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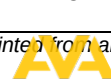
A Continuous Monitoring System For Partial Discharge In Gas-Insulated Substations

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A CONTINUOUS MONITORING SYSTEM FOR PARTIAL DISCHARGE IN GAS-INSULATED SUBSTATIONS

FOREWORD

This Technical Guidance Note states the technical requirements for continuous monitoring systems for partial discharge in GIS using the UHF method.

1 INTRODUCTION

National Grid has a number of gas-insulated substations (GIS). While their reliability is high, any failure of the insulation system is likely to be a costly event. In most cases, such failure is caused by defects which generate partial discharge activity for some time before complete failure occurs. The UHF method of Hampton and Meats [a] is an effective means of detecting partial discharge in GIS so that action may be taken to prevent failures. In the UHF method, couplers installed at intervals round the GIS are monitored to detect UHF energy radiated by discharging defects. Monitoring has been performed in periodic site surveys by engineers using portable instruments. More recently, systems have been developed that provide continuous monitoring of a GIS and which are connected to a headquarters location by telecommunications link. The continuous monitor is able to detect and store information on defects which might be missed by periodic monitoring, such as those that discharge intermittently or develop between surveys and is therefore the more effective means of monitoring. In comparison with periodic site surveys, the continuous monitor makes minimal demands on the engineers' time. The system operates unattended and an engineer need only intervene when the system signals that a discharge has been detected. The master station for the system is located at the headquarters location and receives data from a number of out stations located at substations with GIS.

2 GENERAL

The continuous monitoring system comprises Out Stations at a number of substations and a Master Station at a headquarters location. Further Out Stations and Master Stations may be added to the system in the future.

At an Out Station, a Partial Discharge Detection Network collects partial discharge data from the monitored couplers. The partial discharge data is stored locally and transferred automatically to the Master Station at intervals. The transferred data is stored at the Master Station.

It is important that the System monitors effectively while making minimal demands on the operator's time. In order to achieve this, the System will indicate to the operator at the Master Station when the transferred data indicates partial discharge behaviour which requires his attention. On receiving such an indication, the operator will retrieve and display partial discharge data from the coupler concerned to enable him to decide on action to be taken.

The partial discharge data will be displayed in a way that allows the operator to recognise the type of defect present. It will be necessary to be able to recognise partial discharge signals when signals due to switching operations are also present and to be able to distinguish between partial discharge signals and external sources of interference.

It will also be necessary to be able to retrieve and display data in a way that allows the operator to look for changes in the discharge behaviour that might indicate an escalation in severity (trend analysis).

It will be possible for the operator at the Master Station to interrogate an Out Station manually and display partial discharge data in real time.

Access to partial discharge data and system administration functions will be protected by password.

The technical specification for a continuous monitoring system for partial discharge in gas-insulated substations is attached as Appendix A. It is intended that this specification be used in conjunction with schedules defining the hardware requirements by site (eg the number and position of coupling devices to be connected) and the appropriate commercial conditions.

3 REFERENCES

- (a) Hampton, B F and Meats, R J, "Diagnostic measurements at UHF in gas-insulated substations", IEE Proc, Vol 135, Pt C, No 2, March 1988

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APPENDIX A

TECHNICAL SPECIFICATION FOR A CONTINUOUS MONITORING SYSTEM FOR PARTIAL DISCHARGE IN GAS-INSULATED SUBSTATIONS

FOREWORD

This document states the technical requirements for a continuous monitoring system for partial discharge in GIS using the UHF method.

A1 SCOPE

This document specifies the technical requirements for continuous monitoring systems for partial discharge in GIS using the UHF method. The document applies to equipment located at a substation site and equipment located at a headquarters site. Where a continuous monitoring system is expanded to include equipment at additional substation or headquarters sites, the relevant parts of the document shall apply.

The technical requirements for partial discharge couplers for detecting UHF signals form the subject of TGN(T) 121 and are not covered in the present document.

A2 REFERENCES

A2.1 International Electrotechnical Commission (IEC)

BS EN 60529 "Degrees of protection for enclosures (IP Code)"

A2.2 International Telecommunications Union/ITU Telegraph & Tel

ITU-T Recmn V.90 A digital Modem and Analogue Modem Pair for Use on the Public Switched Telephone Network (PSTN) at Data Signalling Rates of Up to 56 000 BIT/S Downstream and Up to 33 600 BIT/S Upstream - Series V: Data Communication Over the Telephone Network - Simultaneous Transmission of Data and Other Signals

A2.3 National Grid

- NGTS 1 National Grid System Overview
- NGTS 3.1.2 Substation Earthing
- NGTS 3.7.28 Uninterruptible Power Supplies for Substation Control and Protection Systems
- NGTS 3.12.3 Substation LVAC Supplies
- NGTS 3.12.4 48 V and 110 V D.C. Supplies
- NGTS 2.13 Electronic Equipment
- NGTS 3.24.1 Substation Information Control and Protection Local Area Network
- TGN(T) 121 Capacitive Couplers for UHF Partial Discharge Monitoring

A3 DEFINITIONS

A3.1 Continuous Monitoring System

The configuration of a Partial Discharge Detection Network, Master Station, Out Stations and software systems connected together via a communications network to collect partial discharge data from monitored equipment. The subsequent display and analysis of that data to assist in the diagnostic determination process as to the present and future condition of the monitored equipment.

A3.2 Mass Data Storage Device

A peripheral device to store large quantities of data such as an optical disk or magnetic tape device.

A3.3 Master Station

The configuration of hardware (including data storage peripherals) and software that receives incoming data from the Out Station(s). There may be more than one Master Station.

A3.4 Out Station

The configuration of hardware, peripherals and software that controls and is directly connected to the Partial Discharge Detection Network to collect partial discharge data. There may be any number of Out Stations connected to a Master Station.

A3.5 Partial Discharge Detection Network

A network of data acquisition and communication equipment and associated cabling connected to the plant being monitored to deliver data from the partial discharge couplers to the Out Station.

A3.6 Work Station

Generic term relating to a PC and peripherals configured and arranged to allow the system and operator to function in a safe and efficient manner.

A3.7 Change In Partial Discharge Detected

A non-urgent alarm generated when the behaviour of detected partial discharge activity should be brought to the operator's attention, although no risk of failure is indicated at present.

A3.8 Partial Discharge Level Alarm

An alarm generated when the behaviour of detected partial discharge activity indicates a risk of failure.

A4 GENERAL REQUIREMENTS

System Description

Informative: The System is shown schematically in Figure 1.

A4.1 The System shall be a Continuous Monitoring System for partial discharge in Gas Insulated Switchgear (GIS) using the Ultra High Frequency (UHF) method.

A4.2 The System shall comprise Out Stations and Partial Discharge Detection Networks located at a number of substation sites and a Master Station at a headquarters location. The System shall be capable of supporting more than one Master Station.

A4.3 The System shall operate unattended.

Informative: The System may be required to be expanded to monitor further Out Stations in the future. The System may also be required to be expanded, by the addition of appropriate hardware and software, to monitor other quantities relevant to plant condition in the future.

- A4.4** The System shall be structured so as to allow for such future expansion.
- A4.5** System software shall be written in an industry standard language that will allow easy and cost effective development.

Tenderers shall advise with their tender any limitation on the System expansion capability.

- A4.6** Each Out Station and Partial Discharge Detection Network shall preferably be supplied from the site 48 V D.C. supply. Otherwise, each Out Station and Partial Discharge Detection Network shall be supplied with an uninterruptible power supply (UPS) which shall be capable of supplying the system for a minimum of 10 minutes to cover standby generator start up. The UPS shall be of the 'on-line' type, generating no spikes on changeover, and shall conform with NGTS 3.7.28.
- A4.7** The Out Stations and Partial Discharge Detection Networks shall be designed to operate from substation auxiliary supplies as specified in NGTS 3.12.3 and NGTS 3.12.4.
- A4.8** All materials and equipment for a complete installation including all necessary enclosures, mounting accessories, power and signal cables, connectors, conduit, PCs, peripherals and software shall be provided by the supplier.

Data Capture

- A4.9** The system shall monitor the partial discharge couplers at positions stated in the attached schedules and drawings.
- A4.10** The system shall monitor all connected partial discharge couplers independently and continuously.
- A4.11** The System shall be sensitive to partial discharge signals throughout the frequency range 500-1200 MHz with a minimum detectable signal of -65dBm or less. However, it is recognised that in some cases the use of filters may be necessary to reduce the sensitivity of the System to signals arising from telecommunications and other external sources. The use of such filters shall be agreed with National Grid.
- A4.12** Only those UHF signals having an amplitude equal to or greater than a preset threshold shall be stored.
- A4.13** The amplitude threshold for each coupler shall be variable and set by the user.
- A4.14** Captured signals shall be timed with respect to the positive going zero crossing of the power frequency voltage of the appropriate phase for subsequent phase resolved analysis.
- A4.15** The timing resolution shall be 1 ms or less.
- A4.16** A trigger signal for the above timing may be derived from the substation synchronising bus.

Automatic Data Transfer

- A4.17** The captured data shall be transferred periodically from each Out Station to each Master Station.
- A4.18** Communication between the Master Station and Out Stations must be compatible with National Grid's strategy for Substation Information, Control and Protection (SICAP). The Out Station shall be able to be connected by ethernet link and on-site LAN for communication to Master Stations via National Grid's future Wide Area Network as specified in NGTS 3.24.1.
- A4.19** Where the on-site LAN is not available, communication between Master Station and Outstations shall be by modem operating to the ITU V.90 standard.
- A4.20** Data shall be transferred to each Master Station from each Out Station automatically at least once per