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National Grid
Commissioning
Handbook
Procedure

Current Transformers

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CURRENT TRANSFORMERS

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1	J Aspinall	H Habibollahi	Original	Jan 98
2	M Mundell	N Tart	CT testing requirements updated in line with TP106/106A & TP107/107A	Dec 08
3	N Tart	K Harker	CT testing requirements updated following operational incident learning	Jan 10
4	D Kerven A Hackett	K Harker	Requirements updated to include preferred use of automated CT analyser equipment and learning points following an operational incident	Apr 13

1. Purpose

This Handbook describes the tests to be carried out on current transformers during both stage 1 and stage 2 commissioning (TP106).

The purpose of the CT commissioning tests is to prove that the equipment supplied is in accordance with requirements detailed in the design documentation and the CT has not been damaged in transit. In addition, commissioning tests are required to confirm the integrity of the CT following installation and fitting of primary connections, to ensure errors and damage have not been introduced, which may affect the performance of the CT and connected protection schemes.

The following tests must be carried out with strict adherence to ensure the integrity of the CT installation including the associated secondary circuits. Numerous system incidents have been encountered in the past relating to incomplete commissioning practices in this area.

2. Hazard Warning

The driving flux of a CT is always present when load current is flowing and therefore, if the secondary load is inadvertently disconnected (open circuit), very high voltages will be developed across the secondary winding with the risk of injury to personnel and damage to the equipment. Even with the primary circuit out of service a hazard may still be present because of the potential for current to flow in the CT in the event of a system fault or if the primary circuit is Earthed for maintenance (NSI12).

3. Plant Inspection

Inspection of new CTs prior to installation should be undertaken to confirm the name plate details are correct and in accordance with the design documentation, including ratio, class and thermal ratings. In addition confirm that the manufacturer's factory test documentation and certificates have been supplied with new equipment and are available for reference during site commissioning tests.

Post-installation, examine the CT group/post in order to ensure integrity of primary

and secondary connections. Confirm correct CTs have been installed in the correct equipment location, with the correct polarity orientation.

Inspect the CT giving particular attention to damage, equipment earthing, mounting and clamping arrangement and any required insulation collars and isolation gaps. Appendix 3 provides examples of installation defects to be aware of which resulted in mal-operation of protection.

Carry out an inspection of the CT secondary circuits, confirming that the correct CT ratio tap has been wired out, the integrity of star point connections and the CT secondary circuits is earth at one point, only, via a link.

Trace the CT secondary wiring of each CT core through the complete secondary circuit, including kiosks, wall boxes, panel terminal blocks and relays, confirming that the CT is not open circuit.

Where applicable for new build and asset refurbishment, confirm that satisfactory facility has been provided for application of temporary CT shorts and isolation has been provided in accordance with TS 2.19 and DH01 requirements.

4. Test Procedure

All of the following tests should be carried out on newly installed CTs.

Following modification work to the secondary wiring of existing CTs, (i.e. protection changes), not all tests are necessarily required – see section 4.9 below. Special attention should be given to inspection of secondary circuits and overlap testing to identify any inadvertently open circuited CT's, as discussed in Section 4.10.

During preparation of the Commissioning Schedule (TP106 and Commissioning Handbook 1), attention should be given to the staging of the equipment installation and scheduling of the CT tests. Particularly for transformer turret CTs and GIS trunking CTs where any corrective works may require disassembly of equipment and incur high cost and extensive project delays.

4.1 Commissioning tests for Protection type PX and P class CTs (to NGTS 3.2.4)

It is the intention that normal commissioning practice for CT testing shall be undertaken with CT Analyser test equipment as injection voltages are limited to safe working voltages and consistent comparable test reports are produced. The CT Analyser can carry out all tests required by this commissioning handbook including CT ratio, polarity, resistance and magnetising curve tests. The test can be set to run

in a single automated sequence or performed as individual tests.

In circumstances where CT Analyser test equipment is not available, conventional magnetisation curve, winding resistance and polarity tests may be undertaken. If the conventional test equipment can not achieve full knee point voltages advice should be sought from the Settings Engineer (Assurance) to confirm if partial magnetisation curves tests will be acceptable for the protection scheme. In all cases, the test equipment should be capable of a test voltage up to at least 1000V and manufactures factory tests results should be available for comparison.

4.2 Commissioning tests for Settlement Metering Class S CTs (to NGTS 3.2.6)

Commissioning tests for Settlement Metering Class S CTs shall include ratio and polarity tests, only. The CT ratio test should be undertaken by conventional primary injection tests and results recorded in SCT 20.2.

Note, CT magnetising curve tests are not required for Class S Metering CTs.

4.3 Test Method

Initial CT tests should be undertaken prior to installation (ie. while CT is still stored in transport packing). This is to confirm that the supplied CT's are correct and have not been damaged in transit. The CT should be tested from the CT terminals and tests should include ratio, polarity, winding resistance and magnetising curve tests.

Where the CT under test forms part of a multiple CT pack the secondary winding of the CT's not under test should be temporarily shorted.

For multi-tap ratio CTs, tests should be undertaken across the whole CT secondary winding (maximum CT ratio tap).

For CT installations where inspection can not adequately determine presence of installation errors, (for example wall bushing CTs, GIS trunking CTs and SGT turret CTs) magnetising curve tests are required to be repeated following completion of site installation and fitting of primary connections. This is to ensure that the integrity and/or performance of the CT has not been compromised by the installation process or CT mounting arrangements (see Appendix 3 for examples of incorrect installation).

Typical CT installations where repeat magnetisation tests may be deemed not necessary include Post CTs and SGT tank mounted single core neutral CTs.

The minimum requirement for the repeat magnetisation curve test on a multicore CT pack is;

- 1) Magnetisation curve test is undertaken on at least one CT core within the pack, with preference for the outer Class PX Type B CT (typically Core 5)
- 2) The magnetisation curve test is undertaken at the CT terminal box prior to connection of the secondary wiring

Where it is not possible to test at the CT terminal box, an alternative test point should be agreed and recorded in the Commissioning Test Schedule, giving consideration to safe access, isolation of other connected CTs in CT secondary circuits, disturbance of secondary wiring and location of the wiring of the other CT Cores within the CT pack being tested.

As above, where the CT under test forms part of a multiple CT pack the secondary winding of the CT's not under test should be temporarily shorted. The purpose of this is to confirm the absence of an independent primary shorted turn which, if present, is identified by a significant increase in the magnetising current in the CT under test. Appendix 4 shows an example of CT magnetising curve test results for a healthy CT with and with-out primary shorted turns.

It should be noted that the applied CT ratio for the repeated magnetising curve test may be different to the test undertaken across the whole secondary winding. In this case the magnetisation curve test results should be scaled for comparison manufactures factory tests results.

For certain site installations it may be feasible to gain access to the CT terminals following site installation and connect test leads to both CT primary and secondary terminals. In this case it is acceptable that full CT tests are undertaken once. However consideration should be given to risk of high cost to disassemble equipment to gain access to correct any unacceptable CT installations (for example: transformer turret CTs and GIS trunking CTs).

The CT Analyser test report should be attached to SCT 20.1 and sections 1, 2 and 3 of SCT 20.1 completed. This includes entry of the CT secondary winding resistance corrected to 75°C and calculation of TS 3.02.04 knee point requirements.

4.4 Winding Resistance

The CT winding resistance measurement is included in the tests completed by CT

Analysers test equipment. Prior to test, the ambient temperature is required to be measured and entered into the input parameters of the test equipment. The test report details the corrected CT winding resistance at 75°C.

If conventional winding resistance measurements are being undertaken, results should be corrected to 75°C.

The test result for the CT winding resistance corrected to 75°C should be recorded on SCT 20.1 for calculation of TS 3.02.04 knee point requirements and determination of the Pass/Fail criteria.

4.5 Polarity Test

The CT polarity test is one of the tests completed by CT Analyser test equipment and the result is detailed in the test report.

If conventional tests are being undertaken then carry out a flick test, as detailed in Appendix 1.

The CT polarity test result, from either test method, should be recorded in SCT 20.1 Section 2.

Note that polarity test should be undertaken on all transformer turreted CTs and GIS trunking CTs prior to installation.

4.6 Magnetising Curve

For both CT Analyser and conventional magnetisation tests, **the CT secondary's of cores which are not subject to testing should have temporary shorts applied.**

Magnetisation curve test should be undertaken on each CT core using CT Analyser test equipment.

The CT Analyser should be input with the CT parameters detailed on the CT nameplate, including the CT class and IEC standard for test, as below.

Input parameter	PX-A	PX-B	Measurement / Protection	Settlement Metering
	TS 3.02.04			TS 3.02.06
Core Type	Protection CT	Protection CT	Protection CT	Magnetisation curve tests not required for settlement metering CTs
Class	PX	PX	5P20	
Ratio	CT ratio being tested	CT ratio being tested	CT ratio being tested	
Ambient temperature	t°C measured temperature	t°C measured temperature	t°C measured temperature	
R _{CT}	R _{CT} ¹ (Ω at 75°C)	R _{CT} (Ω at 75°C)	-	
Knee point voltage V _k	V _k (V)	V _k (V)	-	
Magnetising current I _e	I _e ¹ (mA at V _k)	I _e (mA at V _k)	-	
Nominal Burden	-	-	VA	
IEC Standard	60044-1	60044-1	60044-1	

Note 1: Enter ? into the CT Analyser input for parameters not specified

The CT Analyser test report should be attached to SCT 20.1 and filed in the commissioning file.

If conventional magnetisation tests are being undertaken, as detailed in Appendix 2, the results should be recorded in SCT 20.1 Section 4.

4.7 Insulation Resistance

Carry out Insulation Resistance test at 500V using electronic or brushless test equipment and record results on SCT 20.04.01 Form.

Confirm single point earthing on the CT secondary wiring and remove earth link on the CT circuit being tested, only. All other CT earth links should be in position during test.

4.8 Primary Injections