

Network Standard

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Service Testing

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Scope

This Network Standard sets out the tests to be performed by authorised persons each time a new connection is made, or a service is replaced, on Ausgrid's network. It also establishes the minimum performance that must be achieved in those tests. This applies to both overhead and underground services.

This document assumes familiarity with and expands upon the requirements of Australian Standard 4741, *Testing of Connections to Low Voltage Electricity Networks*. Service testing shall comply with the requirements of AS 4741 and the additional requirements contained within this Standard.

Reference Documents

All work covered in this document shall conform to all relevant Legislation, Standards, Codes of Practice and Network Standards.

Ausgrid Documents

NS001 Glossary of Terms

NS238 Supply Quality

Other Standards and Documents

Australian Standard 4741:2010, Testing of Connections to Low Voltage Networks

Australian Standard 3017:2007, Electrical Installations Verification

Clause Standard Requirements

Required Tests

When replacing, installing or repairing any phase or neutral conductor of an overhead or underground service connection, all of the following tests listed in Section 1.1 and 1.2 shall be carried out by trained and authorised persons.

1.1 Tests Required Before Energisation of Installation

1.1.1 The customer's installation shall not be energised until the following tests have been performed with *satisfactory* results:

- Polarity;
- Phasing confirmation;
- Phase to neutral voltage;
- Phase rotation, for three-phase circuits;
- Confirmation of installation earth; and
- Neutral integrity.

1.1.2 Except for the tests for which this term has been otherwise provided with a specific definition, a test shall be deemed *satisfactory* when it has been carried out in the manner prescribed, without any unexpected results.

1.2 Test Required After Energisation of Installation

1.2.1 After the restoration of the customer's earth-neutral connection and the energisation of the customer's installation, one final test shall be performed (for M.E.N. installations only):

- Voltage between the customer's M.E.N. and independent earth.

1.3 Test Methods and Interpretation

1.3.1 Each test in Sections 1.1 and 1.2 shall be performed, and its results interpreted, as specified in Sections 2 and 3.

1.3.2 If the results of any test are unsatisfactory, work shall stop until the cause has been identified and rectified. Following rectification, the complete set of tests shall be performed with satisfactory results before energisation can proceed.

1.3.3 The results of the final tests shall be supplied to Ausgrid following energisation.

1.4 Ausgrid's Emergency Line

1.4.1 The results of some tests can reveal the existence of a hazardous situation on the customer's premises or Ausgrid's network, or the possibility that such a situation exists. In such circumstances, as detailed in the sections that follow, the customer shall contact Ausgrid's Emergency Line by telephoning 13 13 88.

1.4.2 Upon contacting Ausgrid's Emergency Line, work shall cease until directed otherwise by Ausgrid staff.

Details of Required Tests

2.1 Polarity

2.1.1 Polarity testing shall be carried out to prevent the incorrect connection of active and neutral conductors which may lead to electric shock hazards or property damage.

2.1.2 The test shall be conducted in a manner that satisfies the requirements of AS 4741 Section 4.3.

2.2 Phasing Confirmation

Correct phasing shall be confirmed prior to any connection of conductors to Ausgrid's network.

2.3 Phase to Neutral Voltage

- 2.3.1 This test shall be carried out on each connected phase to confirm the supply voltage is within the required range. The voltage must be within the voltage range for normal supply (not the maintenance or interim range) defined in NS 238.
- 2.3.2 If the voltage is not in the above range, the person in charge of the work shall contact Ausgrid's Emergency Line. The test result shall be regarded as *unsatisfactory*, and therefore the installation shall not be energised, unless and until such a time as Ausgrid gives approval to proceed.

2.4 Phase Rotation

Where more than one phase has been connected, correct phase rotation must be verified. Attention is drawn to Section 4.5 of AS 4741.

2.5 Confirmation of Installation Earth

- 2.5.1 The existence of an earth connection for the installation shall be verified. As this relates to the installation and not the service connection itself, the methods to perform such tests are beyond the scope of this standard. The reader is directed to clause 3.8.2 of AS 3017.

2.6 Neutral Integrity

- 2.6.1 A neutral integrity test shall be carried out to prove the integrity of the neutral connections between the customer's switchboard and the distribution transformer.
- 2.6.2 The test shall be performed in accordance with the general principles of AS 4741 Appendix B and the specific method and pass-fail criteria outlined in Section 3.2 or Section 3.3, respectively, for the two approved methods.
- 2.6.3 The testing shall include one of the two approved methods.
- 2.6.4 The customer's installation shall not be energised unless the result of the neutral integrity test is *satisfactory*. A *satisfactory* result shall only be achieved in one of two ways:
- The test results are classified as a 'Pass', per the criteria in Section 3 below; or
 - The test results are classified as 'Fail pending investigation', per the criteria in section 3 below, and thereafter Ausgrid grants approval to proceed on the basis of clause 3.2.3.
- 2.7 Voltage Between Customer's Neutral and Independent Earth – M.E.N. systems only
- 2.7.1 Following the *satisfactory* conclusion of all other tests, the restoration of the earth-neutral connection and the energisation of the installation, the voltage between the installation's neutral / earthing system and an independent earth shall be measured. This voltage shall not exceed 6.0V.
- 2.7.2 If this voltage exceeds 6.0V, the person in charge of the work shall de-energise the customer's installation and shall contact Ausgrid's Emergency Line for assistance.

Approved Methods for Neutral Integrity Testing and Interpretation of Results

3.1 Approved Methods Overview

- 3.1.1 The neutral integrity shall be demonstrated using either the Loop Impedance Method, as defined in Section 3.3, or the Voltage Method, as defined in Section 3.4.
- 3.1.2 In both approved methods, the disconnection of the customer's neutral from earth for the duration of the test is required. Methods for the verification of neutral integrity that do not involve neutral isolation from earth are explicitly noted to be inadequate and shall not be used.
- 3.1.3 The neutral-earth connection shall be reinstated upon the conclusion of neutral integrity testing.

3.2 Interpretation and Follow-Up Action

- 3.2.1 If the result of the neutral integrity test cannot be classified as a 'pass' per the definitions in Table 1 or 2, for the loop impedance and voltage methods, respectively, then the person in charge of the work shall re-make all connections and re-perform all tests in Section 1.1, including performing the neutral integrity test for a second time.
- 3.2.2 If the results of this second neutral integrity test can be classified as a 'pass', per the Tables, then the test shall be regarded as *satisfactory* and the first measurement shall be disregarded.

- 3.2.3 If the results of this second test cannot be classified as a 'pass', the person in charge of the work shall contact Ausgrid's Emergency Line. The results of both the first and second tests shall be provided to Ausgrid's staff. The test shall be regarded as *unsatisfactory*, and the energisation of the installation shall not proceed, unless and until Ausgrid states otherwise.
- 3.2.4 Further to the above, if the second result falls into the 'Fail pending investigation' category, Ausgrid shall accept the neutral integrity as being *satisfactory* if, and only if, its staff are able to positively demonstrate that the conditions in both of the following clauses hold:
- 3.2.4.1 1. That the test results are the result of abnormal but safe conditions on the local LV network beyond the premises and its service connection; *and*
- 3.2.4.2 2. That the test results are not caused by a high-impedance neutral connection or conductor that could be hazardous.
- 3.2.5 For example, determination that a higher-than-normal impedance exists in the local distribution network's phase conductors and that, if this were this not the case, the test results would lie within the 'pass' range, would normally be considered a satisfactory basis to proceed with energisation.
- 3.2.6 If the second result falls into the 'fail' (without qualification) range, Ausgrid shall deem the test result *unsatisfactory*, and energisation shall not proceed under any circumstances.

3.3 Loop Impedance Method

- 3.3.1 Confirmation of neutral integrity by means of a loop impedance test shall be carried out using the general method described in Appendix B3 of AS 4741 and the additional requirements of the following clauses.

Attention is drawn to Figure B2 of that Standard.

- 3.3.2 The equipment used shall be able to measure loop impedances of 0.4 ohms and higher with an accuracy of +/-5% (or better).
- 3.3.3 Results shall have a resolution of at least 1 decimal place. Where the equipment displays more than 1 decimal place, the results shall be recorded to 2 decimal places.
- Instruments that do not provide a measured value, i.e. those that provide only a range or a go / no-go indication, shall not be used.
- 3.3.4 The neutral shall be isolated from earth for the duration of the test.
- 3.3.5 The measured loop impedance shall be classified into one of the categories in Table 1. These results shall be interpreted in accordance with Section 3.2.

Table 1 - Loop Impedance Thresholds

Loop Impedance	Result	Interpretation
Not more than 0.6Ω	Pass	Satisfactory
Above 0.6Ω but not more than 1.0Ω	Fail pending investigation	Unsatisfactory without Ausgrid investigation and approval
Above 1.0Ω	Fail	Unsatisfactory

3.4 Voltage Method

- 3.4.1 Confirmation of neutral integrity by means of the voltage method shall be performed by measuring the neutral voltage for a known, substantial load drawn between phase and neutral at the site, with the earth isolated.
- 3.4.2 The test shall be carried out using the general method described in Appendix B2 of AS 4741 and the additional requirements of the following clauses.

Attention is drawn to Figure B1 of that Standard.

- 3.4.3 The instruments used shall be capable of measuring magnitude of the test load to the nearest 0.1 A and the neutral voltage to the nearest 0.1 V. These measurements shall be repeatable, i.e. stable (to the aforementioned accuracy) over multiple measurements.
- 3.4.4 The test load shall be applied between any phase and neutral at the customer's installation on the network side of the main switch. The customer's load shall not be employed as this test load; an external test load shall be used.
- 3.4.5 The neutral shall be isolated from earth for this test. An independent earth reference shall be established to permit the accurate measurement of the neutral voltage.
- 3.4.6 The test load's magnitude shall be known, fixed throughout the test and not less than 9.0 A. In the table below, the test load is referred to as I_{TL} and takes the units of amperes (A).
- The measured neutral voltage shall be classified into one of the categories in Table 2. These results shall be interpreted in accordance with section 3.2. As shown in the table, the maximum neutral voltage for each classification depends on the magnitude of the test load used.
- 3.4.7 The criteria for 'pass', 'fail' pending investigation and 'fail' are defined in the following clauses and summarised in Table 2.
- As shown in the table, in order to achieve a 'pass' result, the maximum permissible neutral voltage (in units of volts) shall be 0.3 times the test load (in units of amps).
 - A measured neutral voltage (in V) higher than 0.5 times the test load (in A) is considered *unsatisfactory*, without qualification.
 - A measured neutral voltage that lies between these two thresholds shall be considered *unsatisfactory* unless and until Ausgrid approve it. See clause 3.2.4.
- Example applications of these rules for test loads of convenience are shown in Table 3.
- 3.4.8 The test load shall not be so high that the calculated 'Fail' voltage threshold would exceed 6.0 V, that is, the test load shall not exceed 12.0 A.

Table 2 - Neutral Voltage Thresholds

Neutral Voltage (V)	Test Load I_{TL}	Result	Interpretation
Not more than $0.3 I_{TL}$	Not less than 9.0 A	Pass	Satisfactory
Above $0.3 I_{TL}$ but not more than $0.5 I_{TL}$	Not less than 9.0 A	Fail pending investigation	Unsatisfactory without Ausgrid investigation and approval
Above $0.5 I_{TL}$	Not less than 9.0 A	Fail	Unsatisfactory

Table 3 – Neutral Voltage Thresholds for Common Test Loads

Test Load	Maximum Neutral Voltage for 'Pass'	Maximum Neutral Voltage for 'Fail pending investigation'
9 A (min)	2.7 V	4.5 V
10 A	3.0 V	5.0 V
11 A	3.3 V	5.5 V
12 A (max)	3.6 V	6.0 V