# Network Standard

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| **NETWORK** | Document No | : NW000-S0061 |
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***Reviewed with no changes***

**NW000-S0061 NS230 TESTING OF DISTRIBUTION SUBSTATIONS**

## ISSUE

For issue to all Ausgrid and Accredited Service Providers' staff involved with the testing and commissioning of distribution substations, and is for reference by field, technical and engineering staff.

Ausgrid maintains a copy of this and other Network Standards together with updates and amendments on www.ausgrid.com.au.

Where this standard is issued as a controlled document replacing an earlier edition, remove and destroy the superseded document

## DISCLAIMER

As Ausgrid's standards are subject to ongoing review, the information contained in this document may be amended by Ausgrid at any time. It is possible that conflict may exist between standard documents. In this event, the most recent standard shall prevail.

This document has been developed using information available from field and other sources and is suitable for most situations encountered in Ausgrid. Particular conditions, projects or localities may require special or different practices. It is the responsibility of the local manager, supervisor, assured quality contractor and the individuals involved to make sure that a safe system of work is employed and that statutory requirements are met.

Ausgrid disclaims any and all liability to any person or persons for any procedure, process or any other thing done or not done, as a result of this Standard.

All design work, and the associated supply of materials and equipment, must be undertaken in accordance with and consideration of relevant legislative and regulatory requirements, latest revision of Ausgrid's Network Standards and specifications and Australian Standards. Designs submitted shall be declared as fit for purpose. Where the designer wishes to include a variation to a network standard or an alternative material or equipment to that currently approved the designer must obtain authorisation from the Network Standard owner before incorporating a variation to a Network Standard in a design.

External designers including those authorised as Accredited Service Providers will seek approval through the approved process as outlined in NS181 Approval of Materials and Equipment and Network Standard Variations. Seeking approval will ensure Network Standards are appropriately updated and that a consistent interpretation of the legislative framework is employed.

**Notes:** 1. Compliance with this Network Standard does not automatically satisfy the requirements of a Designer Safety Report. The designer must comply with the provisions of the Workplace Health and Safety Regulation 2011 (NSW - Part 6.2 Duties of designer of structure and person who commissions construction work) which requires the designer to provide a written safety report to the person who commissioned the design. This report must be provided to Ausgrid in all instances, including where the design was commissioned by or on behalf of a person who proposes to connect premises to Ausgrid's network, and will form part of the Designer Safety Report which must also be presented to Ausgrid. Further information is provided in Network Standard (NS) 212 Integrated Support Requirements for Ausgrid Network Assets.

2. Where the procedural requirements of this document conflict with contestable project procedures, the contestable project procedures shall take precedent for the whole project or part thereof which is classified as contestable. Any external contact with Ausgrid for contestable works projects is to be made via the Ausgrid officer responsible for facilitating the contestable project. The Contestable Ausgrid officer will liaise with Ausgrid internal departments and specialists as necessary to fulfil the requirements of this standard. All other technical aspects of this document which are not procedural in nature shall apply to contestable works projects.

## INTERPRETATION

In the event that any user of this Standard considers that any of its provisions is uncertain, ambiguous or otherwise in need of interpretation, the user should request Ausgrid to clarify the provision. Ausgrid's interpretation shall then apply as though it was included in the Standard, and is final and binding. No correspondence will be entered into with any person disputing the meaning of the provision published in the Standard or the accuracy of Ausgrid's interpretation.

## KEYPOINTS

This standard has a summary of content labelled "KEYPOINTS FOR THIS STANDARD". The inclusion or omission of items in this summary does not signify any specific importance or criticality to the items described. It is meant to simply provide the reader with a quick assessment of some of the major issues addressed by the standard. To fully appreciate the content and the requirements of the standard it must be read in its entirety.

## AMENDMENTS TO THIS STANDARD

Where there are changes to this standard from the previously approved version, any previous shading is removed and the newly affected paragraphs are shaded with a grey background. Where the document changes exceed 25% of the document content, any grey background in the document is to be removed and the following words should be shown below the title block on the right hand side of the page in bold and italic, for example, Supersedes – document details (for example, "Supersedes Document Type (Category) Document No. Amendment No.").

# KEY POINTS OF THIS STANDARD

## Scope and Risks Addressed

This standard is limited to scope identified below and provides controls for associated risks as listed below:

- ☐ This Network Standard is intended for the testing of new pole, kiosk and chamber distribution substations.
- ☐ For existing substations, authorised Ausgrid staff may decide which tests are appropriate during the augmentation.
- ☐ Testing methods within this Network Standard supersede those in the following standards: NS114, NS117 and NS122
- ☐ Testing shall be carried out during the equipping phase or on completion as appropriate and before the commissioning of the substation.
- ☐ All test equipment and instrumentation used for testing shall have been calibrated by a NATA Registered Calibration Organisation and have a current test sticker affixed. This will ensure the test equipment used is traceable.

**Where to for more information?**

Section 1, 2

## General Requirements

The following general requirements apply to the testing procedure:

- ☐ Compliance with the testing requirements will be demonstrated throughout the project at appropriate stages for the tests to be conducted.
- ☐ Use Transformer Commissioning/Breakdown Report (Form A153) to record test results
- ☐ All test equipment used shall be NATA calibrated
- ☐ Defects occurring within warranty period must be reported to T&DSE section within 1 working day
- ☐ Safety signage shall be in place during testing to ensure safety of personnel and the general public

**Where to for more information?**

Section 5

**Tools and Forms**

Annexure A Transformer Commissioning/Breakdown Report

## Transformer and Equipment Testing

This section specifies the required and optional tests to be undertaken and includes:

- ☐ HV and LV Winding Continuity Tests
- ☐ Insulation Resistance Test
- ☐ Induced HV (Winding) Test
- ☐ Transformer Oil Tests (optional)
- ☐ Earthing Tests
- ☐ Voltage Withstand test (optional)
- ☐ Checking connection tightness

Prior to undertaking any test the Distribution Monitoring and Control wiring must be disconnected.

**Where to for more information?**

Section 6

**Tools and Forms**

Annexure A Transformer Commissioning/Breakdown Report

# Network Standard
# NS230
# Testing of Distribution Substations

## Contents

# 1.0 PURPOSE

NS230 applies to the testing of new distribution substations throughout all parts of Ausgrid's supply area. This standard is applicable to pole, kiosk and chamber substations.

Ausgrid is responsible for the management and operation of Ausgrid's electricity supply network. The network is a major infrastructure investment, and is required to operate reliably and effectively.

The site testing requirements specified in this Network Standard are intended to satisfy electrical performance requirements, and to meet all statutory obligations.

This Network Standard may be amended or updated at any time to reflect improvements in design, technology advances etc. The personnel conducting the testing shall ensure the latest version of this Network Standard is used for the testing of the Distribution Substation to which it applies.

# 2.0 SCOPE

This Network Standard is intended for the testing of new pole, kiosk and chamber distribution substations.

For existing substations, authorised Ausgrid staff may decide which tests are appropriate during the augmentation. Tests selected from this Network Standard, for augmentations, shall depend on the specific substation changes completed during the works. Alternative test voltage levels and limits may be applied where appropriate, to previously in-service equipment.

Testing methods within this Network Standard supersede those in the following standards:

- NS114 Electrical Design and Construction Standards for Chamber Type Substations
- NS117 Design and Construction Standards for Kiosk Type Substations
- NS122 Pole Mounted Substation Construction.

# 3.0 REFERENCES

## 3.1 General

All work covered in this document shall conform to all relevant Legislation, Standards, Codes of Practice and Network Standards. Current Network Standards are available on Ausgrid's Internet site at www.ausgrid.com.au.

## 3.2 Ausgrid documents

- Bush Fire Risk Management Plan
- Company Form (Governance) - Network Document Endorsement and Approval
- Company Procedure (Network) – Network Standards Compliance
- Company Procedure (Network) - Production / Review of Network Standards
- Company Procedure (Governance) - Network Document Endorsement and Approval
- Electrical Safety Rules
- Electricity Network Safety Management System Manual
- NS114 Electrical Design and Construction Standards for Chamber Type Substations
- NS116 Design Standards for Distribution Equipment Earthing
- NS117 Design and Construction Standards for Kiosk Type Substations
- NS122 Pole Mounted Substation Construction
- NS161 Specification for Testing of Underground Cables
- NS181 Approval of Materials and Equipment and Network Standard Variations
- NS212 Integrated Support Requirements for Ausgrid Network Assets
- Public Electrical Safety Awareness Plan

- Public Lighting Management Plan
- Tree Safety Management Plan

## 3.3 Other standards and documents

- AS 60076.1 – Power Transformers – General
- ENA Doc 001-2008 National Electricity Network Safety Code

## 3.4 Acts and regulations

- Electricity Supply (General) Regulation 2014 (NSW)
- Electricity Supply (Safety and Network Management) Regulation 2014
- Work Health and Safety Act 2011 and Regulation 2011

# 4.0 DEFINITIONS

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|---|---|
| **Accredited Service Provider (ASP)** | An individual or entity accredited by the NSW Department of Industry, Division of Resources and Energy, in accordance with the Electricity Supply (Safety and Network Management) Regulation 2014 (NSW). |
| **Business Management System (BMS)** | An Ausgrid internal integrated policy and procedure framework that contains the approved version of documents. |
| **DM&C** | Distribution Monitoring & Control equipment used for remote monitoring and control of substations |
| **Document control** | Ausgrid employees who work with printed copies of document must check the BMS regularly to monitor version control. Documents are considered “UNCONTROLLED IF PRINTED”, as indicated in the footer. |
| **HV** | High voltage is normally more than 1,000 volts alternating current (AC) or 1500 volts direct current (DC).. |
| **LV** | Low voltage is normally more than 50 volts alternating current (AC) or 120 volts ripple free direct current (DC) but is not more than 1,000 volts AC or 1500 volts DC.. |
| **Network Standard** | A document, including Network Planning Standards, that describes the Company's minimum requirements for planning, design, construction, maintenance, technical specification, environmental, property and metering activities on the distribution and transmission network. These documents are stored in the Network Category of the BMS repository. |
| **Review date** | The review date displayed in the header of the document is the future date for review of a document. The default period is three years from the date of approval. However a review may be mandated at any time where a need is identified due to changes in legislation, organisational changes, restructures, occurrence of an incident or changes in technology or work practice. |
| **Social impact** | A social impact may exist where changes to Ausgrid’s network standard would cause changes to new or existing customer installations, potential impacts to the public in general (e.g. electromagnetic fields associated with power lines) or changes to Ausgrid’s service options. |

# 5.0 GENERAL

Checks, measurements and tests shall be conducted as per this Network Standard. Compliance shall be demonstrated throughout the procurement, construction and inspection phases of the substation project as appropriate.

The following tests, unless defined as 'Optional', are the minimum required for most new substations. Test results shall be recorded in the Test Report and made available to the relevant Ausgrid Officer prior to the inspection of the substation. Refer Annexure A, Transformer Commissioning/Breakdown Report (Form A153) available in numbered duplicate bound book format from Ausgrid Print Office.

The completed Test Report must be retained in the relevant Region or Area for future reference.

Testing shall be carried out during the equipping phase or on completion as appropriate and before the commissioning of the substation. Ausgrid reserves the right to witness and/or repeat any test procedure that is specified in this document.

All test equipment and instrumentation used for testing shall have been calibrated by a NATA Registered Calibration Organisation and have a current test sticker affixed. This will ensure the test equipment used is traceable.

Results of all tests are to be included in the Test Report and shall include:

- test date
- test completed
- measured values
- result expressed as pass/fail
- instrument/equipment number and calibration date.

In the event of equipment within a distribution substation being identified as defective within the warranty period, whether during testing/commissioning or operation, the Transmission and Distribution Substation Engineering (T&DSE) Section should be notified immediately. For ASP equipped substation projects contact should be made through the relevant Ausgrid Officer for that project.

Contact must be made within one working day of the defect being identified.

Personnel shall arrange appropriate barriers and standby person(s) in accordance with their SWMS and Ausgrid's Electrical Safety Rules, prior to commencement of these tests.

Warning Electric Shock Hazard: Application of test voltages to equipment will result in high voltages appearing on various equipment terminals, suitable precautions are to be taken to ensure personnel do not come into contact or near approach to live parts and test connections during testing. Closing and securing unattended kiosk doors, appropriate safety barriers/ screens and/or an observer shall be utilised to ensure adequate clearances to persons are maintained.

# 6.0 TRANSFORMER & EQUIPMENT TESTING

## 6.1 General

The following tests shall be conducted on the transformer/s and associated equipment at site:

- HV and LV continuity test, refer 6.2
- insulation resistance tests on the total installation, refer 6.3 (transformers, HV & LV switchgear and power cables)
- induced HV test refer 6.4 and requirements below
- Transformer oil tests (if required refer 6.5)

The Induced HV test (Winding test) on Distribution Transformers must be conducted on all transformers at site prior to commissioning, with the following exceptions which apply under the circumstances stated:

(a) For Pole Transformers to be commissioned locally, winding tests can be conducted at a depot provided that no significant cause of concern is identified over the transport and handling to site. This is the preferred option, or

(b) For Pole Transformers and kiosks/padmounts where it is deemed by installation staff as impractical to conduct the testing then remote energisation of the substation from a location elsewhere on the network shall be employed as per current Operating practices.

Where Ausgrid has not supplied the transformer it must comply with Ausgrid's current specification. A copy of the transformer specification and routine test results are to be forwarded to the relevant Ausgrid Officer, who will forward the results to Procurements & Logistics for approval. The routine test results shall include all tests as required by AS-60076 Power Transformers – Part 1 – General.

Upon approval, Procurements & Logistics shall issue an Ausgrid Transformer Asset Number (eg Txxxxxx), via the relevant Ausgrid Officer.

Prior to any testing, all Distribution Monitoring & Control (DM&C) wiring must be disconnected from the LV test and supply points.

Depending on the LV SAIF board's year of construction, the DM&C connections to be disconnected are found on the:

- Top of "Voltage Test Point Fuses" and "GPO Socket Fuse". (See DWG 202327 – Ref. 7a)

Or on earlier models:

- Voltage test point terminals labelled "Voltage Test Block" and the GPO supply terminals labelled "GPO Socket". These are found next to the CT terminal strip. (See DWG 202327 – Ref. 7c)

## 6.2 HV and LV winding continuity tests

**HV Windings**

Test the continuity of the HV Windings. Conduct the test with a 1000V insulation resistance tester in continuity mode. Other suitable and calibrated ohmmeters with appropriate voltage and current outputs are acceptable. Due to the large inductances involved, it is necessary to wait until the insulation resistance tester current stabilises before accurate resistance values are recorded.

As a general rule, substantial differences between the measured resistances on delta-connected HV windings may indicate a faulty tapping switch, open/short-circuited windings or loose/faulty connections.

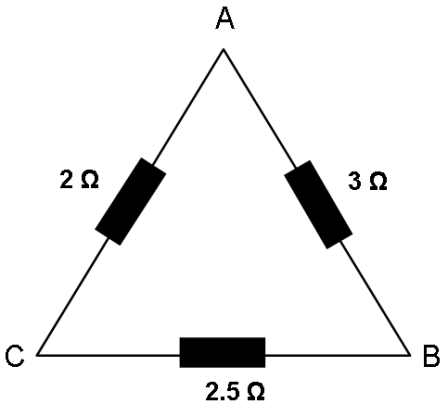


**Figure 1 – Delta Connected HV Windings with example Resistances**

It should be noted that one open-circuited HV delta-connected winding will not result in an infinitely high resistance on measurement.

Measuring between A and B terminals in Figure 1, the resistance when all windings are healthy will be 1.8Ω (2Ω + 2.5Ω in parallel with 3Ω).

If the winding was open-circuited between A and B terminals, the measured resistance would sum to 4.5Ω (2.5Ω + 2Ω). The two other measurements, B-C and C-A, will have respective resistances of 2.5Ω and 2Ω because the open-circuited winding prevents paralleling. Therefore, substantial differences between winding resistances need to be investigated.

**LV Windings**

Test the continuity of the LV Windings. Conduct test with a 1000V insulation resistance tester in continuity mode. Other suitable and calibrated ohmmeters with appropriate voltage and current output are acceptable.

For a 3-phase transformer test : a-n, b-n, c-n and n-earth.

For a single phase transformer referring to nameplate diagram, conduct the test:

- a1/a2 to a3/a4 with the winding bridges installed
- a1 to a3 and a2 to a4 with the winding bridges removed.

Due to the very low resistance of LV windings, results using a standard 1000V insulation resistance tester cannot be relied on to identify shorted windings. Only the presence of abnormally high resistance/open-circuited windings can generally be determined.

## 6.3 Insulation resistance test

Tests shall be conducted while adhering to the minimum approach distance to any energised HV mains. Using a 1000V insulation resistance tester, test and record the insulation resistance of:

- the total HV circuit, measured to earth. This test includes the HV switchgear/fuses. The transformer is to be on Tap position 1 to ensure the entire winding is tested.
- the combined LV circuits, measured to earth. This test includes the connections to the supply side of the LV switchgear/fuses. **The transformer neutral bushing is to be disconnected from earth during the test. All LV surge diverter earth connections are to be disconnected during the test.**
- the HV to LV phases. **The LV neutral shall be disconnected from earth. All LV surge diverter earth connections are to be disconnected during the test.**

For any installation, the insulation resistance measured shall not be less than:

- HV – Earth 200 M Ω *
- LV – Earth 100 M Ω
- HV – LV 200 M Ω *

* A reading of 100 M Ω + is acceptable if this is the maximum full scale reading on the insulation testing instrument.

Due to the inductive characteristics of transformers, the insulation resistance reading shall not be taken until the test current stabilises.

## 6.4 Induced HV (winding) test

Transformer testing by the manufacturer, at the manufacturer's premises, does not negate the requirement to perform this test. Subject to the exceptions set out under Clause 6.1.

This test shall be performed before all site connections are made. For kiosk type substations this removes the possibility of damage to, or loss of grease from the HV connections separable connectors (elbows), when plugging them in and out.

The HV bushing insert connection for test purposes can be made by inserting a metallic type rod of 7.92+0.04mm (5/16") overall maximum diameter with a tapered end to extend out a connection point for the earth test lead. Testing is to be conducted without any insulation over the exposed bushings.

LV test connections for chamber and pole substations can be made directly to the low voltage terminals. For kiosk substations the LV test connections can be made to the bottom terminals of the test auxiliary fuse holders located at the top of the SAIF LV board.

Due to the presence of High Voltage during the test, adequate safety requirements shall be met. Safe working practices shall be consistent with Ausgrid's Electrical Safety Rules.

The induced HV test aims to prove there are no high-impedance earth faults on the transformer's HV windings. Faults are characterised by excessive dielectric discharge. This discharge may be caused by damaged or contaminated winding insulation.

Where winding tests are conducted using a portable generator there is risk of a capacitive voltage rise on the transformer winding due to the capacitance of the transformer. Precautions must be taken to ensure suitable earthing is provided. If these precautions are not taken the consequences could be significant (an electric shock to the operator). If a portable generator (whether hired or Ausgrid owned) does not have a terminal that enables it to be earthed, then it MUST NOT be used for performing winding tests.

### 6.4.1 Induced HV (winding) test for three phase transformers

The test involves energising individual windings on the LV (star) side using a single phase test set. This energises the corresponding HV winding. Attaching an earth to one energised HV terminal will expose the other terminal of the energised HV winding to 11kV to earth.

The practice of increasing the winding/terminal insulation to an over-voltage of 1.73 ($\sqrt{3}$) times the normal terminal operating voltage stresses the transformer's insulation to earth. The inter-turn insulation of the energised HV Winding is also subjected to the induced voltage and therefore tested.

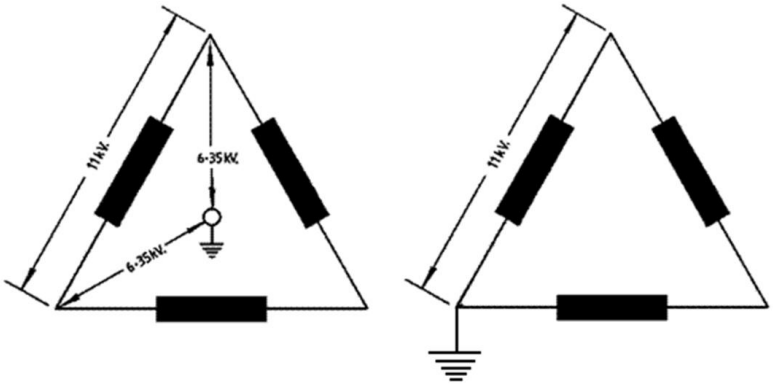


**Figure 2 – Standard Delta vs. Delta winding Earthed**

Earthing all HV terminals individually and energising different windings from the LV terminals, consists of 9 separate tests. There are an additional 3 tests with the HV terminals isolated. This testing method exposes any high resistance winding faults to different voltages. By monitoring the winding test set current for substantial changes, faults can be identified. If the in service earth connections to the transformer tank cannot be used then a separate conductor needs to be connected between the substation earth and the transformer tank before commencing the test.

All tests shall be conducted with the transformer on Tap position '1'. The entire HV winding will then be tested. This will also induce the maximum possible voltage on the tested phase. In order to maintain safe clearances and to prevent damage to the transformer, the Tap switch must not be changed whilst testing is in progress.

**Note:** The transformer isolator on the LV board is to be in the "open/disconnected" position and the RMI tee off switch is also to be in the "open" position.

Current and voltage measurement should be made using a tong ammeter and digital multimeter respectively. The instruments can be connected to the test set at the positions provided.

**Connection layout for the Induced HV Test on a 3 phase transformer:**

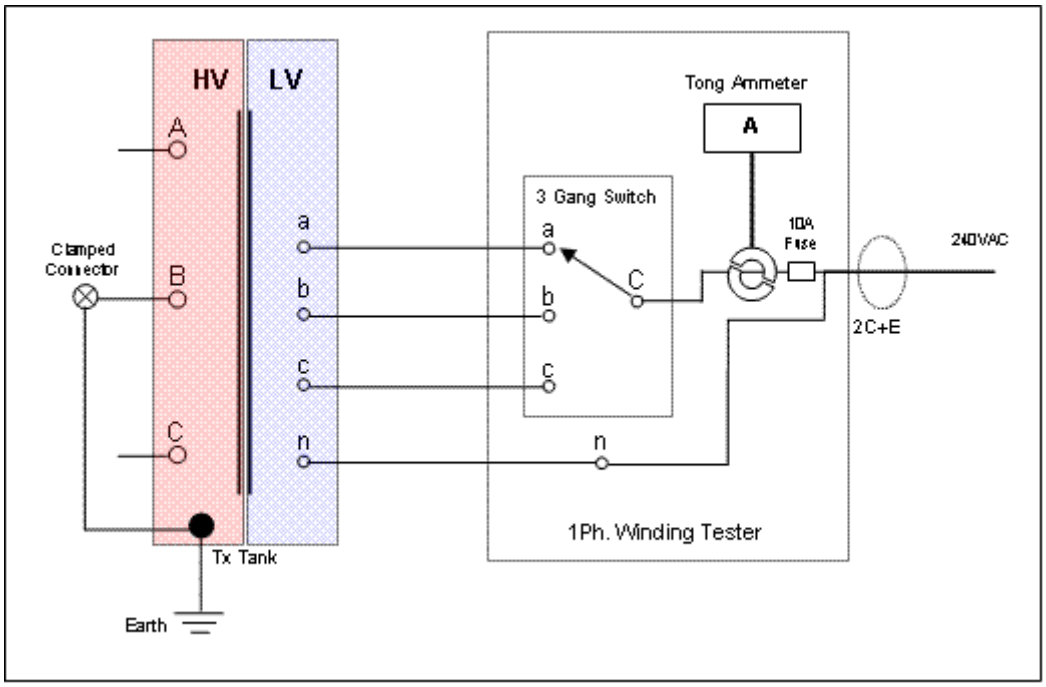


**Figure 3 – Example – 1 of 9 tests with a HV terminal earthed; 'A' winding energised and 'B' terminal earthed**

**Note:** Where a portable generator is used as the supply source the generator frame and earth point must be electrically connected to the transformer tank and to a substation earth point or temporary earth stake. Where the test is performed on a truck bed, the metallic frame of the truck bed must be electrically connected to the transformer tank and earthed.

With the tap switch in position 1, energise the LV windings ‘a’-‘n’, ‘b’-‘n’ and ‘c’-‘n’ individually. With each LV winding energised, measure the no-load current and volts with:

- HV isolated (all HV phases open circuit)
- A phase earthed
- B phase earthed
- C phase earthed

**Ensure the 240VAC Winding Test Set voltage is isolated prior to changing connections.**

The duration of each test should be one minute, with or without cabling attached.

Theoretically, results should indicate the current measured is the same when energising ‘a’ and ‘c’ phases. There should be a small difference in the current measured for ‘b’ phase injection.

A winding problem could be indicated by an audible discharge from within the transformer, fluctuation of the LV injection current, or operation of the test set fuses.

If an audible discharge is heard, the LV current is fluctuating or the test set fuses operate, the Transmission and Distribution Substation Engineering section shall be informed. The transformer will generally be rejected and replaced by another.

### 6.4.2 Induced HV (winding) test for single phase and SWER transformers

In a single phase 11kV or 22kV transformer, attaching an earth to one HV terminal will expose the other terminal of the HV winding to 11kV to earth or 22kV to earth respectively.

Earthing both HV terminals individually and energising a1-a2 LV terminals consists of 2 separate tests. There is one additional test with HV terminals isolated prior to those tests.

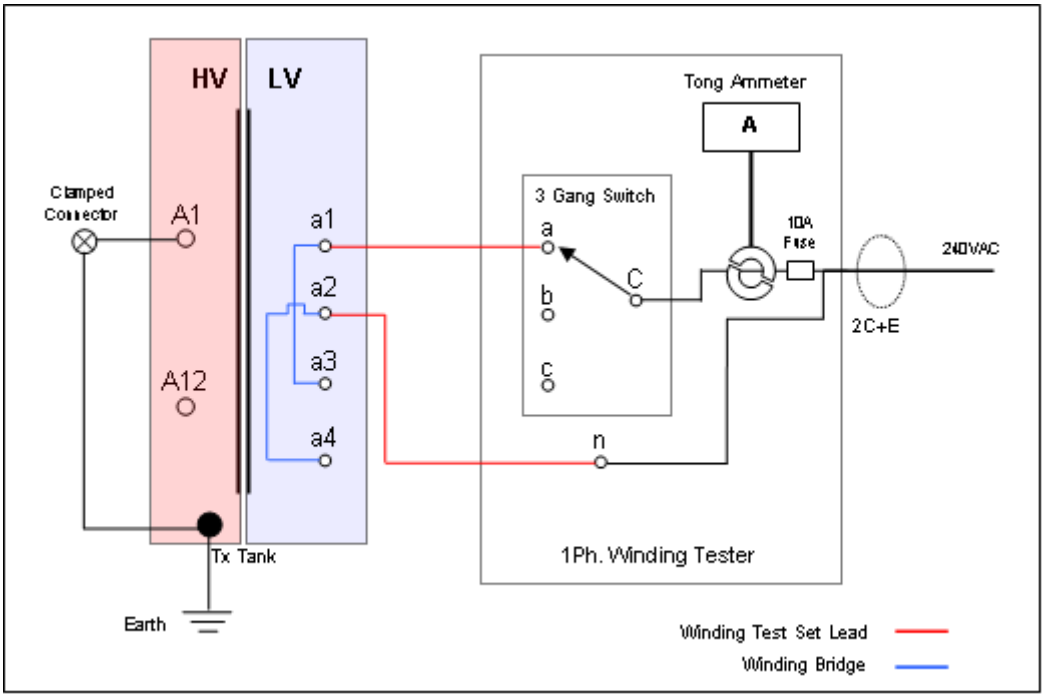


**Figure 4 – Connection Layout-Single phase transformer- 1 of 3 tests with a HV terminal earthed**

**Note:** Where a portable generator is used as the supply source the generator frame and earth point must be electrically connected to the transformer tank and to a substation earth point or temporary earth stake. Where the test is performed on a truck bed, the metallic frame of the truck bed must be electrically connected to the transformer tank and earthed.

With the tap switch in position 1, energise the LV winding a1 and a2 terminals while a1-a3 and a2-a4 winding bridges connected. With terminals energised, measure the no-load current and volts with:

- HV isolated
- A1 terminal earthed
- A12 terminal earthed

Ensure the 240VAC Winding Test Set voltage is isolated prior to changing connections.

The duration of each test should be one minute, with or without cabling attached.

A winding problem could be indicated by an audible discharge from within the transformer, fluctuation of the LV injection current, or operation of the test set fuses.

If an audible discharge is heard, the LV current is fluctuating or the test set fuses operate, the Transmission and Distribution Substation Engineering section shall be informed. The transformer will generally be rejected and replaced by another.

In a SWER transformer, attaching an earth to the ER terminal will expose the other terminal of the HV winding to 12.7kV to earth.

Earthing A1(ER) terminal and energising from a1-a2 LV terminals consist of only 1 test.

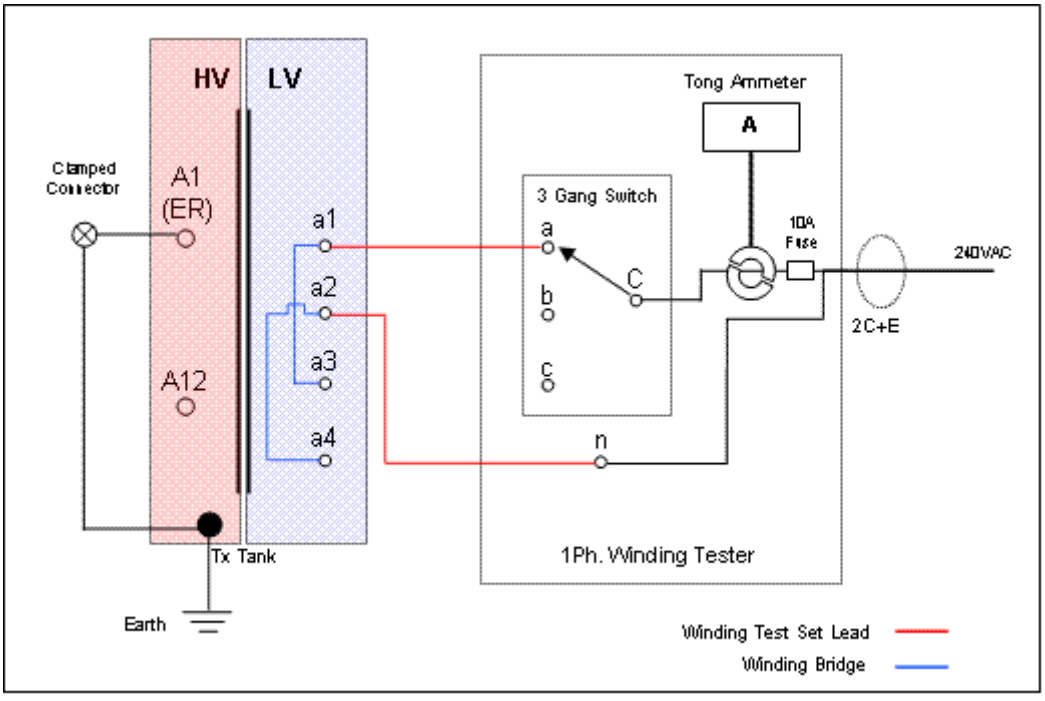


**Figure 5 – Connection Layout –SWER transformer- ER terminal earthed**

**Note:** Where a portable generator is used as the supply source the generator frame and earth point must be electrically connected to the transformer tank and to a substation earth point or temporary earth stake. Where the test is performed on a truck bed, the metallic frame of the truck bed must be electrically connected to the transformer tank and earthed.

With the tap switch in position 1, energise the LV winding a1 and a2 terminals while a1-a3 and a2-a4 winding bridges connected. With terminals energised, measure the no-load current and volts with:

- A1 terminal (ER bushing) earthed

The duration of the test should be one minute, with or without cabling attached.

A winding problem could be indicated by an audible discharge from within the transformer, fluctuation of the LV injection current, or operation of the test set fuses.

If an audible discharge is heard, the LV current is fluctuating or the test set fuses operate, the Transmission and Distribution Substation Engineering section shall be informed. The transformer will generally be rejected and replaced by another.

## 6.5 Transformer oil tests (optional)

Transformers supplied by Ausgrid do not require additional transformer oil tests. Transformers not supplied by Ausgrid shall comply with Ausgrid technical specifications for distribution transformers and shall be of the sealed oil conservation system.

Additionally oil analysis of samples taken from non Ausgrid supplied transformer shall be tested by a NATA approved testing organisation in accordance with Ausgrid requirements. These requirements can be provided upon request.

## 6.6 Earthing tests

The following tests are to be performed on all distribution substations, in addition to the tests detailed in NS116 – Design Standards for Distribution Earthing.

### 6.6.1 HV and LV earth continuity test

Earth continuity is to be measured using a calibrated 1,000V insulation resistance tester on the continuity range. Other suitable ohmmeters with appropriate voltage and current outputs may be used. The earth continuity reading shall be less than 0.5Ω.

Test the earth resistance between the:

- main transformer tank earth to the substation earth bar
- LV neutral bushing to the substation earth bar.

### 6.6.2 HV to LV earth insulation test (segregated earthing installations only)

Using a 1,000V insulation resistance tester on the 1000V insulation test range, measure the insulation resistance between the HV and LV earth system.

This is to be done at the substation earth bar. This earth bond must be disconnected, where fitted, at the test point. The HV and LV earth electrode tails shall also be disconnected at the test points.

The insulation resistance reading shall not be less than 1.0 MΩ.

## 6.7 Voltage withstand test (optional)

Ausgrid may request applied voltage withstand testing on the following equipment:

- HV racking type or site assembled multi cubicle HV switchgear
- Non Ausgrid supplied distribution transformers (this is a separate test from the Induced HV (Winding) Test required under Clause 6.4) where adequate evidence cannot be supplied of this be performed at the manufacturing works.

## 6.8 Connection tightness check

All HV and LV terminations are to be checked to ensure they have been adequately tightened. The LV board and RMI connections are to be tightened as per the manufacturer's manual required torque settings. Additionally, all site assembled LV busbar bolted joints including neutral and earth connections are to be checked for tightness. On verification of adequate tightening, each bolt head shall be marked with a marker type pen to indicate completion, a simple bold line across the bolt head will suffice. This will allow potential visual verification by the relevant Ausgrid Officer during inspection. The process of tightness checking should ideally be done during assembly works; and must be performed by an independent technician to that whom assembled the connection.

# 7.0 RECORDKEEPING

The table below identifies the types of records relating to the process, their storage location and retention period.

**Table 1 – Recordkeeping**

| Type of Record | Storage Location | Retention Period* |
|---|---|---|
| Approved copy of the network standard | BMS Network sub process Standard – Company | Unlimited |
| Draft Copies of the network standard during amendment/creation | TRIM Work Folder for Network Standards (Trim ref. 2014/21250/64) | Unlimited |
| Working documents (emails, memos, impact assessment reports, etc.) | TRIM Work Folder for Network Standards (Trim ref. 2014/21250/64) | Unlimited |

* The following retention periods are subject to change eg if the records are required for legal matters or legislative changes. Before disposal, retention periods should be checked and authorised by the Records Manager.

# 8.0 AUTHORITIES AND RESPONSIBILITIES

For this network standard the authorities and responsibilities of Ausgrid employees and managers in relation to content, management and document control of this network standard can be obtained from the Company Procedure (Network) – Production/Review of Network Standards. The responsibilities of persons for the design or construction work detailed in this network standard are identified throughout this standard in the context of the requirements to which they apply.

# 9.0 DOCUMENT CONTROL

**Content Coordinator** : Transmission and Distribution Substations Engineering Manager

**Distribution Coordinator** : Engineering Information and Services Manager

# Annexure A – Transformer Commissioning/Breakdown Report

The Transformer Commissioning/Breakdown Report (Form A153) is available in numbered duplicate bound book format from Ausgrid Print Office.

## TRANSFORMER COMMISSIONING / BREAKDOWN REPORT

SUPERVISOR _____ ENG. _____ EA _____ DC _____ FILE

P.T. SUB No. _____ NAME _____ ZONE _____

**STRIKE OUT ALL ITEMS THAT DO NOT APPLY**

**1. TRANSFORMER PARTICULARS.**

| NAME PLATE | | H.V. CONNECTIONS | L.V. CONNECTIONS |
|---|---|---|---|
| Pos. No. in Sub _____ | Make _____ | Permanent / Temporary | Permanent / Temporary |
| S.C.C. No. _____ | kVA _____ | S.C.L.C. / 3. C.L.C. | S.C.L.C. / 4. C.L.C. |
| Ser. No. _____ | Nominal Ratio _____ / _____ V. | S.C.P.V.C. / Polythene / | S.C. P.V.C. / |
| Cont. No. _____ | Imp.% _____ | Open Wiring - Solid / Stranded | Open Insulated / In Conduit. |
| Group Ref. _____ | Temp rise _____ °C | Endbox / Trunking | Endbox |
| Diagram of Connections. To be drawn on back on this sheet. (See B.S.I. 4033 re checking of connections and preparing diagram prior to handing over transformer to P.E. for balance checks or P.E./O.E. for "Temporary phase out"). | | Glands | Glands |
| | | Insulators - Terminal / Leadthrough | Insulators - Terminal / Leadthrough. |
| | | Conductor Size _____ | Conductor Size - Active _____ Neutral _____ |

**2. PHASE ROTATION.**

(Using Indicator or Lamps) Clockwise / Anticlockwise

**3. VOLTAGE AND LOAD CHECK.** On transformer. Tapping No. _____ _____ V. / _____ V

| Transformer Voltage (No Load) | | Transformer Voltage (No Load) Date _____ at _____ am/pm | | | |
|---|---|---|---|---|---|
| Date _____ at _____ a.m. | | Volts | | Amps | |
| a-n _____ | a-b _____ | a-n _____ | a-b _____ | a phase _____ | |
| b-n _____ | b-c _____ | b-n _____ | b-c _____ | b phase _____ | |
| c-n _____ | c-a _____ | c-n _____ | c-a _____ | c phase _____ | |
| | | | | Neutral _____ | |

**4. LOAD SHARING CHECK** (MULTIPLE TRANSFORMER STATIONS) Time placed on load _____ am/pm

Station M.D.I. reading _____ A. K. = _____

(FED HAND)

No. 1 Trans. amp. a _____ b _____ c _____

No. 2 Trans. amp. a _____ b _____ c _____

No. 3 Trans. amp. a _____ b _____ c _____

No. 4 Trans. amp. a _____ b _____ c _____

Use two instruments if available.
If load is fluctuating, estimate average value and note here.
Fluctuating / Steady

**5. PROTECTION OPERATION** H.V. Fuse - Overload - Leakage - Differential - Gas Pressure.

**6. EXTERNAL INSPECTION** Diaphragm broken / checked / fitted / Protective Cover Removed / Oil level checked, topped up
Breather checked / Spillage Prevention REmoved (Glass Wool Felt or Cap).
Oil thrown. Tank distorted. Smoke. Any oil leak? _____
Other damage _____

**7. INTERNAL INSPECTION** Smell. Colour of oil _____
Evidence of failure _____

**8. MEGGER TEST** (Disconnect neutral)

| Insulation Tests | MΩ | Continuity Tests | Ω | | |
|---|---|---|---|---|---|
| H.V. Winding - E | _____ | H.V. | A-B _____ | L.V. | a-n _____ |
| L.V. Winding - E | _____ | | B-C _____ | | b-n _____ |
| H.V. - L.V. | _____ | | C-A _____ | | c-n _____ |

If L.V. - earth is less than 5MΩ and H.V. - earth is less than 20MΩ or continuity checks not balanced, isolate cables or tail and recheck. Insert figures on back of sheet. PASS / FAIL

**9. WINDING TEST** N.B. Treat Transformer as alive. Use Single Phase Supply and record the current on the three L.V. Phases with the H.V Terminals Isolated and then Earthed in turn. As far as practicable take readings at a set voltage.

| H.V. WINDING | A. PHASE AMPS | B. PHASE AMPS | C. PHASE AMPS | VOLTAGE APPLIED |
|---|---|---|---|---|
| ISOLATED | | | | |
| A. PHASE EARTHED | | | | |
| B. PHASE EARTHED | | | | |
| C. PHASE EARTHED | | | | |

**10. GENERAL**

(a) H.V. and L.V. switchgear labelled and stencilled where required _____
(b) Permanent labels have been fitted / ordered _____
(c) Are open type connections effectively shielded? H.V. / L.V. _____
(d) State if internal connections or polarity are known to be non-standard, or if external position of neutral is other than standard _____
(e) Is painting necessary? _____
(f) Transformer terminals marked on tank _____
(g) Transformer position marked on tank _____
(h) IS THE L.V. NEUTRAL CONNECTED OT THE EARTH BUS? _____

**11. REMARKS:** If transformer is FAULTY, Technician Fitter is to complete Defective Apparatus Report (Area 101)

_____

_____

_____

_____

_____

_____

Commissioning Date _____ _____ Date _____

A.153 Technician

SAMPLE

# Annexure B – Sample Compliance Checklist

## Network Standard Checklist Form

### NS230 TESTING OF DISTRIBUTION SUBSTATIONS

| | |
|---|---|
| Project Identification: | |
| Prepared by: <Name & Position Title> | Date: |

This checklist is for internal Ausgrid use only and does not apply to ASPs or contractors who have specific compliance requirements in relation to Contestable project works. The checklist is unique for each network standard and is available within BALIN and the BMS as a separate form that can be amended as required, completed and saved in TRIM with the other project documentation.

This section is used to identify compliance checks that when applied to the work associated with this Network Standard will satisfy an audit process to establish that the requirements of the standard have been followed. It is expected that applicable items would normally be checked as Comply (Yes) as non-compliance is generally not tolerated.

Where non-compliance is the result of specific site conditions or design decisions this needs to be identified in the notes section of the form for each non-compliance and approval sought from an appropriately authorised Ausgrid manager responsible for design approval per NS261 Compliance Framework for Network Standards.

Should additional information be available to document non-compliance decisions, these can be attached to the checklist form. The checklist and any attached explanatory notes should be saved in the project document repository.

| Item | Description | Refer Clause | Completed/ Actioned |
|---|---|---|---|
| | **Scope** | | |
| | This Network Standard is intended for the testing of new pole, kiosk and chamber distribution substations. | 1, 2 | |
| | For existing sites some of the tests may be applied depending on the equipment being replaced/installed. | | |
| | | | |
| | **General Requirements** | | |
| 1 | Compliance with standard demonstrated at appropriate stages of the project | 5.0 | Yes/No/NA |
| 2 | Transformer Commissioning/Breakdown Report used to document test results | 5.0 | Yes/No/NA |
| 3 | Transformer Commissioning/Breakdown Report retained by Ausgrid for future reference | 5.0 | Yes/No/NA |
| 4 | All test equipment and instrumentation calibrated by registered NATA Organisation and have current test sticker attached. | 5.0 | Yes/No/NA |
| 5 | Defective equipment reports notified to DASE Section within 1 working day of event | 5.0 | Yes/No/NA |
| 6 | Safety Signage in accordance with Electrical Safety Rules in place for duration of testing procedures | 5.0 | Yes/No/NA |
| | | | |
| | **Transformer and Equipment Testing** | | |
| 7 | Transformer Tests conducted on site with only listed exemptions and conditions applying | 6.0 | Yes/No/NA |
| 8 | Where Ausgrid has not supplied the transformer, test results shall include | 6.0 | Yes/No/NA |

| Item | Description | Refer Clause | Completed/ Actioned |
|---|---|---|---|
| | those specified under AS-60076 Power Transformers - Part 1 – General | | |
| 9 | DM&C wiring disconnected during tests | 6.1 | Yes/No/NA |
| 10 | HV and LV Winding Continuity Tests undertaken and results submitted | 6.2 | Yes/No/NA |
| 11 | Insulation Resistance Tests undertaken and results submitted | 6.3 | Yes/No/NA |
| 12 | Induced HV (Winding) Tests undertaken and results submitted | 6.4 | Yes/No/NA |
| 13 | Transformer Oil Tests undertaken and results submitted (optional) | 6.5 | Yes/No/NA |
| 14 | Earthing Tests undertaken and results submitted | 6.6 | Yes/No/NA |
| 15 | Voltage Withstand Tests undertaken and results submitted (optional) | 6.7 | Yes/No/NA |
| 16 | All connections checked | 6.8 | Yes/No/NA |
| | | | |

Notes:

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The signatures panel of this document has been removed for privacy considerations. The remainder of the document is unchanged.