B.7.4.

Electrical tests of overvoltage protection devices of H.V. cables with water penetration monitoring

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High voltage cables are often subject to small third party damages, that can cause severe damage of the insulation by water if undetected. In order to detect and locate any ingress of water to the cable immediately, monitoring systems with electrical water sensors integrated in the cables and a measuring system e.g. located in a substation are now introduced to the market.

The water sensors consist of metallic wires that are insulated with water permeable insulation and are placed close to the screen wires. At the end and the beginning of the cable system the sensors are connected to each other and to measuring leads, respectively. Because of the distributed arrangement of the sensors, voltages are induced in the sensors as well as in the cable screen.

Under normal operation the voltages induced in the sensors are tolerable low, with regard to insulation level of sensors and measuring equipment. In case of malfunction like short circuit, however, the conductor currents increase to very high levels for a limited time. In the same ratio the screen voltages and currents as well as the sensor voltages and currents increase. Without any protection the sensors and the measuring equipment would be destroyed under that condition. A similar situation is given in case of lightning or switching impulses travelling along the cable line.

In order to avoid any damage from the monitoring system the sensors are connected at both ends of the cables with over voltage protection devices. These devices do not influence the measurement of the low direct voltages of the sensors but must react very fast in case of any overvoltage, independent if the voltage is transient or is continuous for a certain time.

This property of the overvoltage protection device is achieved by fitting the circuits with actively working electronic components in contrast to passive components based on metal oxide used for surge voltage limiters. The reason for the electronic solution is much smaller volume of the protection device.

For verification of proper function of the equipment, a design test had to be performed. Because the application of water sensors in high voltage power cables is new, no respective standards are existing up to now.

Thus the respective voltages of an already realised extended cable link with a water penetration monitoring system were calculated and normalised. From that data maximum values with regard to other possible cable systems were calculated and used for the tests of the protection devices as well as standardised impulse voltages with levels valid for cable accessories and connected equipment like switch gears. The results of these tests were compared with the breakdown levels of the over voltage protection devices, in order to define safety margins.

The water monitoring protection system, the design of overvoltage protection devices and the results of the tests are presented in the paper.