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Engineering Standard – NSW

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Testing of High Voltage Cables

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About This Standard

This publication sets out the general requirements for the testing of new high voltage ac and 1500V dc positive and negative cables.

Tests after installation are to detect defects caused during installation or during the fitting of cable accessories.

The relevant sections of this publication shall also apply when:

- Repairs have been carried out on the high voltage insulation of cables.
- Terminations have been remade on high voltage cables.
- Joints have been installed in high voltage cables.
- Sections of high voltage cables have been replaced.

This publication does not cover the actual testing methods. However values for High Voltage dc Test voltages are provided.

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ISSUE	DATE	CLAUSE	DESCRIPTION
1.1	05/01/2005		Reformatted to ARTC Standard
1.2	11/03/2005	Disclaimer	Minor editorial change

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1 Scope and Application

This document sets out the requirements for the testing of new high voltage ac and 1500V dc positive and negative cables.

Tests after installation are to detect defects caused during installation or during the fitting of cable accessories.

The relevant sections of this document shall also apply when:

- Repairs have been carried out on the high voltage insulation of cables.
- Terminations have been remade on high voltage cables.
- Joints have been installed in high voltage cables.
- Sections of high voltage cables have been replaced.

This document does not cover the actual testing methods. However values for High Voltage dc Test voltages are provided.

The requirements of this document shall apply from this document's Date-of-Issues.

2 References

AS 1026:	1992	Electric cables - Impregnated paper insulated- Working voltages up to and including 33 kV
AS/NZS 1429.1:	2000	Electric cables - Polymeric insulated Part 1: For working voltages 1.9/3.3 (3.6) kV up to and including 19/33 (36) kV
AS/NZS 1429.2:	1998	Electric cables - Polymeric insulated Part 2: For working voltages above 19/33 (36) kV up to and including 76/132 (145) kV
PCP 07		System Substation Commissioning Tests

3 Introduction

Before a new high voltage cable or an alteration or addition to an existing high voltage cable can be placed into service, tests shall be carried out to ensure that the process has been satisfactorily performed and the electrical integrity of the cable is maintained.

All high voltage cables are individually tested to the relevant Standard at the time of purchase and subsequent tests after installation are to detect defects caused during installation or during the fitting of cable accessories.

This publication specifies the additional tests and/or checks that are necessary to verify the performance of the installed high voltage cable including the high voltage cable accessories such as joints and terminations.

4 Tests for High Voltage Cables

Where practical tests on high voltage cables shall be carried out with the cable disconnected from all equipment including surge arresters etc. Otherwise surge arresters and voltage transformers must be disconnected and current transformers short-circuited for the test.

4.1 Electrical Continuity

Continuity of conductors, screens and metallic sheaths shall be tested using a continuity tester. The use of “earth” is to be avoided where possible as it has varying dc currents that lead to erroneous readings.

4.2 Electrical Resistance

The resistance of each conductor and screen shall be measured and recorded using four terminal instruments (Kelvin Bridge, Voltmeter/ammeter, Ductor Type Tester) with an accuracy within 0.5%.

4.3 Insulation

4.3.1 Insulation Resistance

Cable insulation levels shall be tested using a dc insulation resistance tester \geq 2.5kV.

The insulation resistance readings shall be recorded including the voltage used and nominated as either the “nominal” or “terminal” voltage used for the test.

For three core cables the insulation shall be tested between each phase conductor with the other phase conductors connected to earth.

After installation of the cable and prior to connecting the metal sheath or copper screens to earth the insulation resistance shall be measured between the metal sheath and copper screens of the cable and earth.

For single core unscreened cables (1500V negative cables) the insulation shall be tested between the conductor and earth.

4.3.1.1 New Cable Installations

The minimum acceptable insulation resistance for new cable installations shall not be less than 95% of the calculated insulation resistance based on the cable manufacturer's specifications. For three phase cables the variation between insulation resistance values of each phase conductor to earth shall be within 5% from the mean.

4.3.1.2 In Service or Recommissioned Cables

The minimum acceptable insulation resistance between phases and phases to earth for in service or recommissioned cables shall not be less than 90% of the values last recorded in the cable history. The prevailing weather conditions at the time of the test shall be recorded.

Paper Insulated Cables

If the insulation resistance is less than 90% of the last recorded values the cable shall be subjected to a high dc voltage test as specified in section 4.5.4 to verify the insulation resistance values. If the results of the high voltage dc test are acceptable no further testing is required.

Polymeric Insulated Cables

If the insulation resistance is less than 90% of the last recorded values the cable shall be subjected to a test at normal system operating voltage as specified in section 4.5.2.1. If the results of the test are acceptable no further testing is required.

4.3.1.3 Paper Insulated Cables with Sections Replaced with Polymeric Insulated Cable

Paper insulated cables that have had sections replaced with lengths of polymeric insulated cable shall be treated as polymeric insulated cable as specified in section 4.3.1.2.

4.3.2 Insulation Moisture Test for Paper Insulated Cables Prior to:

- Carrying out repairs to damaged insulation.
- Making joints in cables.
- Terminating cables.

Paper insulated cables shall be tested for the presence of moisture by immersing one or two outer and inner papers and textile fillers in insulating oil that has been heated to about 125 °C. Bubbles in the hot oil indicate the presence of moisture in the paper or textile fillers.

If any moisture is detected in the paper insulation the paper insulation shall be stripped back until there is no indication of moisture in the samples being tested. It may be necessary to remove the wet section of the cable.

This test is not applicable to 1500V negative cables.

4.4 Phase Identification Check

A phase identification check shall be carried out on all new cables to confirm that 'A' phase at the start of the cable is 'A' phase at the opposite end of the cable. This test shall also be carried out for 'B' and 'C' phases.

The phase identification check also applies to in service and recommissioned cables that have had two or more cores jointed, reterminated or disconnected from equipment.

4.5 High Voltage Test

4.5.1 New Cables

4.5.1.1 Polymeric Insulated Cables

All new polymeric insulated ac cables shall be tested by applying normal system operating voltage at power frequency (energised from one end under no load conditions) for 24 hours immediately after completion of the insulation resistance test.

All new 1500V positive cables shall be tested by applying normal system operating voltage (energised from one end under no load conditions) for one (1) hour immediately after completion of the insulation resistance test.

This test is not applicable to 1500V negative cables.

4.5.1.2 Paper Insulated Cables

The cable insulation resistance values shall be measured before this test.

All new paper insulated ac and 1500V dc positive cables shall be tested by applying a high dc voltage to each of the cable cores in turn for 15 minutes, (in accordance with Section 4.5.3) without breakdown. Any screens and other phase conductors shall be earthed.

The leakage current shall be steady and each test value shall be recorded.

After successful testing the cable shall be energised at normal system voltage from one end under no load for one hour. The electrical phase identification check may be done at this time.

This test is not applicable to 1500V negative cables.

4.5.2 In Service or Recommissioned Cables

4.5.2.1 Polymeric Insulated Cables

All in service or recommissioned ac polymeric insulated cables shall, subsequent to recommissioning or after any insulation repairs, be tested by applying normal system operating voltage at power frequency at no load for 24 hours.

All in service 1500V positive cables subsequent to recommissioning or after any insulation repairs shall be tested by applying normal system operating voltage at no load for one (1) hour.

This test is not applicable to 1500V negative cables.

4.5.2.2 Paper Insulated ac and 1500V dc Positive Cables

The cable insulation resistance shall be measured before this test.

In service or recommissioned paper insulated cables, subsequent to recommissioning or after any insulation repairs, shall have a reduced high dc voltage test applied to each of the cable cores in turn for 10 minutes (in

accordance with Section 4.5.4) without breakdown. Any screens and other phase conductors shall be earthed.

The leakage current shall be steady and each test value shall be recorded.

Tests after being decommissioned or repairs are to detect defects caused during the decommissioned period or during the fitting of cable accessories.

4.5.3 Test D.C. Voltage for New Paper Insulated Cables

The test dc voltage for new cable installations shall be as shown in Table 2 for 15 minutes.

Cable Voltage Designation	Test Voltage for New Cable
1500 V d.c. positive cables	10 kV d.c.
11 kV	25 kV d.c.
33 kV	75 kV d.c.

Table 2
D.C. Test Voltage after Installation

4.5.4 Test D.C. Voltage for In Service and Recommissioned Paper Insulated Cables

A reduced high dc voltage test shall be applied to ac and 1500V positive cables when:

- Cables are being recommissioned.
- In service cables have had the high voltage insulation repaired.
- In service cables have had sections replaced.
- In service cables have had joints installed or reterminated.

Paper insulated cable that have had sections replaced with polymeric cable shall be treated as polymeric cable as specified in section 4.5.2.1

This test is not applicable to 1500V negative cables.

The test dc voltage for in service and recommissioned cable installations shall be as shown in Table 3 for of 10 minutes.

Cable Voltage Designation	Test Voltage for In Service and Recommissioned Cables
1500 V d.c. positive cable	6 kV dc
2.2 kV	N/A
3 core 11 kV belted	9 kV d.c.
11 kV screened	15 kV dc
33 kV	45 kV d.c.

Table 3
Reduced D.C. Test Voltage for In Service Cables

Alternatively in service 1500V dc positive, 2.2kV ac and 11kV belted ac cables may have the insulation resistance measured using a 6kV dc insulation tester and 11kV ac screened cables using a 10kV dc insulation tester in lieu of the reduced high voltage dc test.

4.6 Sheath Integrity Test

A sheath integrity test (1,000V minimum insulation resistance tester) shall be applied to new or recommissioned cables with a polymeric sheath to identify post installation damage. The test shall be applied between the outer-most metallic layer and earth.

4.7 Electrical Phase Check for AC Cables

Any new or repaired cable installation that have had two (2) or more cores jointed, reterminated or disconnected from equipment, and are capable of being paralleled, or before a cable is paralleled with any other circuit, an electrical phase check shall be carried out against a known supply to verify that the cable has the correct phase relation to the system.

4.8 Phase Rotation Check for AC Cables

Before any work is commenced on a dead end cable that could effect the phase relationship, a phase rotation check shall be carried out at the remote end of the cable. A similar phase rotation check shall be carried out at the completion of the work to verify the correct phase rotation.