

## 1. PURPOSE AND SCOPE

Provide guidelines for testing of circuit breakers.

Details of specialised circuit breaker tests are not included in this SWP.

## 2. STAFFING RESOURCES

Adequate staffing resources with the competencies to safely complete the required tasks as per MN000301R165: 8 Level Field Test Competency.

These competencies can be gained from, but not limited to any or all of the following:-

- Qualifying as an Electrical Fitter Mechanic
- Qualifying as a Technical Service Person
- Training in the safe use of relevant test equipment

Requirement for all live work:

- Safety Observer (required for all “live work” as defined in the ESO Code of Practice for Electrical Work).

All resources are required to:

- Have appropriate Switching and Access authorisations for the roles they are required to perform and have the ability to assess and maintain relevant exclusion zones from exposed live electrical apparatus
- Hold current licences for any vehicles and equipment they may be required to operate.

### **Required Training**

Staff must be current in all Statutory Training relevant for the task.

All workers must have completed Field Induction or have recognition of prior Ergon Energy Field Experience.

Contractors must have completed Ergon Energy's Generic Contractor Worker Induction.

## 3. DOCUMENTATION

CS000501F115. Daily / Task Risk Management Plan

ES000901R102. HSECH Risk Control Guide

MN000301R165. 8 Level Field Test Competency

SP0509R01. Circuit Breaker Testing Job Safety Analysis

SP0509C01. Circuit Breaker Test Report

SP0509C01R01. Circuit Breaker Sample Test Report

SP0509C02. Circuit Breaker HV Withstand Test Report.

SP0509C03. Circuit Breaker Testing Competency Assessment

SP0506. Substation Primary Plant and Secondary Systems Field Testing SWP

AS 1931 – 1996 – High Voltage Test Techniques Parts 1 and 2

AS 2006 – 1986 – High Voltage A.C. Switchgear and Controlgear – Circuit Breakers for Rated Voltages Above 1,000V

AS 2650 – 1986 – High Voltage A.C. Switchgear and Controlgear – Common Requirements

AS 2467 – 1981 – Maintenance of Electrical Switchgear  
Test Equipment Manual

Circuit breaker Manual / Manufacturer's Drawings

## 4. KEY TOOLS AND EQUIPMENT

Test Equipment within calibration date, tested and tagged

## Safety Barriers

HVIA Operating Equipment – PED's, Live Line Tester, Class 0 gloves. All equipment to be inspected and confirmed within test date prior to use

PPE including full-length protective cotton clothing, safety footwear, helmet. Additional PPE as required: brim for safety helmet, leather work gloves, class 00 gloves, hearing protection, safety eyewear, high visibility clothing when working on or near roadways. All PPE to be inspected and confirmed within test date (where applicable) prior to use

Sun protection to be used when working outdoors

## 5. TASK STEPS

### 5.1. Carry out an on site risk assessment

Prior to performing this activity any hazards associated with prerequisite tasks at the worksite shall be identified and assessed with appropriate control measures implemented and documented in accordance with the [Daily/Task Risk Management Plan CS000501F115](#) and using reference document [HSECH Risk Control Guide ES000901R102](#).

If any risks cannot be managed or reduced to an acceptable level, do not proceed with the task and seek assistance from your Supervisor.

### 5.2. All work to be done with circuit breaker de-energised

All of the tests described in this SWP should be carried out with the CB de-energised and appropriate control measures in place (eg barriers, matting) to prevent inadvertent contact with adjacent live plant or breaching exclusion zones. Furthermore, the P53 Operate the Network Process is applicable at all times for isolation and earthing.

Careful consideration should be taken with the selection and placement of test leads. Only use appropriately rated test leads that are placed to be clearly visible to reduce the risk of them being not seen and removed prior to placing plant back into service. Where possible, use leads that are supplied with the test equipment since these will have suitable connectors and the correct current and voltage rating. Leads should be selected and used such that it is not possible to leave leads connected to the plant under test when the test equipment is removed (for example an integrated lead set or trifurcated leads).

As described in Carry Out Field Testing SWP SP0506, particular safety risks applicable to Circuit Breakers include:

- Contact with high voltage at CB primary connections.
- High fault current at CB primary connections.
- Stored energy (eg charged spring) in the closing and tripping mechanism
- Initiation of other protection or control functions by change in state of circuit breaker auxiliary contacts

### 5.3. Record identification details.

- Manufacturer's name, manufacturer's type description and manufacturer's serial number;
- Plant number;
- Description, ie. dead tank, live tank etc;
- Rated voltage and insulation level;
- Rated nominal and short-circuit current and duration;
- Rated operating sequence;

- Interrupting medium;
- Specialised requirements such as:

Rated Transitional Recovery Voltage envelope, Rated Out of Phase Breaking Current, Rated Cable Charging Breaking Current, Rated Capacitor Bank Breaking and Inrush Making Currents, Rated Small Inductive Breaking Current.

#### 5.4. Visual inspection of Circuit Breaker condition.

Inspect the circuit breaker for any sign of damage or leaks both externally and in the circuit breaker marshalling box. Confirm that the interrupting medium level/pressure is correct before commencing tests and that assembly is complete and no transport bracing has been left in place.

Inspect the external surfaces and ensure the circuit breaker is clean and dry.

Check all connections for adequate labelling. The connections should be unambiguous, legibly and adequately marked.

#### 5.5. Auxiliary and Control Circuit Voltage Withstand.

The circuit breakers auxiliary and control circuitry shall be subjected to a 1 minute power frequency withstand test at 2kV to confirm insulation integrity.

The circuitry shall be considered to have passed if no disruptive discharge occurs during the test.

Consideration shall be given where electronic components are used in the auxiliary and control circuitry. Different testing procedures and values maybe adopted subject to agreement by the Commissioning Engineer.

#### 5.6. Measure Resistance of the Main Circuit.

Measurement shall be made using D.C. current of at least 50A and less than the nominal current rating of the circuit breaker. The test shall be conducted as close as practical to ambient temperature.

A four wire ductor should be used for measuring the resistance of the main contacts.

#### Measure Insulation Resistance.

DC insulation tests are to be carried out between terminals of the circuit breaker as detailed below. Note that these connection arrangements have been specified for consistency with AS2650 and to allow for future insulation condition diagnostic assessment. The voltage applied will be as per Table 1 for a duration of 1 minute.

With the circuit breaker in the closed position:

- A or a to Earth and all other terminals
- B or b to Earth and all other terminals
- C or c to Earth and all other terminals

With the circuit breaker in the open position:

- A to Earth and all other terminals
- B to Earth and all other terminals
- C to Earth and all other terminals
- a to Earth and all other terminals
- b to Earth and all other terminals
- c to Earth and all other terminals

A, B and C refer to one set of CB high voltage terminals (eg fixed contact – top of CB) and a, b, and c refer to the other set of terminals (eg moving contact – middle of CB)

Minimum acceptance value for new plant is 1,000M $\Omega$ .

**Table 1. Applied Voltages for IR Tests**

Primary Voltage Rating	Test Voltage in kV (D.C.)
Up to 1kV	1
Above 1kV to 3.6kV	2
Above 3.6kV to 12kV	5
Above 12kV	10

## Measure Timing.

The time taken for the circuit breaker to complete an operation shall be measured for both opening or closing. Timing should be started by the application of voltage to the trip/close coil and stopped by operation of the main contacts. For both single and three pole CBs, each pole is timed independently as per clause HH2.4.2.1 of AS2006 - 1986

**Note** – test both trip coils. Time travel measurement is required for 110 kV and above CBs or any CBs assembled on site.

Measure spring charge time following close operation.

## 5.7. Carry out HV Testing.

AS 2006 – 1986 specifies that normally no dielectric tests are performed at site on the main circuit, however AS 2067 – 1984 specifies that a 90% power frequency withstand test be carried out

on site after erection. The level of high voltage testing to be applied is therefore:

- Where no HV testing has been carried out at the manufacturer's works – 100%.
- Where HV testing has been carried out at the manufacturer's works but subsequent assembly of the HV chamber / bushings is required on site – 90%.
- Where HV testing has been carried out at the manufacturer's works and no on-site assembly is required – No HV withstand test.
- If the circuit breaker is aged or refurbished – 75%.

Where  $U_m \leq 66\text{kV}$  the value of voltage applied shall be as per AS 2650-1986 as listed in the table below.

Where  $U_m > 66\text{kV}$  the value of test voltage shall be in accordance with AS 2650-1986.

Note that the test voltage used may be limited by the output capability of the test equipment. In this case a reduced test voltage for an extended duration as specified in Table 11.1 of AS 2067 – 1984 may be used.

The requirements of the test are satisfied if no disruptive discharge occurs.

An insulation resistance test is to be repeated after the HV withstand test to confirm that insulation degradation has occurred.

Application of a 1 minute power frequency withstand test is to be in accordance with AS1931 Part 1 between the load and line terminals of the circuit breaker as detailed below. Note that these connection arrangements have been specified for consistency with AS2650 and AS2006 (Clause 7.1).

# CIRCUIT BREAKER TESTING SWP



With the circuit breaker in the closed position:

- A/a and C/c to Earth and all other terminals
- B/b to Earth and all other terminals

With the circuit breaker in the open position.

- A, B and C to Earth and all other terminals
- a, b and c to Earth and all other terminals

Nominal voltage of system (Un) kV r.m.s.	Highest Voltage for equipment (Um) kV r.m.s.	Rated Short term Power-frequency withstand voltage (PFVV) KV r.m.s.
3.3	3.6	10
6.6	7.2	20
11	12	28
22	24	50
33	36	70
66	72.5	140

## Schedule of Tests

The table below details the circumstances in which different tests are carried out:

Test	New Circuit Breaker	Aged or refurbished Circuit Breaker
High Voltage Withstand	Workshop or on-site test required at discretion of Commissioning Engineer *.	Workshop or on-site test required. Reduced values apply.
Auxiliary and Control Circuit Voltage Withstand	Review manufacturers test result only	On-site test required if circuit breaker wiring has been substantially modified
Insulation Resistance	On-site test required	On-site test required
Resistance Of Main Circuit	On-site test required	On-site test required
Timing	On-site test required	On-site test required
Time Travel	Required for transmission CBs or CBs assembled on site	Required for transmission CBs or CBs assembled on site

\*otherwise review manufacturer's results only

DDF and capacitance measurement of the CB insulation may be required at the request of the client, particularly if DLA test equipment is available on site at the time of commissioning.

## 5.8. Complete Pre-commissioning Checklist

Circuit breakers being placed in service for the first time or after refurbishment require that the following items are checked prior to energisation:

- a) Check closing with 85% normal supply volts;
- b) Check closing with 85% normal air pressure;
- c) Check tripping with 70% normal supply volts (85% if AC);
- d) Check insulation medium/pressure;
- e) Check gas pressure alarm;
- f) Check gas pressure trip/lockout;
- g) Check fuses and links in service position;
- h) Check main earth on cabinet and support structure;
- i) Check motor overload/excess run timer set;
- j) Check local trip operation, including operation with both trip coils in parallel;
- k) Check local close operation;
- l) Check remote trip operation;
- m) Check remote close operation;
- n) Check SCADA trip operation;
- o) Check SCADA close operation;
- p) Check protection trip operation;
- q) Check protection reclose operation;
- r) Function test all Local/Remote/Maintenance switch;
- s) Check operation of pole discrepancy protection (if fitted);
- t) Check anti-pumping relay operation ie apply a close command and then a trip command while the close is maintained;
- u) Apply a latched trip command and then a close command while the trip is maintained;

- v) Check operation of interlocks;
- w) Check operation of all alarms;
- x) Check control switches in service position;
- y) Check operational nameplate and labels are in place.