



DayCor II™: RWTÜV registered association - Product Check

Statement of operation and field-testing for the DayCor II camera in connection with partial discharge recognition in high-voltage arrays

1. Introduction

The company GIGA Energy GmbH, Kortumstr, 55 in Essen requested us to provide a statement regarding the functions and operation of the DayCor II camera. This camera is produced by the company OFIL and is capable of displaying and localizing partial discharge effects during daylight. In addition, we were requested to provide a statement regarding the outdoor utilization of this camera and to suggest further examinations which would prove helpful in future evaluations.

2. Description of the camera

Before describing the mode of operation of the camera, we will first provide some explanations pertaining to the subject of partial discharge in high-voltage arrays.

2.1 Partial discharges in high electric fields

Partial discharges occur when the electrical field strength locally exceeds critical field intensity within a dielectric which then appears as electromagnetic waves. Partial discharge can be detected acoustically but can also be measured by direct or indirect measuring of the current pulse in the electrical circuit. The unit of measurement used for these partial discharges or electrical charges is known as pC (Pico-Coulomb). Corona discharges are a special kind of partial discharge and are visible at the surface of electrical operating material by ionization of the surrounding gas, which in most cases is air. Due to their low intensity, these discharges can only be perceived with the naked eye in almost absolute darkness.

Partial discharges are an unintentional phenomenon which can generally be overcome only by introduction of additional equipment. These partial discharges are electrical losses which can be considered as minor in relation to the signal power. Since they cannot be calculated, they are subject to "estimation from experience value" in reference to power loss dissipation and stray. This is similar to situations that occur in outdoor facilities (i.e. overhead lines and outdoor switchgears). They are subject to changes in weather and can appear two to four times stronger in damp weather than they do in dry ambient air. In the long run, partial discharges can damage fixed insulating materials.

Due to the steep rise in their frequency pattern, partial discharge impulses have a broad frequency spectrum. Depending on the frequency, there are three different measurement techniques. The purely acoustic technique detects and locates them via a microphone between the frequency range from 0 kHz to about 10 kHz. This process can sometimes be difficult due to reverberant sound. A quantifiable statement is nearly impossible. The second measuring technique is that of electromagnetic radiation over 1 MHz. This measurement is accomplished by using measuring receivers in the VHF and UHF spectrum. The third technique, which is most frequently used in laboratories, consists essentially of a four-pole, which is connected to a ground wire and a measurement amplifier that evaluates and visually



displays the current pulses. All described techniques strongly depend on the type and quality of the experimental method and on the measuring environment.

The radiation of corona discharges normally takes place in the ultraviolet range and can be made visible with the appropriate UV-sensitive measuring equipment. Outdoors, this is only possible at night since solar radiation contains a high UV value that masks the measuring signal during bright daylight hours. Efforts to increase the contrast by usage of high-selective filters combined with power frequency algorithms have not led to the anticipated success until now.

2.2 Mode of operation of the camera

The Ofil DayCor II camera also uses the ultraviolet emission spectrum of an air corona discharge. However, for this analysis, only the wavelength range between 240 to 280 nanometers was taken into consideration. The manufacturer chose this range due to the fact that UV radiation of the sun is absorbed completely by the ozone layer before reaching the earth. The intensity in this frequency range is distinctly lower than in the rest of the UV spectrum of the corona and can be compensated for by using corresponding image enhancements. The sensitivity of the camera is such that it can detect discharges of relatively small quantities of pC's in distances up to 10 m. This is due to the development of a special selective filter that makes it possible to use in full daylight by fading out the UV caused by solar radiation.

To be able to identify these UV discharges, an image is created in the visible range and displayed on a monitor using a second built-in CCD (Charge Coupled Device). The camera uses only one lens and supplies the images via a mirror system to the two CCD's, thus avoiding parallaxes.

As an option, a fixed cropped image window can be opened for ease of impulse counting. The window doesn't give information about the height of the partial discharges; it only serves as a qualitative comparison of two test points.

3. Practical examination

In order to certify the practical operations of the camera, several tests were conducted on November 22, 2001 at the high-voltage laboratory "Eurotest" of RWE in Dortmund. During the course of these tests, partial discharges were intentionally created using several experimental methods and various electrode geometries. The camera was mounted to a stand located at about 8 m away from the electrode arrangement. The applied voltage range was approximately between 25 kV and 330 kV, depending on the electrode geometry. The partial discharge measuring equipment of the high-voltage laboratory was also utilized as a reference. The response sensitivity of the camera in each case was clearly below 100 pC. The absolute limit of sensitivity of the camera in relationship to distance could not be established due to the limits of the experimental methods. In all cases the partial discharges were detected by the camera and were correspondingly displayed on a monitor.

In the afternoon of the same day the camera was tested at a 380/220 kV transformer station. The camera was carried on a special carrying strap providing ease of operation and stability to the user.



Several different types of equipment were examined by the camera including insulators, contacts of disconnectors, switches and executions of transformers. The distances from camera to subject during the measurements were in the approximate range of 10 to 50 m. The displayed discharge effects were plausible and could, without exception, be identified and matched to the various types of equipment. An examination of the results showed that the effects of the discharges could be traced and technically substantiated.

4. Summary

The tests carried out showed that the camera under both laboratory conditions and in the field is able to identify and display partial discharges in the air. The camera isn't a measuring instrument in the classic sense but rather a method of displaying effects that cannot be recognized with the naked eye. It can be used in high-voltage laboratories for research, as well as for manufacturing inspection or in development laboratories. Due to its operational modes it is easy to identify the source of partial discharges in comparison to most other methods currently available. In addition, it is also well suited for measurements taken in the field.

The expert witness of RWTÜV registered association
(Dr. U. Adolph)
Ad/Bkl/ November 27, 2001

* This document is an English translation of the original German document