

Disclaimer

Copyright © National Grid plc 2011, all rights reserved

This information should not be forwarded to third parties.

WINDING TEMPERATURE INDICATOR (WTI)

TABLE OF CONTENTS

PURPOSE AND SCOPE.....	1
PART 1 – PROCEDURAL	1
1 FUNCTIONAL REQUIREMENTS	2
2 SETTINGS.....	9
3 COOLER MONITORS AND ALARMS.....	9
4 TEST REQUIREMENTS	10
5 TYPE REGISTRATION	10
6 FORMS AND RECORDS	10
PART 2 - DEFINITIONS AND DOCUMENT HISTORY	10
7 DEFINITIONS	10
8 AMENDMENTS RECORD	10
9 IMPLEMENTATION.....	11
PART 3 - GUIDANCE NOTES AND APPENDICES	11
10 REFERENCES	11

PURPOSE AND SCOPE

The Technical Specifications for all new plant, equipment, apparatus and services, for use on the National Grid UK Electricity Transmission system are contained in a three level hierarchy of documents. Level 1 covers ratings and general requirements, Level 2 covers major plant categories and Level 3 covers specific related plant functions.

This document is a Level 3 specification, which describes the functional and performance requirements for Winding temperature indicators (WTI) to be used in all liquid immersed Power Transformers, Reactors and Quad boosters at National Grid switching stations.

The document is intended to cover both WTI systems provided as part of an overall transformer installation contract and individual supply of WTI equipment for retro-fit or repair purposes. When considering individual WTI equipment supply, requirements that are clearly written to address overall transformer installation issues should be disregarded – where there is any doubt as to the applicability of any part of this document, clarification must be sought from National Grid.

This document permits the offering of both electro-mechanical and electronic WTI solutions, where electro-mechanical solutions have electronic elements incorporated to achieve the overall functionality required, any such electronic elements shall also comply with the relevant parts of this specification as written for electronic WTIs.

PART 1 – PROCEDURAL

TS 2.03 states that the cooler fans and pumps for Transformers, Reactors and Quad boosters immersed in liquid are to be normally controlled by a WTI (OFAF/OFAN/ONAN). This is to achieve the following prime purposes:

- To start and stop the fans and pumps on rising and falling transformer temperature.
- To provide alarms and/or trip signal should the transformer be subject to overloading or suffer cooling equipment failure to protect it from excessive heat and development of gas bubbles which in turn cause premature ageing of transformer insulation and may lead to premature failure of the transformer itself.

1 FUNCTIONAL REQUIREMENTS

1.1 General Requirements

The WTI system shall have the following analogue inputs:

- a) Top oil temperature
- b) HV (Series) winding current input
- c) LV (Common) winding current input
- d) TV (Tertiary) winding current input (if the Tertiary winding is used)
- e) Cooler state indicator for gradient switching
- f) Bottom oil temperature or Ambient temperature

Informative: Bottom oil or Ambient temperature is required for new transformer installation.

The system shall generate the following outputs:

- g) Cooler stage 1 control
- h) Cooler stage 2 control
- i) Alarm for hotter of the HV (series) or LV (common) windings hot spot temperature
- j) Trip for hotter of the HV (series) or LV (common) windings hot spot temperature
- k) Alarm for the Tertiary winding hot spot temperature.
- l) Trip for the Tertiary winding hot spot temperature.
- m) Cooler fan fail alarm
- n) Cooler pump /fans fail alarm
- o) Cooler monitor faulty alarm

Informative: The functionality can be provided with one WTI unit or with multiple discrete WTI units.

The WTI shall be capable of measuring and displaying the corrected winding hot spot temperature accurately between 0°C and 180°C

The WTI instruments shall have a minimum Ingress Protection (IP) rating of IP54 if installed in Marshalling Kiosk (MK). If installed in a protection block house then an IP rating of IP50 will be acceptable.

All ancillary devices supplied with WTI instrument shall adhere to the above IP ratings.

The WTI instruments shall be capable of operating between -25°C and 50°C ambient temperature.

The WTI system shall have an anticipated design life of at least 20 years.

The WTI system shall be RoHS (Restriction of Hazardous Substances Directive) compliant.

1.2 Accuracy Performance

The WTI solution along with the instrument, contacts and temperature sensing probe shall have an accuracy of $\pm 1.5\%$ for full scale range and the indicated temperature shall reflect the calculated hot spot temperature to within 2°C under all conditions including overload and including all possible cooler states. Where OD (directed oil flow) cooling is used the hotspot gradient must change when the pumps are stopped to reflect accurately the hotspot temperature under ON (non-directed oil flow) conditions.

1.3 Step Function

The WTI solution shall be provided with a step function that switches the cooling on at a pre-defined HV (series) or LV (common) winding load current irrespective of temperature and maintains the cooling on for a set period even if the load drops below the threshold in this period. This function is in addition to the winding hot-spot temperature based cooler control function.

This functionality shall be user configurable for threshold load and on period.

A typical setting for this function is to switch on at 80% of full load winding current and for the cooling system to remain on for 90 minutes after the initiation.

1.4 Hot Spot Gradient

The hotspot temperature shall be calculated according to the IEC 60076-7 standard based on the top oil temperature and the winding load current and the winding hotspot gradient (appropriate to the cooling condition) for each of the three windings separately.

The WTI shall be capable of recognising the oil flow status from a digital input and changing the hot-spot gradient used in the hot-spot temperature calculation depending on whether ON or OD cooling conditions exist in the transformer.

Ammeters are required to indicate the currents in each WTI CT secondary circuits, and a switch for each WTI CT circuit is required to enable the WTI calibration to be safely checked by current injection with the transformer on load.

Informative: If the CT secondary current is indicated by the WTI itself then a separate ammeter is not required.

1.5 Auto Cooling Facility

The WTI solution shall be capable of initialising a weekly automatic test run of the pumps and fans to ensure the integrity and the availability of the cooling system. In the case of failure of either a pump and/or a fan during the test, the WTI solution shall be configured to annunciate alarms at the local Substation Control System (SCS) and at the remote ENCC (Electricity National Control Centre).

There should be at least a six hour interval between initialising the auto test functionality on different transformers situated in same site. Where this setting is not practical, advice should be obtained from ENCC to ensure adequate security of supply is maintained in case a cooler test unexpectedly initiates a transformer trip.

For sub-zero weather conditions the WTI shall be able to inhibit the auto cooling test functionality. However, this function shall not affect the other functionality of the WTI. The settings for this functionality shall be user configurable.

Informative: The inhibition of auto cool testing facility is required to ensure no oil surge, pump trip or electrostatic charging is introduced by initiating the pumps when the oil is very cold. On some transformer designs mal-operation of the Buchholz relay due to oil surge under