Study Committee D1

Materials and Emerging Test Techniques

Paper D1-PS1-10883

Requirements for Ultra-High Frequency Partial Discharge Monitoring Systems for Gas Insulated Switchgear

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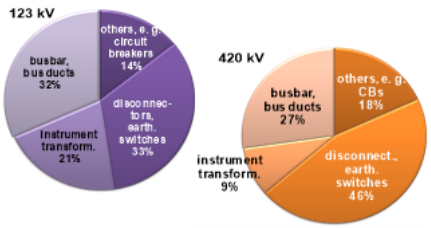
Motivation

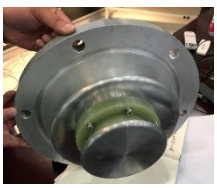
CIGRE WG D1.66 is tasked with defining requirements for GIS PDM systems to ensure that signals from incipient PD defects are reliably detected, monitored, and interpreted, so that asset managers can take prompt and appropriate actions to prevent equipment malfunction.

Dielectric failures in GIS



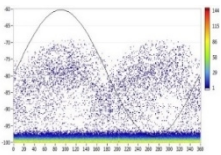
Main root causes of failures in 123 and 420 kV GIS, CIGRE Report A3-202, 2012

Functions and features of current PDM systems

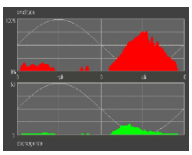


Internal UHF sensor

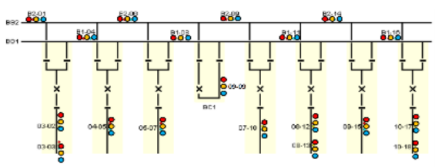
Acquisition system



Example of PRPD graph



Point-on-wave graph (POW)



Example of a GIS PDM system substation overview

Technical weaknesses of current PDM systems

- Discrimination of interference is very challenging, thus leading to large numbers of false alarms
- Expert systems are not yet efficient or accurate
- Alert/warning procedure does not consider results from the sensitivity check and from the signal-profile measurements

Automated recognition of PD defects

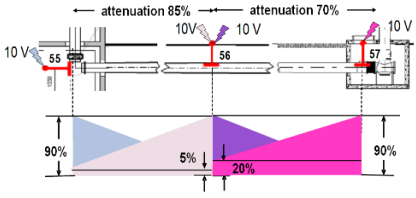
PDM systems should provide an efficient and automated evaluation of the PD defect type A set of data files representing five typical GIS PD defects were used to test the efficacy of the available pattern recognition algorithms.

PD defect / noise	A	B	C	D	E	Experts
Particle	■	■	■		■	■
Void			■	■	■	■
Protrusion	■	■	■		■	■
Floating Electrode			■		■	■
Particle on Insulation						
Noise	■	■				■

Results of PD identification by pattern recognition algorithms (A – E) and human experts (green box indicates correct identification)

UHF signal attenuation profile approximation

The results from the TB 654 UHF sensitivity check along with approximated UHF signal attenuation profile should be used to set threshold values for each UHF sensor and to define the PDM alarm procedure.



Attenuation profile acquired at sensitivity verification, Step 2

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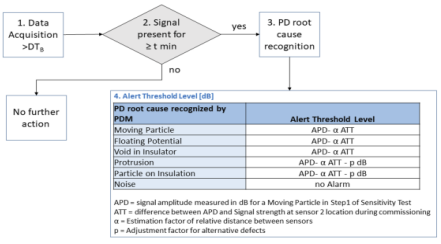
(continued)

Warning and alert procedure

One of the most pressing challenges facing GIS PDM systems is to significantly reduce the number of false alarms.

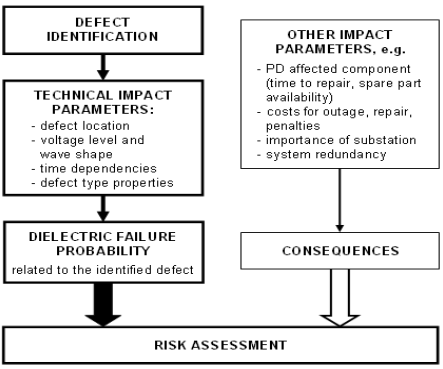


$AL = APD - \alpha ATT \qquad \alpha = 0{,}5\ (ATT-|PD1-PD2|)/ATT$

Proposed alert procedure

Risk assessment procedure

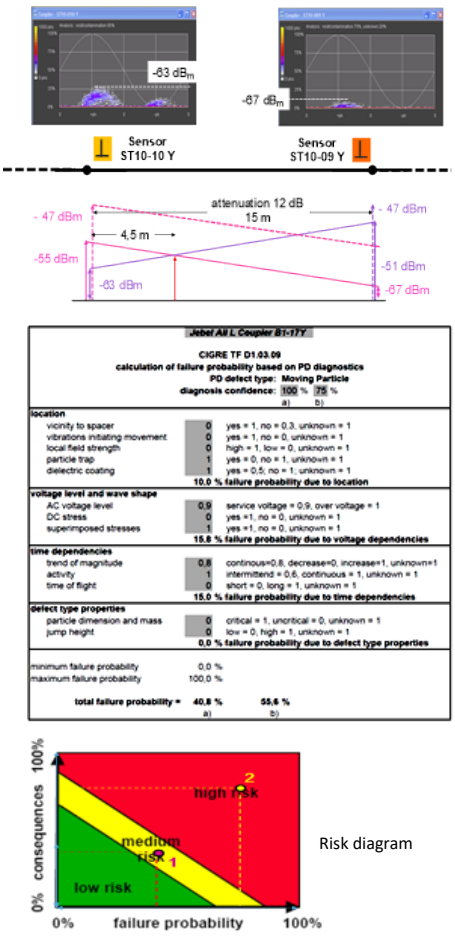
The technical impact parameters estimate the failure probability and the non-technical impact parameters estimate the consequences in case of a failure. The goal of this process is to obtain a risk index which can give an indication of which action should be taken. The most preferred approach is the concept of the traffic light.



Risk assessment procedure (CIGRE TB 525)

Case study

PD signal was acquired in a bus duct of a 400 kV substation consisting of 20 bays. The signal was identified to be caused by mobile particles. The PD defect was located 4.5 m away from the sensor. The failure probability was determined by means of the spreadsheet suggested in CIGRE TB 525



Risk diagram

Conclusions

- As one of the most pressing challenges facing GIS PDM systems is to significantly reduce the number of false alarms, and for this purpose, a novel warning/alert procedure is proposed. It recommends using the results from the CIGRE TB 654 UHF sensitivity check along with UHF signal attenuation profiles to set threshold values for each UHF sensor. In addition, the accurate and reliable automated PD defect type recognition as playing a pivotal role in both reducing false alarms and revealing defects which actually pose risk to operation have to be implemented.