.

5.6.2 Preparing For Test

- Install an independent earth at least 2 metres away from the consumer main earth electrode or metal water pipe.
- Connect the voltage tester to the independent earth and test as one continuous unit against a known voltage source.
- Confirm continuity of service fuse cartridges.

5.6.3 Test Procedure

Note :-Two persons are required to perform this test.

Step	Instruction
1	While monitoring the voltage tester connected between the customer earth reference and the independent earth for a no-voltage indication, insert a service fuse for under1 second on a phase and then immediately remove it.
2	Repeat for each fuse.
3	Retest the voltage tester and independent earth as one continuous unit on a known voltage source.
4	Recheck continuity of service fuse cartridges.

5.6.4 If Testing Is Successful

- Install the service fuses.

5.6.5 If Testing Detects A Problem

- If a voltage is detected, check all connections and re-test.
- If voltage is still detected isolate the supply (affix a hazardous caution tag) and contact the Fault Centre for an Electrical Technician.

5.7 Testing Sequence For Service Renewals

5.7.1 Test Procedure

Step	Instruction
1	Complete a JRA.
2	Notify the customer.
3	Visually inspect and test for energised parts.
4	Locate the consumer earth electrode or a metal water pipe.
5	Turn off the customer main switches and record positions where accessible.
6	At the POS, take a phase sequence on the consumer mains and record.
7	Remove the service fuses.
8	Positively identify the consumer main neutral.
9	Disconnect and tie back the service neutral.
10	Perform a neutral continuity test.
11	Perform any required pole work. This may include a conductor identification test and phase sequence test.
12	Complete a polarity test at the POS.
13	Complete a network analyser test.
14	Immediately carry out a phase sequence test on the consumer mains and confirm the final sequence is the same as the original sequence.
15	Connect the service neutral to the consumer neutral.
16	Perform a “tug test”.
17	Perform a final check test.
18	Insert the service fuses.
19	Turn on the consumer main switches and notify the customer.
20	Carry out a test for exposed energised parts.
21	Carry out a visual inspection and leave the job site tidy.

6 Electrical Technician LV Testing Procedures

This section contains the requirements detailing all electrical tests that must be performed by accredited Electrical Technicians.

6.1 Earth Continuity & Resistance Test – Electrical Technician

6.1.1 Purpose Of Test

- This test is to confirm the resistance and continuity of the earthing.
- Earth continuity and resistance tests are necessary to confirm that the earthing system has been correctly installed and that resistance is low enough for circuit protection devices to operate effectively in the event of a fault.

6.1.2 Test Procedure

Step	Instruction
1	Disconnect the supply at the main switchboard.
2	Identify the main neutral and active conductors before proceeding.
3	Disconnect the consumer MEN and main earth at the switchboard.

Note :-Some installations have soldered earths and it is impractical to separate sub circuit soldered joints from the main earth. The MEN should always be disconnected.

6.1.2.1 New Installations

Step	Instruction	Required result
4	Using a trailing lead, carry out a continuity test between the earthing conductor at the main switchboard and the earth electrode.	No greater than 0.5 ohms (excluding the resistance of the trailing lead).
5	If the consumer earth electrode cannot be identified, do not proceed. Report the non-compliance to an Electrical Inspector from Tech Safe to deal with the issue.	

6.1.2.2 Existing Installations

If a risk assessment identifies that the earthing system needs to be tested and if the consumer main earth, which may include the water pipe system, has been located then :-

Step	Instruction	Required result
4	Using a trailing lead carry out a continuity test between the earthing conductor at the main switchboard and the earth electrode.	Not greater than 0.5 ohms and ensure you exclude the resistance of the trailing lead.
5	If unable to locate the consumer main earth, confirm earth reference by performing a Network Analyser Test, and report main earth connection not physically identified for an Electrical Inspector from Tech Safe to follow up and deal with the issue.	

6.2 Correct Circuit / Conductor Connections Tests – Electrical Technician

6.2.1 Purpose Of Test

- A test to confirm correct circuit and conductor connections.
- To ensure all conductors are continuous and correctly identified from the installation switchboard to the POS.

6.2.2 Test Procedure

Step	Instruction
1	Disconnect conductors at both ends and ensure there is no possibility of the disconnected ends coming in contact with any foreign object that may record a false reading.
2	Carry out a continuity test on each conductor: • for an existing installation at the switchboard main switches; or • for new installations at the meter isolation point to the POS using the trailing lead on the independent earth, or a proven earth reference to each conductor.

6.3 Insulation Resistance Test – Electrical Technician

6.3.1 Purpose Of Test

- Insulation resistance tests are necessary to ensure that the insulation resistance between energised conductors, other conductors and the earth is sufficient to prevent shock hazards, fire hazards and equipment damage.

Note :-This procedure applies to new installations before they have been connected to the distribution system. Existing installations are only tested if a risk assessment determines there is a risk of damaged conductors due to faults and/or external influences.

- This test is necessary to ensure the insulation integrity of the consumer mains and associated metering conductors complies with the requirements of AS/NZS 3000/3017.

6.3.2 Preparing For The Test

Step	Instruction
1	Isolate the supply and disconnect the consumer mains neutral and active conductors.
2	Test against a proven earth reference.

6.3.3 Test Procedure

Step	Instruction	Required result
1	Using 500 V setting on insulation resistance tester, test insulation resistance between: • Active conductors and earth • Neutral conductors and earth • Active and neutral conductors • Active and other active conductors	At least 20 Meg ohms
2	Record the test results.	

6.3.4 If Testing Detects A Problem

- Isolate the supply (affix a hazardous caution tag) and report the problem to the TasNetworks Fault Center for an Electrical Inspector from Tech Safe to deal with the issue.

6.4 Polarity Test – Electrical Technician

6.4.1 Purpose Of Test

- A polarity test is completed to ensure of active, neutral and earthing conductors are correctly connected.
- To ensure there are no shock hazards.

6.4.2 Preparing For Test

Step	Instruction
1	Complete a JRA.
2	Complete a visual inspection and test for energised parts.
3	Locate the consumer Main Earth Electrode (which can include the metal water pipe) and check that it is in good condition.
4	Ensure any prerequisite tests have been carried out correctly before testing.

Step	Instruction
5	Record position of all consumer main switches and isolate the installation. **Note.** The minimum number of main switches should correspond with the number of tariffs at that installation. If any uncertainty exists or the switchboard is poorly marked, isolate all switches / circuit breakers on the installation being tested. If still unsure, STOP and seek advice before the installation is energised to prevent electrical hazards and damage to consumer equipment. (Be aware of dual tariff and Time of Use meters that will have multiple main switches, and pay particular attention to main switches supplied by inverter energy systems.)
6	Record the phase sequence in multi-phase installations at the consumer main switch.
7	Isolate the supply.
8	Disconnect the following: • Main neutral from the neutral link in the installation switchboard. • MEN. • Main earth where possible at the switchboard. **Note.** For multiple tenancy switchboards and switchboards where the consumer main neutral, main earth or MEN are unable to be removed due to electrical hazards refer to :-TESTING SWITCHBOARDS - Multiple Tenancy and Difficult Installations.
9	Check the switchboard for exposed energised parts.
10	Reconnect the supply.

6.4.3 Test Procedure

A diagram of the test connections can be found in the Polarity Test At Switchboard Diagram.

Note :-Voltages listed are approximates.

Step	Instruction	Required result
1	Consumer main earth to consumer neutral conductor	0 volts
2	Consumers main earth conductor to main active conductor(s): • Line side of meter isolation point for new installations • Line side of consumer main switch for existing installations	230 volts 230 volts

Step	Instruction	Required result
3	Repeat step 2 for each phase in multi-phase installation	
4	Consumer main neutral conductor to mains active conductor(s): • Line side of meter isolation point for new installations • Line side of consumer main switch for existing installations	230 volts
5	Repeat step 4 for each phase in multi-phase installation	
6	Multiphase: • Red phase to white phase - active conductor • Red phase to blue phase - active conductor • Blue phase to white phase - active conductor	 400 volts 400 volts 400 volts

Note :-If the phase sequence needs to be corrected, a polarity test must be performed again in its entirety.

6.4.4 If Testing Is Successful

If all tests are successful complete the following steps :-

Step	Instruction
1	Perform a Network Analyser Test.
2	Check the switchboard for exposed energised parts.
3	Isolate the supply.
4	Reconnect: • Installation switchboard - main neutral conductor to neutral link. • Installation switchboard - consumer main earth and MEN.
5	Reconnect the supply.
6	Reinstate all installation circuit breakers, switches and fuses as found.
7	Ensure three phase equipment is installed in the correct rotation.
8	Ensure all metering equipment is sealed.
9	Complete a final visual inspection.
10	Record test results.

6.4.5 If Testing Detects A Problem

- If any of the readings fall outside these ranges, recheck connections, carry out any necessary repairs then re-do all tests.
- If the fault still exists, isolate the supply (affix a hazardous caution tag) and report the problem to an Electrical Compliance Inspector from Tech Safe.
- If unable to locate the consumer main earth:
  - Confirm earth reference by performing a Network Analyser Test.
  - Report any main earth connection not physically identified for follow up by a Tech Safe Electrical Compliance Inspector.

6.5 Phase Sequence Test – Electrical Technician

6.5.1 Purpose Of Test

Phase sequence testing is necessary to ensure that multi-phase metering and installed equipment, such as motors, operate correctly.

The purpose of performing a phase sequence test is to ensure that:

- New installations are connected in a “Standard” rotation at the meter isolation point.
- Existing installations are as recorded at the consumer main switch prior to disconnection.

6.5.2 When To Test

A phase sequence test must be performed on all new three-phase installations and, before and after works on existing three phase installations where there is any:

- Alteration
- Addition
- Repair

NOTE. All information is to be recorded for each job.

6.5.3 Test Procedure

6.5.3.1 New Installations

- All tests on new installations must be completed at the line side of the meter isolation point.
- Ensure that the phase sequence on a new installation is standard.

6.5.3.2 Existing Installation

IMPORTANT Before starting any work, perform a phase sequence test at the consumer main switch and record the results.

- If authorised and issued with sealing pliers, check for a standard phase sequence connection at the three-phase meter.

- Ensure the phase sequence remains the same as recorded at the consumer main switch.
- All three-phase equipment must be checked for correct rotation with consumer before leaving installation connected.
- If the phase sequence is corrected after testing, a polarity test must be completed.
- If phase sequence was not recorded before starting work (e.g. outage due to service damage from falling tree), then the customer may previously had a non-standard phase rotation and wired equipment accordingly. Three phase equipment must be locked out & tagged until confirmation of correct operation of consumer equipment has been confirmed.

6.6 Network Analyser Test – Electrical Technician

6.6.1 Purpose Of Test

- The Network Analyser tests voltages, impedances, and prospective short circuit currents between line, neutral and earth.
- To prove the integrity of the earthing system and supply conductors from the circuit transformer to the meter isolation point for new installations and at the consumer switchboard for existing installations.

6.6.2 Preparing For Test

- Carry out this test at the switchboard after polarity and all associated tests have been performed.

6.6.3 Test Procedure

A diagram of the network analyser connections can be found in the Network Analyser Test at Switchboard Diagram.

Step	Instruction	Required result
1	Ensure that the consumer main neutral, MEN and where possible main earth are disconnected.	
2	Connect the earth lead to the consumer main earth.	
3	Connect the neutral lead to the consumer main neutral.	
4	Connect the active lead to the incoming active at the line side of the meter isolation point for new installations. For existing installations use the consumer main switch.	2 green LED lights.
5	Press the TEST button to bring up the V-line neutral screen.	Between 225 V and 253 V.

Step	Instruction	Required result
6	Press TEST button to bring up the V-line earth screen.	Between 225 V and 253 V.
7	Press TEST button to bring up the Z line earth screen.	Impedance less than 2000 ohms.
8	Press TEST button to bring up the Z line neutral screen.	Impedance less than 1 ohm.
9	Repeat these steps for each phase on multi-phase installations.	

6.6.4 If Testing Is Successful

- Leave the installation energised if:
  - The polarity light is green.
  - The tests all returned results in the required ranges.
  - V Line neutral does not vary from V Line earth by more than 5 volts on any given phase.
- Record all readings on the testing checklist.

6.6.5 If Testing Detects A Problem

- If any of the readings fall outside these ranges :-
  - Recheck connections.
  - Carry out any necessary repairs.
  - Re-test.
- If V line neutral does vary from the V line earth by more than 5 volts on any phase it may indicate that :-
  - A pole bond is connected to an active conductor.
  - There is a reverse polarity nearby.
  - A faulty/loose neutral connection is causing a floating voltage.
- If a fault still exists isolate the supply (affix a hazardous caution tag) and contact the Fault Centre to follow up.

7 Record Keeping

- It is a legislative requirement that electrical test results are kept and stored away for a minimum of ten (10) years. All electrical test forms must be filled out and returned to the work group Team Leader.
- All test results are required to be recorded in the approved format, either electronic or hard copy, signed and dated by the individual(s) who completed the tests.
- Ensure testing checklists are archived and can be produced upon request.

7.1 Testing Checklists For Tasnetworks Employees

7.1.1 New Testing Checklist For Line Worker And Electrician

- **Electrical Work Certification Sheet – Electrician/Line Worker.**
- The Electrical Work Certification (EWC) test form shall be used by both Line Workers and Electricians and replaces the old testing forms.
- EWC Test form booklet from TasNetworks Store :- Stock Item Number :-362902.

7.1.2 Test Form For Testing Multiple Installations

- Test form booklet from TasNetworks Store :-Stock Item Number :-362899

7.2 Private Electrical Work

7.2.1 EIN – Replaced With EWC

- It is a legislative requirement that an electrical installation notice (EIN) must be submitted for all work on private electrical assets detailing work performed and test results.
- However, under the TasNetworks Energy Electrical Safety Management Scheme (ESMS) approval has been obtained through Work Standards Tasmania, to use an **Electrical Work Certification** (EWC) testing check list to replace EINs.
- The EWCs will be used and recorded within TasNetworks in accordance with **Work Practice/Technical Specification Certification of Electrical Work** under the ESMS.

7.2.2 Electrical Work Certification

- Line Workers and Electricians are now required to complete and submit an Electrical Work Certification (EWC) testing check list sheet (replaces the EIN) for all work performed on privately owned electricity supply assets, in accordance with Work Practice/Technical Specification Certification of Electrical Work.

- An EWC certifies that all electrical work performed by TasNetworks on privately owned electricity supply assets is done to the TasNetworks, Design & Construction Manuals, such as the Overhead and Underground Manuals.

7.3 Reporting Requirements

- Legislation requires EINs (now called the EWC) to be submitted within 3 days.
- Once an EWC has been completed:
  - Present to Team Leader / Job Manager
  - Team Leader / Job Manager to forward via internal mail or to :-

    TasNetworks
    HSEQ & Technical Competence Group
    PO Box 191
    Hobart 7001
- Further information can be obtained by calling 6271 6648.

8 Accountabilities

8.1 Line Managers

- Must ensure all employees under their control, who are required to carry out low voltage electrical tests, are accredited, and comply with the requirements of this procedure and associated field instructions.
- Must ensure systems and processes are in place for recording and filing all electrical test results. These records need to be readily available for auditing.
- Ensure all employees are provided with :-
  - Specified test equipment.
  - All relevant Standards and Work practices.
  - PPE
  - Training/refresher training.

8.2 Employees

- Must comply with this procedure and the associated field instructions when conducting low voltage electrical testing.
- Have a duty of care to ensure all electrical sites are tested to be electrically compliant.
- Must ensure all test equipment and PPE is in current test date and in good condition.
- Must ensure all accreditation is current.