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National Grid
Commissioning
Handbook
Procedure 19

**Primary and Secondary Injection Of
Double Wound Transformers and their
Main Protections**

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1 PURPOSE

The purpose of this procedure is to provide a model process for the checks and tests to be performed on double or triple wound power transformers. It specifies minimum requirements and may be added to by the contractor when devising test programmes. These checks and tests are required to ensure that:

- The transformer is correctly phased to the HV, LV and tertiary systems
- The protection equipment is correctly aligned in phase and magnitude with its associated power transformer.

2 GENERAL OVERVIEW

This commissioning handbook assumes that the transformer primary and protection configurations are generally in line with TPS 5/11 Protection Arrangements for Transmission Plant on 400 and 275kV Systems – Part 3.

Figures A1 to A3 and B1 to B3 show typical schemes.

Although it is recognised that protection schemes may not exactly match those shown, it is likely that many transformers will have systems that comply. Further, the principles herein will provide a general guideline to be applied for most situations.

3 PROCEDURE

3.1 General

In accordance with TP 106, a two stage commissioning procedure is required. Checks on the correct installation and functioning of the new scheme are undertaken in Stage 1. Connection to the system, and consequent load and conjunctive tests are carried out in Stage 2.

3.2 Phasing Diagram

Consult the transformer nameplate diagrams and overall A.C. main connections and protection circuit diagrams to establish phase connections to produce a phasing diagram. These should be similar to the figures given at the end of this document.

Checks should be carried out to establish at the outset the relative phasing of the National Grid and customer's supply systems. For example in some parts of the country the 66kV REC network is 120° displaced and the National Grid's R-Y-B phase sequence becomes Y-B-R. Although the transformer nameplate will indicate it is a Yy0, its transposed phase connections correspond to Yy8!

3.3 Protection Scheme Variations

Two alternative protection arrangements for double wound transformers are described in this document:

- A) Conventional transformer HV-LV biased differential protection with separate HV and LV Restricted Earth Fault (REF) protection (Figs. A1 & A2). LV phase CTs are normally mounted in the switchgear.
- B) HV REF plus a separate LV Overall Differential Protection (i.e. no transformer overall protection). Applied typically on steelworks supplies where harmonic bias may not be suitable. (Figs B1 - B3). LV phase CTs are mounted inside the transformer tank and in the LV switchgear.

These two should cover most installations. If other protection arrangements are provided the principles outlined in this document should be adapted to suit the installation. The figures attached are typical only and care should be taken to check against the actual site schematic drawings.

The delta tertiary winding on an auto transformer (if used) constitutes a second winding. The CTs and protection associated with it will need to be testing using the principles outlined in this document where appropriate.

Numeric transformer protections are now being installed which have integral Biased Differential and REF functions. These usually allow for CT ratios and vector groupings to be selected in the software settings. However it is essential to prove the CT ratios and grouping using the general principles outlined in this document. Great care is needed to select the correct HV and LV Interposing CT software settings.

Note

The transformer manufacturers use terminal phase designations A, B & C (or R, S & T). These do not necessarily relate to the system phase colours Red, Yellow & Blue respectively.

Relay manufacturers use A, B, C (or other designations). These will usually correspond to the system phase colours Red, Yellow & Blue but may not relate to the transformer terminal phase designations.

3.4 Primary Injection

3.4.1 Stage 1: Preliminary Tests and Considerations

General guidance on commissioning protection equipment is given in Site Commissioning Test (SCT) Schedule 01.

The vector grouping of the power transformer itself should have been ascertained using the method outlined in SCT Schedule 15, Section 4.3.

Current Transformer 'flick' tests using a 1½ V battery should have been carried out at an early stage on all CTs to establish the correct identity and phasing of primary, secondary and test winding terminals (P1, P2, S1, S2 etc). Refer to Commissioning Handbook 6 for details.