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Engineering Standard - NSW

Category

Electrical

Title

System Substation Commissioning Tests

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About This Standard

This publication sets out the general requirements for the testing and the recording of test results during the commissioning of a new system substation. The relevant sections of this publication shall also apply when a new item of equipment is commissioned in an existing system substation or an existing piece of equipment re-commissioned following an overhaul.

This publication does not cover the actual testing methods. It requires that the ‘tester’ determine the necessary tests and the acceptable results. However some minimum acceptable values for Insulation Resistance and Continuity tests are provided.

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1 Introduction

Before a new system substation, or a new item of equipment in an existing system substation, can be 'livened up' and placed into service, it is necessary to test and/or check all equipment to ensure that the design and construction process has been satisfactory.

All items of equipment shall be individually tested to the relevant Australian Standard at the time of purchase. Where such a standard does not exist, the method of determining the equipment's suitability shall be stated.

Section 3 of this publication specifies the additional tests and/or checks that are necessary to verify the performance of the installed equipment individually and as part of various sub-systems (eg rectifier, rectifier transformer and rectifier AC and DC circuit breakers operation as a whole).

2 Documentation of Test Methods and Results

The proposed method of carrying out all commissioning tests and the acceptable results shall be documented for each type of equipment, and submitted to ARTC for approval. The test results shall be recorded.

Absolute minimum standards for Insulation Resistance and Continuity tests are stated in Table 1 of section 4 and Table 3, of section 5, respectively.

3 Tests for Installed Equipment and Sub-systems

3.1 Description of Tests

3.1.1 Connections

All connections shall be checked for correct tightness.

3.1.2 Continuity

Continuity of circuits shall be tested with all switches and circuit breakers in the closed position. The resistance of the contacts for each pole shall be tested. Continuity of all transformer windings and tap changers shall be tested.

3.1.3 Control Voltages

Correct operation of equipment shall be tested at the minimum and maximum control voltages.

3.1.4 Earthing

Equipment earths shall be tested by measuring the resistance from the equipment earth to the substation earth mat.

3.1.5 Electrolyte

Batteries shall have electrolyte checked for correct level and density.

3.1.6 Insulation

Equipment insulation levels shall be tested using a suitable insulation resistance meter. For ac equipment, the insulation shall be tested between phases, and each phase to earth. For 1500 Vdc the insulation shall be tested between the 1500 V circuit and earth.

3.1.7 Leakage

High voltage and 1500 V cables shall be tested by applying a high dc voltage to each core for 1 minute and measuring the leakage. Any screens must be earthed. The cables are insulation tested before and after this test.

3.1.8 Oil

An oil sample shall be taken from all oil-cooled equipment and tested. The oil level shall also be checked.

3.1.9 Operation

Correct operation of equipment shall be tested in response to all automatic controls, safety interlocks, protection devices and alarms. Local and remote controls shall be tested.

3.1.10 Phase Check

All high voltage supplies shall be tested to ensure that they are in phase. All auxiliary supplies shall be tested to ensure that they are in phase.

3.1.11 Protection

Correct functioning of all protection devices shall be tested in response to all fault conditions at appropriate magnitudes. Where appropriate, this may be tested by suitable simulation techniques such as secondary injection.

3.2 Equipment and Sub-system Tests

The following is a list of equipment which must be tested in a typical system substation. Appropriate tests for equipment not listed shall be determined by analysis and submitted to ARTC for approval on an individual basis.

3.2.1 1500 V Links

Insulation, continuity, operation, earthing.

3.2.2 1500 V Bus Isolating Switches

Insulation, continuity, operation, earthing.

3.2.3 Air Break Switches, Manual

Insulation, continuity, operation, earthing.

3.2.4 Air Break Switches, Motor Operated

Insulation, continuity, operation, control voltages, earthing.

3.2.5 Battery

Insulation, voltage, connections, electrolyte.

3.2.6 Battery Charger

Insulation, voltage, connections, operation.

3.2.7 Bus Bars, Outdoor

Insulation, continuity, earthing.

3.2.8 Cables, DC

Insulation, continuity, leakage.

3.2.9 Cables, High Voltage

Insulation, continuity, leakage.

3.2.10 Circuit Breakers, AC Feeder & Bus Section

Insulation, continuity, operation, control voltages, protection, earthing.

3.2.11 Circuit Breakers, AC Rectifier

Insulation, continuity, operation, control voltages, protection, earthing.

3.2.12 Circuit Breakers, DC Feeder Sectioning Hut

Insulation, continuity, operation, control voltages, protection.

3.2.13 Circuit Breakers, DC Feeder Substation

Insulation, continuity, operation, control voltages, protection.

3.2.14 Circuit Breakers, DC Rectifier

Insulation, continuity, operation, control voltages, protection.

3.2.15 Earthing System

Visual inspection, earth resistance.

3.2.16 High Voltage Supplies

Phase check.

3.2.17 Low Voltage Light & Power Circuits

Insulation, continuity, operation, control voltages, protection, earthing.

3.2.18 Rail-Earth Contactor

Continuity, connections, operation.

3.2.19 Reactor

Insulation, continuity, oil.

3.2.20 Rectifiers

Insulation, continuity, earthing, protection.

3.2.21 SCADA system

Operation, control voltages.

3.2.22 Transformers, Auxiliary

Insulation, continuity, operation, voltage, protection, earthing.

3.2.23 Transformers, Rectifier & System

Insulation, continuity, oil, control voltages, protection, earthing.

3.2.24 Transformer, Rectifier and AC & DC Circuit Breakers as a Unit

Operation, control voltages, protection.

4 Insulation Resistance Values

The minimum acceptable Insulation Resistance values for equipment shall be as shown in Table 1.

Equipment Voltage	Test voltage of Insulation Resistance Meter	Minimum acceptable value in dry conditions @ 20° C
11 kV and above	5 kV	100 M
1500 V incl. 600 V transf. windings	2.5 kV	20 M*
415/240/120 V wiring & C.T. wiring	500 V	10 M

Table 1 Minimum acceptable Insulation Resistance

* *DC positive feeder cables shall have a minimum acceptable value of 100 M between the core and screen. A minimum value of 20 M is acceptable between the earth and screen.*

Insulation Resistance is a function of temperature. Values measured at other than 20° C can be converted to 20° C as follows:

Temperature at which measurement made	Multiply measured resistance value by
10° C	0.5
30° C	2.0
40° C	4.0
50° C	8.0

Table 2 Insulation Resistance temperature conversion

5 Continuity Test Values

The maximum acceptable resistances of closed contacts shall be as shown in Table 3.

Equipment Voltage	Resistance @ 20°C
1500 V	20
11 kV	30
33 kV and above	100

Table 3 Minimum resistances of closed contacts