TESTING PROCEDURE FOR EXISTING ELECTRICAL INSTALLATIONS

By Clem Capdevila 'together we can make a difference' – standard for **TESTING PROCEDURE FOR EXISTING ELECTRICAL INSTALLATIONS**

The following steps apply for testing and checking existing installations (already previously energised and deemed to be electrically operational)

The purpose of this standard is to:

1. Protect the electrical worker during testing against an electric shock
2. Protect the property owner from the risk of an electric shock and property fire
3. Protect a landlord's duties under the Queensland Electrical Safety Act 2002
4. Identify a present danger before it causes an electric shock or fire

Important note: Some steps might not apply to all installations directly; only experienced electricians should conduct testing and must be aware of specific installation requirements. For example, a MEN will not be present or required on a sub board, where an earth cable is connected from the main board (containing a MEN). In this case it will pass if not present and will fail if present.

How this standard differs from conventional testing requirements is due to the following:

An insulation resistance test, interconnection, fault loop impedance, correct circuits and the earth testing has already been completed when the installation was installed originally. The testing method shown in this standard is based on a preventative solution in the prevention of a future electric shock or fire. This standard performs testing with a combination of the power supply de-energised during part 1, with the power supply energised during part 2.

The live testing system consists of a multi meter, network analyser and digital safety switch power point tester.

An advantage of these electronic testers is that the earth and neutral does not need to be removed from the main neutral bar, so no possibility of forgetting to re-connect them as can happen with conventional testing. The other major advantage is that both the network analyser and safety switch power point tester have lights that indicate correct circuit. A correct light configuration on these electronic testers verifies the following:

1. Correct polarity
2. No voltage on the earth
3. Earth is connected to the men

For the safety switch power point tester additional features include (if correct circuit is indicated)

1. Earth is connected to the back of the power point
2. Earth connected to the power point is connected to the MEN

For the network analyser additional features include (if correct circuit is indicated)

1. Voltage reading active to neutral
2. Voltage reading active to earth
3. Z line earth fault loop impedance reading in ohms resistive value
4. Z line neutral fault loop impedance reading in ohms resistive value
5. Short circuit current active to neutral
6. Short circuit current active to earth
7. Resistive ohms value for the earth cable on tested circuit
8. Resistive Ohms value for the neutral cable on tested circuit

Testing live - Understanding how it works - how it saves lives and property damage

This section of the standard is to explain the following:

1. Why use a method different to existing proven methods?
2. How a cable deteriorates
3. How this deterioration can be identified with a network analyser
4. How we can use this information to prevent electric shock and fire

A flat electrical cable in our homes/workplace/schools consists in a copper core surrounded by insulation. The insulation keeps the electricity within the copper core, to prevent an electric shock or fire from contact with the copper core.

The insulation has an expiry date that when reached will cause micro cracks within the walls of the insulation and induce the active copper cores current from the active core to the earth and neutral core.

This induced voltage on the earth and neutral cores produce a resistive value that when the cable is energised, can be measured by a digital network analyser.

Conventional testing cannot measure a resistive value that can cause electric shock and fire for 2 reasons in general:

1. It measures values deenergised.

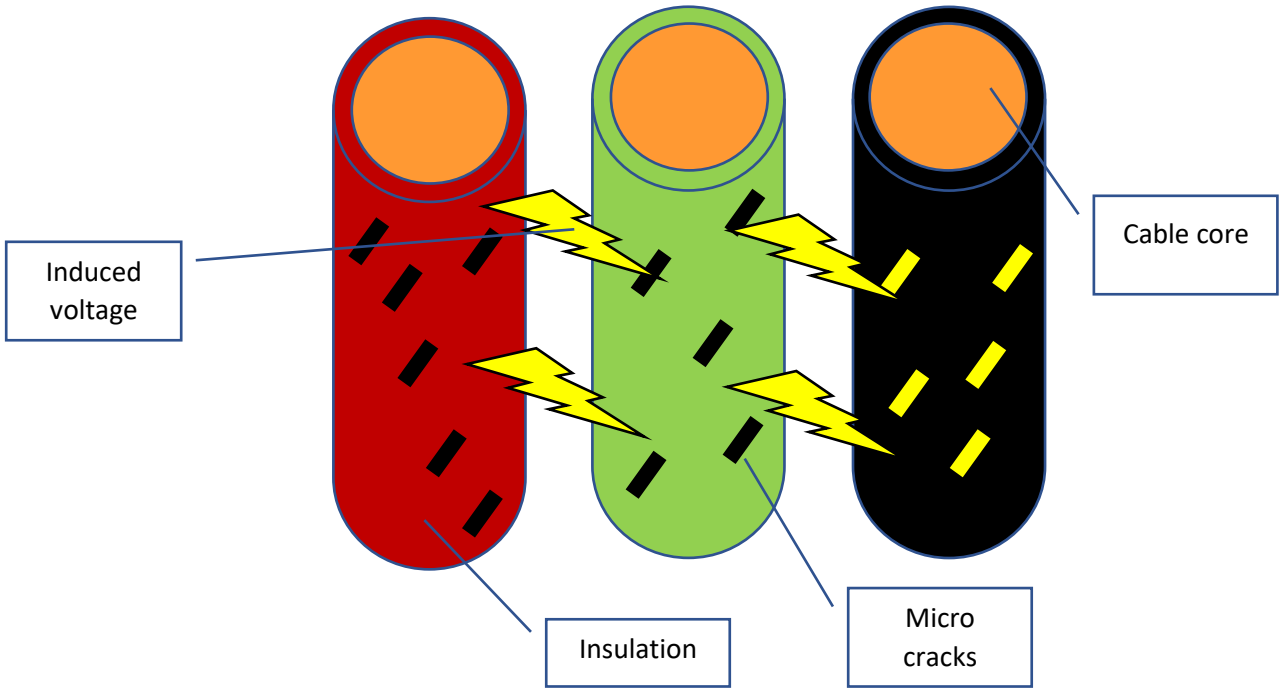
2. The machine used to test insulation resistance does not measure resistive values.

An earth cores infrastructural resistive values when in an energised state and subject to high level of induced voltage from the active core, can reach levels as high as 944,000 ohms (0.9 ohms is classed as a safe level), can prevent a safety switch and circuit breaker from tripping. Therefore, causing an electric shock and fire hazard as seen with the Olsen and Infinity cables in Australia.

Testing live and reading the values measured by the network analyser and comparing them to safe electrical parameters in the ASNZS3000:2018 wiring rules, is provided in a testing sheet (page 8).

By testing every property in Queensland completely and periodically, following the procedures presented in this standard, a preventative solution can be achieved for the prevention of electric shocks and fires.

Illustration of a single insulated cable with micro cracks inducing voltages between cores.



Part 1- Testing and checking - Visuals (de-energised)

Step 1. – Risk assessment

1) **Conduct a risk assessment**
    a) Include a section for feedback from electricians and apprentices on completion of works
        i. Effectiveness of control measures applied
        ii. PPE available and used by staff
        iii. Suggestions for improvements
        iv. Complaints (apprentices too)

2) **Communicate with the owner of the property a testing procedure will occur, and the power will be on and off during the process.**
    Points to consider:
    a) How long the power will be disrupted for
    b) All internet modems to be disconnected at the power point
    c) If any power supply is required during the testing – options include
        i. Mobile hot spotting and laptops for workstations
        ii. Power supply generators
        iii. Extension leads from a neighbour

Step 2. – Prepare switchboard for de-energisation

1) **De-energise installation at main switchboard**
    a) Press all buttons on safety switches
        i. This will identify if any of the existing safety switches are not working
    b) Turn off all main switches
    c) Turn off all circuit breakers
    d) Turn off solar supply – if installed
    e) Turn off battery supply – if installed

3) **De-energise the power supply to the property via**
    a) overhead fuse or pillar fuse removal - must be registered to do so

Step 3. – Power is isolated (not proven dead – insulation gloves to be used)

1) Test metal switch board with independent earth to prove no voltage on switch board metal housing
2) Expose earth and neutral bar on switchboard
    a) Visual check for MEN
    b) Test with independent earth for any voltage on earth bar, neutral bar, and consumer mains active – confirm no voltages are present
        i. If a voltage is found on the neutral, earth or active contact Energex or equivalent network provider
3) Test with independent earth load and feed side of all switches from left to right of switch board
4) Isolation of power supply is confirmed

Step 4. – Power is isolated (proven dead – insulation gloves not required)

Step 5. – Visual check of switchboard installation

1. **Check MEN**
    a) Check cable size
    b) Check cable age
    c) Cable visual condition

2. **Check earth stake cable identified and connected to main earth**
    a) Check cable size
    b) Check cable age
    c) Cable visual condition

3. **Check earth stake**
    a) Check if installed – if yes
    b) Check unable to pull out
    c) Check in correct location
    d) Check exposed portion length
    e) Check earth clip condition
    f) Check label
    g) Check if painted

4. Check metal board is earthed with earth cable from earth bar to fixture on switchboard metal body
    a) Check if installed – if yes
    b) Check cable size
    c) Check cable condition
    d) Check secured correctly

5. Check consumer mains cable (active)
    d) Check cable size
    e) Check cable name
    f) Check cable age
    g) Cable visual condition

6. **Check consumer mains cable (neutral)**
    a) Check cable size
    b) Check cable visual condition
    c) Check for soldered connection point for meter or neutral link

7. **Check circuits cabling**
    a) Check cable size
    b) Check cable name
    c) Check cable age
    d) Check cable visual condition
    e) Check earth cables on all circuits

8. **Check bridging cables**
    a) Check size of cables
    b) Check for heat spots
    c) Check loading compliance
    d) Tighten screws

9. **Check tariff feeds**
    a) Check size of cables
    b) Check for heat spots
    c) Check main switch labels on circuit

10. **Check metering Cables**
    a) Check cable size
    b) Check cable age
    c) Check does the metering cabling comply with metering manual

11. **Check for Sharp edges or single insulated wiring touching sharp edges**
    a) Check consumer mains single insulated cable near sharp meter board edges
    b) Check metering cables damaged by screws

12. **Check main switch**
    a) Check if circuit breaker
    b) Check if circuit breaker, is the correct size for consumer mains amperage capacity
    c) Check correct wiring Check if circuit breaker size correct
    d) Tighten screws

13. **Check circuit breakers**
    a) Check if circuit breaker
    b) Check if circuit breaker, is the correct size for consumer mains amperage capacity
    c) Check correct wiring Check if circuit breaker size correct
    d) Tighten screws

14. **Check safety switches**
    a) Note circuits protected and not protected by a safety switch
    b) Check if any recalled safety switches are installed
    c) Check and note testing sequence requirement on safety switch (some are monthly)
    d) Amperage size suitable for cable and load
        i. Cable might be suitable for a 20-amp circuit breaker but load on air conditioner might only be 9amp.
    e) Not more that 3 circuits on 1 safety switch
        I. Circuits amperages combined do not exceed the rated value of the safety switch
        II. Feeds connected to the safety switch first, then to circuit breakers (4 pole safety switches with multiple circuits may not work if wired to circuit breaker first then safety switch when 1 circuit is turned off)
    f) Check if light and power is on 1 safety switch – when only 1 safety switch installed
    g) Check that light and power are balanced if more than 1 safety switch
    h) Tighten screws

Visual check of the electrical fittings – Excluding power points checked later in Part 2

15. **Check light switches**
    a) Check for correct function of switch mechs – wobbly or cracked
    b) Check plate for cracks
    c) Check light switch is correctly secured
    d) Check for exposed single or double insulated cabling
    e) Check for exposed internal circuitry components

16. **Check light fittings (including any fitting on lighting circuit)**
    a) Check light fitting for cracks
    b) Check lights fittings are correctly secured
    c) Check for exposed single insulated cabling
    d) Check for exposed internal circuitry components

17. **Check for non-mechanically protected cable at arm's reach**
    a) Check for cables non protected traveling from floor to switch
    b) Check for cables non protected traveling from switch to 2.4 meters
    c) Check if any tools/frames/poles or other are touching/leaning against cables over 2.4 meters high
    d) Check for exposed single insulated cabling at any height

18. **Check exterior corrugated conduit**
    a) Check for cracks, tears, or any damage
    b) Check for corrugated conduit not supported against a solid permanent fixture
    c) Check for exposed single insulated cabling
    d) Check for any double insulated cable at heights under 2.4 meters

19. **Check oven**
    a) Check for broken dials or visible damage
    b) Check the oven is correctly secured
    c) Check for free standing ovens (tipping)
    d) Check for exposed single or double insulated cabling
    e) Check for exposed internal circuitry components

20. **Check cooktop**
    a) Check for broken dials or visible damage
    b) Check cooktop is correctly secured
    c) Check ceramic glass cooktops for cracks over electrical circuitry
    d) Check for exposed single or double insulated cabling
    e) Check for exposed internal circuitry components
    f) Check for isolation switch – if required

21. **Check rangehood**
    a) Check for broken dials or visible damage
    b) Check rangehood is correctly secured
    c) Check broken covers over electrical circuitry
    d) Check for exposed single or double insulated cabling
    e) Check for exposed internal circuitry components

22. **Check hot water system**
    a) Check for condition of corrugated or solid conduit
    b) Check the hot water system is correctly secured
    c) Check for exposed single or double insulated cabling
    d) Check for exposed internal circuitry components
    e) Check for isolation switch – if required
    f) Check for visible damage

23. **Check air conditioner**
    a) Check for condition of corrugated or solid conduit
    b) Check the air conditioning system is correctly secured
    c) Check for exposed single or double insulated cabling
    d) Check for exposed internal circuitry components
    e) Check for isolation switch

24. Check spas

a) Check for broken dials or visible damage
b) Check for condition of corrugated or solid conduit
c) Check the spa system is correctly secured
d) Check for exposed single or double insulated cabling
e) Check for exposed internal circuitry components
f) Check for isolation switch – if installed

25. Check pool equipment

a) Check for broken dials or visible damage
b) Check for condition of corrugated or solid conduit
c) Check the pool equipment is correctly secured
d) Check for exposed single or double insulated cabling
e) Check for exposed internal circuitry components

26. Check main connection box

a) Check for broken cover or visible damage
b) Check for correct location and compliance
c) Check the mains connection box is correctly secured
d) Check for exposed single or double insulated cabling
e) Check for exposed internal circuitry components

27. Check solar installation

a) Check inverter for visible damage
b) Check connections are secure
c) Check inverter is correctly secured
d) Check for condition of corrugated or solid conduit
e) Check isolators
f) Check for exposed single or double insulated cabling
g) Check for exposed internal circuitry components

28. Check battery installation

a) Check battery for visible damage
b) Check connections are secure
c) Check for condition of corrugated or solid conduit
d) Check isolators
e) Check for exposed single or double insulated cabling
f) check for exposed internal circuitry components

29. Check incoming service line

a) Check for cracked cabling or visible damage
b) Check for correct location and compliance
c) Check the service line is not obstructed by trees
d) Check for exposed single or double insulated cabling

30. Tighten all screws and perform visual

a) Tighten earth bar screws
b) Tighten neutral bar screws
c) Tighten isolation link screws
d) Tighten neutral link screws
e) Tighten main switches, safety switches, circuit breakers, surge protectors and timer screws

End of Part 1

Part 2- Testing the existing installation (energised)

SAMPLE TESTING SHEET **DATE:** / /2020

Customer name:_____ Phone:_____

ADDRESS: _____

CHECK →	**VISUAL**	**P/F**	**POLARITY**	**P/F**	**MEN**	**P/F**	**M/EARTH**	**P/F**	**C/CIR**	**P/F**	**Board Earth**	**P/F**	**Earth Stake**	**P/F**
TEST ↓	**RATINGS**	**MAINS**	**LIGHT**	**POWER**	**POWER**	**POWER**	**A/C**	**A/C**	**H/W**	**POOL**	**OVEN**	**HOT/P**	**SHED**	**SPA**
RCD elect.	**-30mA/-40ms**	N/A												
V-LINE A/N	**230-258v**													
V-LINE A/E	**230-258v**													
Z-LINE E	**0 – 0.9OHMS (-16 OHMS LOAD)**													
Z-LINE N	**0 – 0.9OHMS**													
PSC/L/N	**300 – +800 AMPS**													
PSC/L/E	**300 – +800 AMPS 0- 20AMPS IF +Z**													
Z/L/N	**0 – 0.9OHMS**													
Z/L/E	**0 – 0.9OHMS**													
Z L/XFORM	**0.2 – 0.80 OHMS**													
Metal E cont/Vol		N/A	P/F				P/F	P/F	P/F	P/F	P/F	P/F	P/F	P/F
RCD ALL P/P	**-30mA/-40ms**	N/A		P/F	P/F	P/F				P/F			P/F	P/F

All appliances, hot water, oven, cooktop, air conditioners, solar, pool, spa, shed, granny flat, lights, fans, sensors, etc. working correctly and no sign of danger. Yes / no. Mixed circuits identified? yes/no if yes, correct circuit breaker protection? Yes/no

Notes:_____

_____

_____

_____

_____

_____

_____

JOB TESTED/ INSPECTED BY: _____**LICENCE:**_____

SIGNATURE: _____ **DATE:** _____ **Reported to manager Yes / No**

Office use only: (circle actions taken) filed reported rectification quote sent result sent to customer

Step 1. Your risk assessment must include insulation gloves to be used when working near live contacts or single insulated live cables during switchboard testing

Step 2. Ensure all the circuits are turned off on the main switchboard (no load will be drawn when the fuse is re-inserted)

Step 3. Re-energise the power supply to the property – via overhead fuse or pillar fuse (must be registered to do so)

Step 4. Test with independent earth (multi meter)

b) Voltage on earth bar
c) Voltage on neutral bar
d) Voltage on switchboard metal housing
e) Voltage consumer mains active

Step 5. Test all circuits left to right of switchboard (network analyser)

a) Training must be obtained on how to use network analyser on switch board
b) Match value on network analyser to testing sheet
    i. Tick appropriate sections on testing sheet- if within values
    ii. Write down value if outside of values shown on test sheet
    iii. Important note: if a load is connected when testing, the Z line earth value can read up to 16 Ohms and the short circuit current on the earth will read 0 - 20 Ohms. This result is still a pass.

An example of a deteriorated cable, that can prevent a safety switch and circuit breaker from tripping, can read a value as high as 944,000 Ohms on the Z-line earth. This is what you will find on deteriorated Olsen cable, Infinity cable, some cables just 30 years old and most cable 50+ years when using this testing system.

How to use network analyser on switchboard (a set of removable alligator clips leads is required)

Test 1. Consumer mains

a) Turn main switch off
b) Connect earth lead with alligator clip onto earth bar or neutral bar
c) Remove alligator clip from neutral lead and push lead end onto neutral bar
d) Remove alligator clip from active lead and push lead end onto feed side of main switch
e) A correct circuit light indicator will appear (if do not proceed appears – check your lead placement. Revisit (b) to (d) and check origin connections on leads into analyser).
f) Press the test button on the network analyser and view the readings
    a. V-LINE A/N, V-LINE A/E, Z-LINE E, Z-LINE N, PSC/L/N, PSC/L/E, Z/L/N, Z/L/E, Z L/XFORM
g) On testing sheet - tick if correct reading range or write in figure, if out of range
h) Turn the main switch on

Test 2. (Type a) Independent single pole safety switches (rcbo)

a) Turn on rcbo to be tested
b) Connect earth lead with alligator clip onto earth bar or neutral bar
c) Remove alligator clip from neutral lead and push onto neutral terminal screw on load side of rcbo
d) Remove alligator clip from active lead and push onto active terminal screw on load side of rcbo
e) A correct circuit light indicator will appear (if do not proceed appears – check your lead placement)
f) Press the test button on the network analyser and view the readings
    a. V-LINE A/N, V-LINE A/E, Z-LINE E, Z-LINE N, PSC/L/N, PSC/L/E, Z/L/N, Z/L/E, Z L/XFORM
g) On testing sheet - tick if correct reading range or write in figure, if out of range
h) Turn off tested safety switch

Test 2. (Type c) 4 pole safety switches with active and neutral of circuit connected to load side of rcd

a) Turn on rcd to be tested
b) Connect earth lead with alligator clip onto earth bar or neutral bar
c) Remove alligator clip from neutral lead and push onto neutral cable terminal screw on load side of 4 pole rcd
d) Remove alligator clip from active lead and push onto active cable terminal screw on load side of 4 pole rcd
e) A correct circuit light indicator will appear (if do not proceed appears – check your lead placement)
f) Press the test button on the network analyser and view the readings
    a. V-LINE A/N, V-LINE A/E, Z-LINE E, Z-LINE N, PSC/L/N, PSC/L/E, Z/L/N, Z/L/E, Z L/XFORM
g) On testing sheet - tick if correct reading range or write in figure, if out of range
h) Turn off rcd

Once network analysing is completed on switchboard, and test results show no danger, turn on all circuits.

Step 6. Test all power points (digital safety switch tester)

a) Plug machine in test ramp function on 0 and 180 – highest value is the number recorded
        i. This test and step 4(a) indicate a clean earth at the power point
b) Check for correct function of switch mechs – wobbly or cracked
c) Check plate for cracks
d) Check power point is correctly secured
e) Check correct orientation of power point

Step 7. Test for earth on taps/metal fittings and for any voltage on taps (multi meter)

a) Test earth connected to taps/metal with multi meter (an extension lead can be used to reach between power point to fitting)
    i. Set multi meter to continuity with audible sound
    ii. Insert 1 end of multi meter into earth lug of power point (earth on power point is already confirmed that it exists and is connected to the MEN)
    iii. Press the other end of the multi meter onto the tap/metal fitting
        1. Listen for an audible sound

b) Test if any voltage is present on taps/metal fittings with multi meter
    i. Set multi meter to AC voltage
    ii. Insert 1 end of multi meter into neutral lug of power point (correct polarity on power point is already confirmed)
    iii. Press the other end of the multi meter onto the tap/metal fitting
        1. Read the voltage

Step 8. Record information from testing onto testing sheet

Step 9. Plug in modems, notify owner testing is completed and power restored

End of Part 2

End of document