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WP4 INTERNAL REPORT

SPECIFICATION OF EFI FUNCTIONS

Monitor stator winding conditions (S2)

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PREFACE

This document contains a description of the maintenance function "Monitor stator winding condition" (S2). I order to optimise the presentation a pilot installation will be developed on a PC platform (MMT-Maintenance Monitoring Tool).

The preparation of this specification presumes that analogue signals of partial discharges are available from measuring value converters.

1. OBJECTIVE OF FUNCTION

The function reveals need for maintenance on stator winding insulation by recording phase resolved discharge patterns. The information can be used to recognise different defect types (i.e. end-winding discharge, loose bars etc) in stator windings of hydro generators and trend their developments.

Early detection of failure and ageing in the stator winding insulation system will allow for optimisation of repair. It may avoid failures that can constitute a hazard to operation of a power plant and to human life.

The recording system and software tools (MMT) shall acquire and present partial discharge (PD) signatures from the stator windings.

2. FUNCTION ENVIRONMENT

This function is a part of the condition monitoring system. The purpose of the function is to detect and localise defects in the stator winding.

Generally the function will be activated on request. The function can be addressed by other functions within the monitoring system, e.g. "Trend Analyses on Insulation Systems" (function S1). The function can only be initiated and operated after a generator shutdown. There is no data exchange between S1 and S2.

The local or remote maintenance operator shall request the S2 function. A specialist must handle the MMT equipment. Normally, the operator will be a specialist on generator discharge patterns and he has to analyse the data.

High frequency voltage and current signals from partial discharges within the generator stator winding insulation are the signal sources for the function. Signal couplers fitted to the high voltage system of each phase will detect the high frequency signals.

The data collected are analogue signals. I order to detect the phase position a phase synchronous voltage is needed. The stored data are statistical values obtained from sampling and calculation performed on the analogue signals.

The data acquired will be stored as bitmaps and in matrixes. There is need for an operator to perform a historical comparison between new and previously made measurements.

Table 1. Sequence of request and responses necessary to utilise the function.

Event	Request/Response (RQ/RS)	From	To
Perform registration	RQ	Maintenance operator (MO)	Specialist operator (SO)
Collect data			
- Specify sample rate, input data levels of PD threshold	RQ	SO	MMT
- Qualify data	RQ	SO	MMT
- Store data	RS	MMT	Data Base (DB)
Performing monitoring	RQ	SO	Data Acquisition System (DAS)
Present results	RQ	SO	DB
Present curves, diagrams, patterns	RS	DB	SO

3. INPUT DATA DEFINITION

3.1. PROCESS DATA

A data file including a nxm matrix with results from a measuring period specified by the operator.

The discharge level and the phase interval (i.e. time interval for the measurements) are divided into n,m intervals respectively. For each intersection of row and column, i.e. partial discharge level and phase position, the matrix values gives the number of discharges within the measuring period for that particular discharge level and phase position.

The process data consist of raw data in files (256x256 per time unit). The MMT equipment acquires these values. The MMT equipment can display the discharge patterns.

PDMAX		(real matrix)
- ROWn:	Number of discharges at phase position n, [1,2, n, 256]	(real scalar)
- COLm:	Number of discharges at discharge level m, [1,2, m, 256]	(real scalar)
BMPDMA	Bitmap of PDMAX	

3.2. PARAMETERS

No parameters have to be specified for this function.

4. OUTPUT DATA DEFINITION

In this first version of the S2 function the output is equal to the input values.

PDMAX		(real matrix)
- ROWn:	Number of discharges at phase position n, [1,2, n, 256]	(real scalar)
- COLm:	Number of discharges at discharge level m, [1,2, m, 256]	(real scalar)
BMPDMAX	Bitmap of PDMAX	

5. DYNAMIC BEHAVIOUR

The S2 function has to be activated when an alarm has been raised on threshold overstepping or discharge gradient raised above the pre-set value. A complete shutdown of the generator has to be performed.

6. DATA PROCESSING (ALGORITHMS)

The algorithms are simple routines to store bitmaps and matrixes in data files.

7. INTERFACES

7.1. OPERATOR INTERFACE

The maintenance or control operator shall be able to monitor the data files storing the PDMAX-matrix and the bitmap.

7.2. SYSTEM INTERFACE

The MMT equipment (PRPDA) consist of the data acquisition units, signal processing unit and a local PC. The MMT is a PC operated NIM-based multichannel analyser for

acquisition of PD-signatures. The instrument can be used with different types of sensors. The instrument facilitates noise gating. It is a prototype instrument originally developed by ABB Baden, and further developed by EFI. The instrument produces data files that can be analysed by a software package developed by EFI.

The data from the MMT will not go directly to the CIU unit but to the Ethernet/TCPIP communication string in the local data acquisition application. The software necessary for transferring data from the PC to Ethernet/TCPIP will be a part of the MMT.

8. ERROR MANAGEMENT

If there is no output from the MMT the specialist operator has to improve the test set-up. He must be able to manage the adjustments of the MMT and to be familiar with the software that transfer data from the PC to the Ethernet/TCPIP.

9. CONSTRAINTS

In order to acquire proper discharge data the PD sensors have to be installed on the generator busbars and properly connected to the MMT. The software required for data transfer to the Ethernet/TCPIP must work properly.

10. HARDWARE AND SOFTWARE REQUIREMENTS

Hardware constraints:

In order to detect partial discharges it is necessary to install HV couplers like moulded ceramic capacitors, mica capacitors etc. on the generator busbars to limit the power frequency voltage derived from a coupler to a harmless level. Included in the set-up are preamplifiers that cover the frequency range of e.g. 2-20 MHz. The signal energy of a PD pulse found in this frequency band is converted down to the acquisition bandwidth of the system (e.g. 40 kHz-800 kHz).

Software constraints:

In order to optimise the data output from the MMT units a program for transferring data from the PC to the Ethernet/TCPIP has to be prepared. The software is an integral part of the MMT.

11. TEST PLAN

The first test site will most probably be equipped with instrumentation from EFI. There have been made a lot of measurements and evaluations of acquired data by specialists from EFI.

ANNEX - Functions input data

Item	**Hydroelectric set**
Domain	**Supervision/Monitoring**
User Need	**To request insulation system condition trend**
Function	**Trend analysis on insulation systems**

No.	System, Subsystem	Component, Subcomp.	Parameter	State	Type	Unit of measure	Range	Alarm value	Trip value	Remarks	Data label
1.	**Hydroel. set, Generator**	**Stator, Stator winding**	**Discharge level, number of discharge, phase information**		Matrix	pC - ms	[10, 10^6] - [0,40]				_HS_GE_ST_SWI_#PDMAX
2.	**Hydroel. set, Generator**	**Stator, Stator winding**	**Scope display**		Bitmaps						_HS_GE_ST_SWI_#BMPDMAX