**SECTION 8: VERIFICATION**

**8.1 General**

**8.1.1 Application**

This section specifies the minimum requirements for the inspection and testing necessary to satisfy the fundamental safety principles of Part 1 of this Standard in relation to the verification of an installation.

**8.1.2 General Requirements**

Prior to placing an electrical installation, or any part thereof, in service following construction, alteration, or repair, it shall be verified, as far as practicable, that the installation is safe to energize and will operate in accordance with the requirements of this Standard. To confirm that the requirements of this Standard have been met, after completion and before being placed in service, the installation shall be:

(a) Inspected in accordance with Clauses 8.1.3 and 8.2 as far as is practicable; and (b) Tested in accordance with Clause 8.3.

Precautions shall be taken to ensure the safety of persons and to avoid damage to property and the electrical installation equipment during inspection and testing.

Where the electrical installation is an alteration or repair to an existing electrical installation, it shall be verified that the alteration or repair complies with this Standard and does not impair the safety of the existing electrical installation.

**Notes:**

1. Additional visual inspections and testing may be required for specific installations, such as separated supplies, SELV and PELV installations, electromedical installations, transportable structures and vehicles, and marinas. Guidance on these electrical installations can be obtained from Section 7 and the specific installation Standards referenced in Clause 7.8.
2. In New Zealand, attention is drawn to the requirements of NZECP 55 for wiring and fittings located near conductive thermal insulation.

**8.1.3 Periodic Inspection and Testing**

Periodic inspection and testing of electrical installations shall be performed in accordance with the requirements of: (i) The regulatory authority; and (ii) The owner or occupier of the premises.

**Note:** Recommended periodic testing arrangements are set out in AS/NZS 3019.

**8.2 Visual Inspection**

**8.2.1 General**

A visual inspection shall be made when work on an electrical installation has been completed to verify that the work complies with the requirements of this Standard. The visual inspection shall be carried out before, or in association with, testing. The visual inspection should, where practicable, be made before the relevant part of the electrical installation is placed in service.

**Exception:** Where the visual inspection of a part of the electrical installation is not practicable at the completion of the work, e.g., not accessible because of enclosure in the building structure, consideration should be given to inspecting that part during the course of the installation.

**8.2.2 Checklist**

The following items shall be checked, where applicable during the visual inspection, to assess that the relevant requirements of this Standard are satisfied:

(a) **General:**

* (i) Basic protection (protection against direct contact with live parts), e.g., insulation and enclosure.
* (ii) Fault protection (protection against indirect contact with exposed conductive parts), e.g., by the use of automatic disconnection of supply, double insulation, or isolating transformers.
* (iii) Protection against hazardous parts, e.g., enclosure, guarding, or screening of flammable materials, hot surfaces, and parts that may cause physical injury.
* (iv) Protection against the spread of fire, e.g., penetration of fire barriers.
* (v) General condition of the electrical equipment, e.g., signs of damage that could impair safe operation, disconnection of unused electrical equipment.

(b) **Consumer Mains:**

* (i) Current-carrying capacity.
* (ii) Voltage drop, e.g., size of conductors.
* (iii) Underground installation conditions, e.g., enclosure, depth of burial, mechanical protection.
* (iv) Aerial installation conditions.
* (v) Connection of wiring.
* (vi) Protection against external influences.

(c) **Switchboards:**

* (i) Location, e.g., access and egress.
* (ii) Protective devices, e.g., selection and setting of adjustable protective devices for compliance with overcurrent protection, arc fault protection, and discrimination requirements.
* (iii) Isolating devices, e.g., main switches.
* (iv) Connecting devices, e.g., neutral bars, earth bars, and active links.
* (v) Connection and fixing of wiring and switchgear.
* (vi) Identification and labelling of electrical equipment.
* (vii) Protection against external influences.

(d) **Wiring Systems:**

* (i) Conductor size, e.g., current-carrying capacity and voltage drop.
* (ii) Identification of cable cores.
* (iii) Adequate support and fixing.
* (iv) Connections and enclosures.
* (v) Particular installation conditions, e.g., underground, aerial, safety services.
* (vi) Segregation from other services and electrical installations.
* (vii) Protection against external influences, e.g., enclosure.

(e) **Electrical Equipment:**

* (i) Isolation and switching devices for protection against injury from mechanical movement devices and motors.
* (ii) Isolation and switching devices for protection against thermal effects, e.g., motors, room heaters, water heaters.
* (iii) Switching devices for particular electrical equipment, e.g., socket-outlets, water heaters, etc.
* (iv) Particular installation conditions, e.g., locations affected by water, explosive atmospheres, extra-low voltage, high voltage.
* (v) Compliance with required Standard.
* (vi) Connection, support, and fixing.
* (vii) Protection against external influences including ingress of moisture where required by any clause.
* (viii) Suitability for intended voltage, current, and frequency.

**Notes:**

1. An RCD is deemed suitable for operation under residual alternating current and residual pulsating direct current conditions if it is marked with one of the symbols cited in Clause 2.6.2.2.1 Note 1 Items (b) to (e). If the marking is not clearly legible, the RCD should be replaced prior to testing.
2. Appendix Q contains further guidance for DC circuits.

(f) **Earthing:**

* (i) MEN connection.
* (ii) Earth electrode.
* (iii) Earthing conductors, e.g., size, identification.
* (iv) Equipotential bonding conductors, e.g., size, identification.
* (v) Connections, joints, and terminations.
* (vi) Protection against external influences.
* (vii) Connection to earthing arrangements for other systems.
* (viii) Creation of earthed situations that may require earthing of additional electrical equipment.

**8.3 Testing**

**8.3.1 General**

After completion of, or in association with, the visual inspection, tests shall be carried out in accordance with Clause 8.3.3 on the electrical installation to verify that it complies with the requirements of this Standard and that it is suitable for the use intended. If necessary, additional tests may be carried out.

**8.3.2 Test Methods**

**8.3.2.1 General**

AS/NZS 3017 sets out common test methods that may be used to verify by testing that a low voltage electrical installation complies with this Standard and includes minimum safety standards for test instruments. Testing shall be carried out in such a manner that the safety of the operator and other people in the vicinity, and test equipment is not placed at risk.

**Note:** The test methods set out in this Clause (Clause 8.3) are given as reference methods. Other methods are not precluded, provided that they give equally valid results.

**8.3.2.2 Recording of Results**

It is recommended that the results of the tests, especially tests that require a value for verification, be recorded and maintained.

**Note:** Legislative requirements may be made in each State or Territory of Australia or New Zealand relating to the format and contents of test records.

**8.3.3 Mandatory Tests**

**8.3.3.1 Low Voltage**

Testing shall be carried out on parts of electrical installations designed to operate at low voltage as follows:

(a) Continuity of the earthing system (earth resistance of the main earthing conductor, protective earthing conductors, PEN conductors, and bonding conductors), in accordance with Clause 8.3.5. (b) Insulation resistance, in accordance with Clause 8.3.6. (c) Polarity, in accordance with Clause 8.3.7. (d) Correct circuit connections, in accordance with Clause 8.3.8. (e) Verification of impedance required for automatic disconnection of supply (earth fault-loop impedance), in accordance with Clause 8.3.9. (f) Operation of RCDs, in accordance with Clause 8.3.10.

**Exception:** Verification of earth fault loop impedance may be omitted where automatic disconnection of supply (refer to Clause 1.5.5.2) is not the method used to provide fault protection.

**Notes:**

1. Item (e) above may require that supply is available.
2. Item (f) above requires that supply is available.
3. Additional tests for isolated supplies are detailed in Clause 7.4.8.

**8.3.3.2 Extra-Low Voltage**

Testing shall be carried out on parts of electrical installations designed to operate at extra-low voltage as follows:

(a) Continuity of the earthing system for PELV circuits in accordance with Clause 8.3.5. (b) Insulation resistance in accordance with Clause 7.5.12. (c) Polarity for PELV circuits in accordance with Clause 8.3.7. (d) Correct circuit connections in accordance with Clause 8.3.8.

**8.3.3.3 Test Failures**

If any part of the electrical installation fails a test, that test and any preceding tests that may have been influenced by the fault indicated shall be repeated after the fault has been rectified.

**8.3.4 Sequence of Tests**

A testing sequence is shown in Figure 8.1.

**8.3.5 Continuity of the Earthing System**

**8.3.5.1 General**

Testing to prove the continuity of the earthing system (earth resistance of the main earthing conductor, protective earthing conductors, combined protective earthing and neutral (PEN) conductors, and bonding conductors) shall be carried out to ensure that the earthing system has been installed in a manner that will cause circuit protective devices to operate if there is a fault between live parts, other than the neutral, and the mass of earth. An effective earthing system will ensure that exposed conductive parts of electrical equipment do not reach dangerous voltages when such faults occur.

**Note:** Where a PEN submain is installed in accordance with Clause 5.5.3.1 (c), testing shall confirm that the earth terminal, point, or bar of the sub-board is connected via the PEN conductor to the earth terminal, point, or bar of the main switchboard

**8.3.5 Continuity of the Earthing System**

**8.3.5.2 Results**

The resistance of protective earthing conductors shall be:

(a) Low enough to permit the passage of current necessary to operate the overcurrent protective device; and (b) Consistent with the length, cross-sectional area, and type of conductor material.

The resistance of the main earthing conductor or any equipotential bonding conductor shall be not more than 0.5 Ω.

**Notes:**

1. Under the subsequent tests for earth fault-loop impedance, the maximum allowable resistance of the protective earthing conductor associated with any particular circuit depends on the type and rating of the protective device and the impedance of the live conductors that comprise the circuit.
2. Resistance values (Rₑ) for earthing conductors are given in Table 8.2 as a function of the rating of the associated overcurrent protective device. These values may be used when testing for earth continuity.

**8.3.6 Insulation Resistance**

**8.3.6.1 General**

Insulation resistance testing shall be carried out to ensure that the insulation resistance between all live conductors and earth or, as the case may be, all live parts and earth, is adequate to ensure the integrity of the insulation. This testing is to prevent:

(a) Electric shock hazards from inadvertent contact; (b) Fire hazards from short-circuits; and (c) Equipment damage.

In addition, an insulation resistance test between conductors is necessary for consumer mains and submains to minimize the risk of injury or property damage because of insulation breakdown.

**8.3.6.2 Method**

The integrity of the insulation is stressed by applying a direct current at 500 V for low voltage circuits.

**Exceptions:**

1. Where equipment, such as electromagnetic compatibility (EMC) filters, equipment containing surge protective devices connected to earth, or electronic equipment, is likely to be damaged by the test:
   * Such equipment may be disconnected or switched off before carrying out the insulation resistance test on the circuit; or
   * The test voltage for the particular circuit may be reduced to 250 V d.c.
2. Where connected equipment, such as sheathed heating elements of appliances or an RCD with an FE connection, is likely to influence the verification test, the equipment may be disconnected before carrying out the insulation resistance test on the circuit and the equipment tested separately.

The insulation resistance tester used shall be able to maintain its terminal voltage within +20% and -10% of the nominal open circuit terminal voltage, when measuring a resistance of 1 MΩ on the 500 V range or 10 MΩ on the 1000 V range.

**8.3.6.3 Results**

The insulation resistance between:

(a) The conductors of consumer mains and submains; and (b) Live and earthed parts of an electrical installation, or parts thereof, including consumer mains and submains,

shall be not less than 1 MΩ.

**Exceptions:** Acceptable insulation resistance values for items likely to adversely affect test results are as follows:

1. For sheathed heating elements of appliances: not less than 0.01 MΩ.
2. A value permitted in the Standard applicable to the electrical equipment.
3. For functional earth connections of RCDs: not less than 0.05 MΩ, or as prescribed by the manufacturer.

**Notes:**

1. For shorter cable runs, the insulation resistance should be significantly greater than 1 MΩ, e.g., for polymeric cables up to 50 m, a value in excess of 50 MΩ would be expected.
2. Insulation resistance varies with insulation materials and decreases with increased length and/or higher temperature.
3. PVC insulated cables with a route length of 50 m can be expected to have insulation resistances of at least 20 MΩ at a temperature not exceeding 20°C but only 6 MΩ at a temperature of 30°C.
4. XLPE insulated cables can be expected to have insulation resistance of at least 1500 MΩ for a route length of 50 m.

**8.3.7 Polarity and Correct Circuit Connections**

**8.3.7.1 General**

This testing is to prevent:

(a) The transposition of active and neutral conductors of the consumer mains, or submains supplying an outbuilding having an MEN connection, resulting in the electrical installation earthing system becoming energized; (b) Combinations of incorrect active, neutral, and earthing conductor connections, resulting in the exposed conductive parts of the electrical installation becoming energized; (c) The connection of switches or protective devices in neutral conductors, resulting in parts of appliances, such as heating elements and lampholders, remaining energized when the switches are in the "OFF" position; (d) Multi-phase equipment, such as multi-phase motors, and semiconductor-controlled equipment operating in an unpredictable manner; (e) Protective earthing conductors carrying current under normal conditions of operation;

**Note:** For purposes of this Clause, a PEN conductor is not regarded as a protective earthing conductor (PEC).

(f) Short-circuits existing between conductors.

**Note:** A short-circuit current flowing between live conductors or through part of the earthing system can cause considerable fire damage or personal injury, particularly in high current locations.

**8.3.7.2 Results**

The polarity and correct circuit connection testing shall show that all active, neutral, and protective earthing conductors in the electrical installation are correctly connected to the corresponding terminals of electrical equipment so that:

(a) There is no transposition of conductors that could result in the electrical equipment becoming unsafe when it is connected to supply, particularly where appliances are connected by socket-outlets; and (b) Switches or protective devices do not operate in the earthing or a combined protective earthing and neutral (PEN) conductor; and (c) Switches or protective devices do not operate independently in neutral conductors; and (d) All Edison screw lampholders that are not incorporated in an appliance or provided with a shroud or skirt that prevents contact with the outer contact shall have the neutral connected to the outer contact; and (e) All fixed socket-outlets for multiphase supplies are connected so the phase sequence is the same throughout the installation; and (f) No protective earthing conductor is connected in parallel with any neutral conductor; and (g) There are no short-circuits between the conductors; and (h) There are no interconnections of conductors between different circuits.

**Note:** Any MEN or ESR connection is not considered a short-circuit.

**8.3.9 Verification of Earth Fault-Loop Impedance (EFLI)**

**8.3.9.1 Low Voltage Socket-Outlet Circuits**

Where an installation includes circuits satisfying (a), (b), and (c) below, EFLI testing, in accordance with Clause 8.3.9.2, shall be carried out for those circuits:

(a) Fault protection is by automatic disconnection of supply. (b) Supplying one or more socket-outlets. (c) Where socket-outlets are not protected by a residual current device with a residual current rating of 30 mA or less.

**Notes:**

1. The tests described in Clause 8.3.9.2 are carried out to verify that the protective device will operate to disconnect an earth fault current within the time and touch voltage requirements of Clauses 5.7 and 1.5.5.3.
2. Further information on the earth fault-loop impedance is contained in Appendix B, Paragraph 84, and Clause 5.7.
3. EFLI testing is not required for RCD-protected socket-outlets, as the maximum operating time of RCDs providing additional protection is less than the 0.4 s specified by Clause 5.7.2, Item (a), and Clause 1.5.5.3, Item (d).
4. EFLI testing is not required for socket-outlets on separated supplies because, for these circuits, fault protection is not by automatic disconnection.
5. EFLI testing is not specifically required for circuits supplying equipment other than socket-outlets because of the risk of electric shock when performing the test on live electrical equipment. For a circuit supplying other than socket-outlets, the longer permitted operating time combined with verification of earth continuity in accordance with Clause 8.3.5.2, is considered to adequately verify compliance with Clause 5.7.
6. While EFLI testing is not required for other circuits, the maximum trip time requirement still has to be complied with. In most cases, if voltage drop requirements are complied with, the EFLI will be acceptable.

**8.3.9 Verification of Earth Fault-Loop Impedance (EFLI)**

**8.3.9.2 Methods**

**8.3.9.2.1 General** One of the following methods (Clause 8.3.9.2.2 or 8.3.9.2.3) shall be used, depending on the availability of supply.

**8.3.9.2.2 Supply Available** Where supply is available, the earth fault-loop impedance for each branch of each final subcircuit shall be determined using an earth fault-loop impedance tester at the socket-outlet furthest from the supply on each branch of the final subcircuit. The MEN connection shall be left intact.

**8.3.9.2.3 No Supply Available** Where no supply is available, the total resistance (Rpne) of the active and protective earthing conductors of the circuit shall be measured using an ohmmeter. Each active conductor in turn and the protective earthing conductor shall be connected together at the origin of the circuit (normally where the protective device is fitted). The resistance of each active-PEC pair shall be determined using an ohmmeter at the furthest point of each branch of the circuit.

**Notes:**

1. Where supply is available and the electrical installation is connected to a distribution system, the earth fault-loop impedance test is preferred in order to verify the complete earth fault-loop including the integrity of the MEN connection and the supply neutral (PEN) conductors.
2. Where no supply is available, the resistance method establishes the contribution of the final subcircuit to the total impedance of the full earth fault loop.
3. Reference to voltage drop values are in Table B1.

**8.3.9.3 Results** The values obtained shall satisfy the requirements of Clause 5.7.4. This requirement is deemed to be satisfied if:

(a) The earth fault-loop impedance, measured in accordance with Clause 8.3.9.2.2, does not exceed the value shown in Table 8.1 for the applicable type and rating of the protective device; or (b) The total resistance (Rpne) of the active and protective earthing conductors, measured in accordance with Clause 8.3.9.2.3 does not exceed the value shown in Table 8.2 for the applicable circuit protection rating and required disconnection time.

**Notes:**

1. The values of Zs in Table 8.1 were calculated as shown in Paragraph B4.5.
2. The values in Table 8.2 were calculated using the d.c. resistance values for conductors at 20°C, as specified in AS/NZS 1125, and the maximum circuit lengths given in Table B1.

**8.3.10 Operation of RCDs**

To verify that RCDs have been correctly installed, tests shall be performed on all RCDs. The function of the RCD shall be verified either by the operation of the integral test device, or by the use of special test equipment. In all cases, isolation of all switched poles shall be verified after the RCD has operated to disconnect the designated circuit. Isolation of all poles shall be verified by voltage tests or, after removing supply, by continuity checks through each pole.

**Notes:**

1. Tripping the RCD by means of the integral test device establishes:
   * (a) The RCD is functioning correctly; and
   * (b) The integrity of the electrical and mechanical elements of the tripping device.
2. Operation of the integral test device does not provide a means of checking:
   * (a) The continuity of the main earthing conductor or the associated circuit protective earthing conductors;
   * (b) Any earth electrode or other means of earthing; or
   * (c) Any other part of the associated electrical installation earthing.
3. Guidance on the suitability of types of RCD is contained in Clause 2.6.2.2.
4. There is no requirement to test the operating time of RCDs. Operating time is a function of the type of RCD.
5. A suitable test could be performed using a test plug with a resistor between the active and earth pins.

**8.4 Verification Records**

**The date of initial certification of an installation shall be available on-site, by permanent, indelible marking on or at the main switchboard.**

**Note:** In order to enable reverification, it is necessary to know the details of the original verification. This will facilitate the operation of a reverification regime, when instituted.