AUSTRALIAN CONSTRUCTORS ASSOCIATION

Construction & Building Industry Safety Guideline

Testing Electrical Installations

Disclaimer

This Guideline contains information regarding work health and safety. It includes some of your obligations under the work health and safety and electrical safety legislation that jurisdictional regulators administer. To ensure you comply with your legal obligations you must refer to the appropriate Acts and Regulations that apply in the jurisdiction where you are conducting your work.

This publication may refer to legislation that has been amended or repealed. When reading this Guideline you should always refer to the latest jurisdictional laws. It is the responsibility of the businesses and the individuals involved to ensure that a safe system of work is employed and that statutory requirements are met.

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Construction & Building Industry Safety Guideline
Testing Electrical Installations

Intent

To eliminate electric shock to persons and damage to equipment caused by incorrectly or poorly installed electrical equipment or wiring.

In most cases other than those of deliberate interference or tampering, a fixed electrical installation will not pose danger to workers, plant, equipment or machinery if it is installed according to the standards AS/NZS 3000:2007 (Incorporating Amendments No1 and 2), AS/NZS 3012:2010 and other relevant standards specific to the installation type.

Given the potential variation in the quality of electrical installation work and the work practices themselves, greater emphasis has been placed on the testing and commissioning of fixed construction electrical wiring rather than attempting to control the installation work itself.

Listed below are the minimum checks and tests required to be carried out by the electrical installer and or repairer of an electrical installation prior to the installation being handed over to the client, or for temporary works, being used by workers. Note some tests may require supply to be connected.

Scope

These tests and checks apply to low voltage electrical installations using the multiple earth neutral (MEN) system of earthing and comply with the principles of testing for AS/NZS 3000 – 2007 (Incorporating Amendments No1 and 2)

Safety Imperatives

a. A visual inspection shall be carried out to ensure that all electrical installation work has been correctly completed.

b. Earthing resistance and continuity checks shall be carried out on all completed electrical installation work.

c. Insulation resistance checks shall be carried out on all completed electrical installation work.

d. Polarity tests shall be carried out on all completed electrical installation work.

e. Checks to confirm correct circuit connections shall be carried out on all completed electrical installation work.

f. A fault loop impedance test (FLI) shall be carried out on all completed electrical circuits through measurement.

g. Residual current device (RCD) tests shall be carried out on all completed final electrical sub circuits where RCDs are required.

P = Primary responsibility **S = Support role / Involved**

Electrical Safety Guideline

Imperative Item	Safety Imperative	Element Guidance	Element Timing	Electrical Supervisor	Engineer	Workplace Manager	Installing Electrician	General Manager	Managing director/CEO	Expected Outcome	Regulation / COP Reference
a.	A visual inspection shall be carried out to ensure so far as reasonably practicable that all electrical installation work has been correctly completed.	All cables and equipment have been correctly installed and terminated and the installation complies with AS/NZS 3000 (Incorporating Amendments No 1 and 2), AS/NZS 3012 and other relevant standards specific to the installation type.	Prior to the electricity supply being connected to the installation	S	S	S	P	S	S	Visual inspection identifies any potential unsafe or non-compliant works prior to the installation being energised.	AS/NZS 3000/2007 1.8 & 8.2
b.	Earthing resistance and continuity checks shall be carried out on all completed electrical installation work.	The resistance from any point of the electrical installation required to be earthed, to the point where the main earthing conductor is connected to the neutral conductor (MEN connection) of the supply system, shall be low enough to permit the passage of current necessary to operate the circuit protective devices.	On completion of electrical work.	S	S	S	P	S	S	The integrity of the electrical installation is such that if a fault or damage were to occur, the installation earthing system would mitigate the risk of electrocution and equipment damage.	AS/NZS 3000/2007 8.3.5 & Table 8.2 AS/NZS 3012:2010 3.6.2
c.	Insulation resistance checks shall be carried out on all completed electrical installation work.	The resistance between all live conductors and earth, or as the case may be, live parts and earth, must be adequate to prevent electric shock, fire and equipment damage.	Prior to the electricity supply being connected to the installation	S	S	S	P	S	S	The integrity of the electrical insulation is such that the potential for short circuit faults causing potential electrocution, fire or equipment damage are minimised.	AS/NZS 3000/2007 8.3.6 & Table 8.1 AS/NZS 3012:2010 3.6.3
d.	Polarity tests shall be carried out on all completed electrical installation work.	Polarity tests are carried out to ensure that no shock hazard arises from the incorrect connection of active, neutral and earth conductors and to ensure that switches are not installed in neutral conductors.	Prior to the electricity supply being connected to the installation	S	S	S	P	S	S	To ensure energised plant and equipment is not inadvertently made live and exposing workers to electrocution, or plant, equipment or machinery to damage.	AS/NZS 3000/2007 8.3.7 AS/NZS 3012:2010 2.1.5
e.	Checks to confirm correct circuit connections shall be carried out on all completed electrical installation work.	Circuit connection checks shall confirm that: • protective earthing conductors do not carry current • there are no 'short circuits' within the installation • all switches operate in the active conductors • there are no interconnections between circuits	Prior to the electricity supply being connected to the installation	S	S	S	P	S	S	To ensure energised plant and equipment is not inadvertently made live, and that conductors carrying return and fault currents are clearly identified and used only for their specified purpose.	AS/NZS 3000/2007 8.3.8

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Imperative Item	Safety Imperative	Element Guidance	Element Timing	Electrical Supervisor	Engineer	Workplace Manager	Installing Electrician	General Manager	Managing director/CEO	Expected Outcome	Regulation / COP Reference
f.	A fault loop impedance test (FLI) shall be carried out on all completed electrical circuits through measurement.	A Fault Loop Impedance test should confirm the fault-loop impedance value of each circuit is low enough to ensure the operation of the protective device during a fault. In the interest of safety and the integrity of the installation, RCD protected circuits are not exempt from a Fault Loop Impedance test.	On completion of electrical work.	S	S	S	P	S	S	To ensure that in the case of electrical fault, the impedance of all circuits are low enough that the device providing circuit protection will operate as designed.	AS/NZS 3000/2007 8.3.9 & B4.4
g.	Residual current device (RCD) tests shall be carried out on all completed final sub circuits where RCDs are required.	Testing of an RCD is carried out to ensure that the RCD operates and disconnects the designated circuit. The function of the RCD is verified by the operation of the integral test device and by the use of special test equipment to test the operating time of the RCD. The testing of RCDs should be carried out at the furthest point of a final subcircuit to confirm their correct operation and connection.	On completion of electrical work.	S	S	S	P	S	S	To ensure that in the combined case of installation electrical fault and direct human electrical contact with a live part, current flow through the human body is limited to the prescribed level.	Clause 165 WHS Regulations or jurisdictional equivalent (Qld, Vic & WA) AS/NZS 3000/2007 1.5.6 AS/NZS 3012:2010 3.5

Other Key references applicable to this Safety Guideline are:

Safe Work Australia

Code of practice: Managing electrical risks in the workplace

Australian and New Zealand Standards

AS/NZS 4836 – Safe working on or near low-voltage electrical installations and equipment

AS/NZS 3000 – Wiring rules

AS/NZS 3012 – Electrical installations - construction and demolition sites

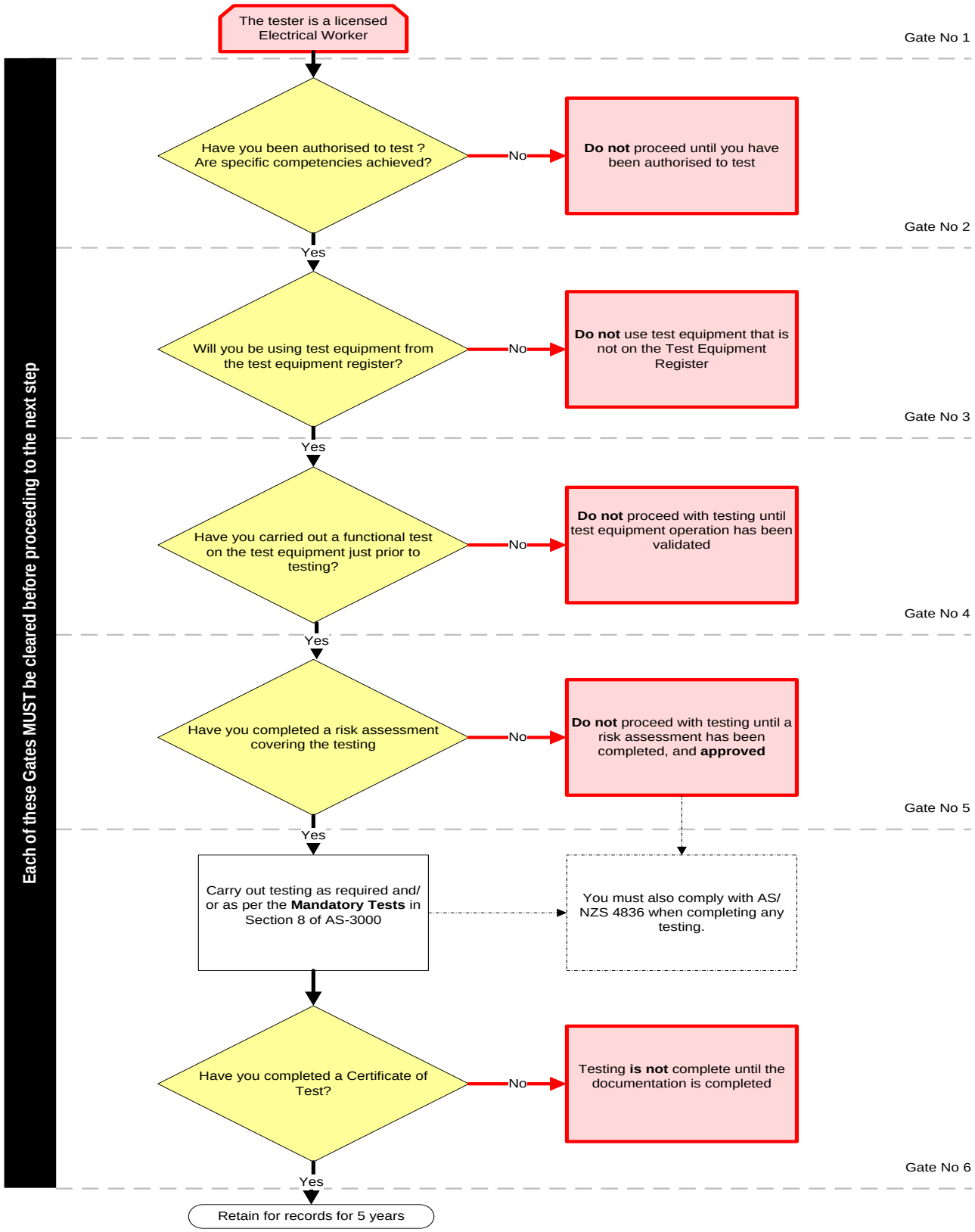
AS/NZS 3017 – Electrical installations — Verification guidelines

Appendices

- Appendix A- Testing flow chart
- Appendix B- Instructions for performing the tests required by AS/NZS 3000 – 2007 (Incorporating Amendment No 1)
- Appendix C- Test sequence flow chart

APPENDIX A

TESTING FLOW CHART



APPENDIX B

INSTRUCTIONS FOR PERFORMING THE TESTS REQUIRED BY AS/NZS 3000 - 2007

The mandatory checks and tests are:

- Visual inspection
- Continuity of earthing system
- Insulation resistance
- Polarity
- Correct circuit connections
- Fault loop impedance measurement
- Operation of Residual Current Devices (RCDs)

TESTING PROCEDURE

This testing procedure can be used for the testing of new installations or a full electrical test on an existing installation.

Ensure testing instruments are suitable for the required tests, are in-test and that tools are in good condition.

If supply is connected isolate supply at the service fuse. Disconnect any earth bond to the neutral when there is an aerial supply.

VISUAL

A visual examination of the electrical work must be conducted to ensure that the electrical work is complete and that all cables are properly terminated.

EARTHING CONTINUITY

A bonding or equipotential conductor is to ensure all metal is at the same potential. An earthing conductor carries any return or fault current.

- Remove the main earthing conductor and the main neutral conductor from the neutral link. Where practicable, disconnect any earth bond conductor (e.g. water heater earth).
- Test continuity of the main earthing conductor between the electrode, adjacent to the main earth connection and the main switchboard. Maximum Resistance 0.5 mΩ.
- Test continuity between the main earthing conductor at the switchboard and any portion of metallic water piping required to be bonded, i.e. any copper water pipe leaving the ground and entering the building. Maximum Resistance 0.5 Ω
- Test continuity between the main earthing conductor at the switchboard, all accessories and permanently connected appliances that are required to be earthed e.g. HWS, socket outlets, lights, motors, range, etc. Maximum resistance shall be low enough to allow the passage of current necessary to operate the circuit protective device. Reconnect any earth bonds that were disconnected.

  ***NOTE**: If insulation resistance tests are carried out before continuity tests a defective continuity* test may require a further insulation resistance test of the circuit affected.

INSULATION RESISTANCE

- Test insulation resistance between the main earthing conductor at the switchboard and each conductor of the consumer's mains. Minimum Insulation Resistance 1 mΩ.
- Test insulation resistance between the main earthing conductor at the switchboard and the neutral link and terminals of the main switch/s.
- Minimum Insulation Resistance for the general installation is 1 mΩ and for appliances incorporating heating elements it is .01 mΩ.
- Where circuits with low insulation resistance incorporate appliances, the appliances are to be disconnected where practical and the test repeated on the circuit to establish whether the equipment or the circuit has the low insulation resistance.
- Test insulation resistance between active and neutral conductors of consumer's mains (between phases if three phase), sub-mains and final sub circuits. Ensure that parallel conductors have no interconnection. Minimum Insulation Resistance 1 mΩ.
- Test insulation resistance between any conductive parts of low pitched rooves or rooves associated with cathedral ceilings and the main neutral link and the terminals of the main switch/s. Minimum Insulation Resistance 1 mΩ.

POLARITY TESTING OF MAINS

- Turn OFF the main switch/s and any circuit breakers or remove all fuse carriers. Confirm that bonding conductor to a service support is not connected and that main neutral is still disconnected from link.
- Reconnect supply.
- Test between the main neutral conductor and the line terminal/s of the main switch/s and on a multiphase installation, between phases. The test lamps should light, proving that the test lamps are in order and that the required supply is available.
- Test between the main neutral conductor and an independent earth electrode. The test lamps should not light.
- Test between an independent earth electrode and the line terminal/s of main switch/s. The test lamps should light.

  ***NOTE**: Failure of the test lamps to light during this test indicates that the resistance between the independent electrode and the general mass of earth is too high. The last two tests must be repeated using an approved instrument (voltmeter) in lieu of test lamps.*
- Test between the main neutral conductor and both line and load side of all circuit protective devices. The test lamps should not light, proving there is no supply at the circuit protective devices with the main switch/s in the "OFF" position.
- Replace the main neutral conductor and main earthing conductor into the neutral link.
- Turn the main switch ON.

  ***NOTE**: A similar polarity test sequence is required for sub-mains.*

  ***NOTE**: Replacement of the main earth and neutral into the neutral link at this time is to minimise the possibility of a potential rise on the earthing system during tests and causing others on* site to receive a shock.
- Test between the main neutral conductor and the line side of all circuit protective devices (CPDs) – proves supply at CPDs.
- Test between the phases of circuit protective devices on a multiphase installation.
- Test between the main neutral conductor and the load side of any circuit breakers (CBs). Test lamps should not light proving the CBs turn off.

- Reinstate any service bonding conductor that was removed.

TESTING AND CHECKING OF CIRCUITS

WATER HEATER

- Energise circuit.
- Check that the control switch, over temperature cutout and thermostat are connected in the active conductor.
- Check that the neutral conductor corresponds with the active conductor and that there is no interconnection with other circuits.
- Check access is available for component replacement and maintenance.
- Check circuit loading and that the current carrying capacity of the cable, control switch and protection device has not been exceeded and the switchboard is correctly marked.

RANGE/COOKING APPLIANCE

- Ensure that any isolating switch and all range element control switches are in the "OFF" position.

  NOTE: *kW rating of range and check the current carrying capacity of all cables and equipment* forming part of the final sub-circuit for the range has not been exceeded.
- Connect supply and prove that any isolating switch is connected in the active conductor and effectively isolates supply. If fuses are incorporated in the range prove they are connected in the active conductor.
- Check that the neutral conductor corresponds with the active and that there is no interconnection with other circuits.

POWER CIRCUITS

- Energise and test one circuit at a time, checking each outlet individually for continuity polarisation and polarity.
- Energise the RCD/s and test for accuracy with an RCD test instrument. The RCD/s should trip between 50% and 100% of rated value.
- Energise all applicable circuits and press any RCD test button to ensure it is operational.
- Check cable rating, RCD current and trip rating, fuse element or circuit breaker size and switchboard marking.

LIGHTING CIRCUITS

- Energise each lighting circuit separately. Check that each light works.
- Test light switches for correct polarity.
- Energise any RCD/s and test for accuracy with an RCD test instrument. The RCD/s should trip between 50% and 100% of rated value.
- Check cable rating, circuit breaker size and switchboard marking.

PERMANENTLY CONNECTED APPLIANCES OR EQUIPMENT

- Energise each circuit separately.
- Check the circuit protection device does not exceed the current carrying capacity of the conductor.
- Energise any RCD/s that may be associated with permanently connected appliances and test for accuracy with an RCD test instrument.

GENERAL

Using total loading obtained from previous tests, calculate the maximum demand and check that the rating of the consumer's mains and main switch are suitable.

Measure voltage at the extremity of any power circuit to ensure it is satisfactory and is greater than 215 volts.

Check marking and rating of main switch/s is correct and refit neutral link cover where required.

Test with the whole of the installation energised, including lighting points switched ON, that any exposed conductive parts are not live.

APPENDIX C

SEQUENCE OF TESTS FLOWCHART