Influence of Nonuniformity of ZnO Varistors on Their Energy Absorption Capability

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Abstract: A simple thermomechanical model is applied to evaluate the influence of the nonuniformity of ZnO varistor disks used in surge arresters on their energy-handling capability. Puncture is the dominating failure mode for slightly nonuniform disks, but cracking becomes more likely as the degree of nonuniformities increases. It is shown that minimization of the chance of a failure of varistor disks at high-current pulses can be achieved by adjusting their resistivity in the upturn region of the *I-V* characteristic. Simulation of the behavior of varistor disks under high-current 4/10 μs pulses required by the ANSI standard tests shows that these tests provide very little information about the actual energy-handling capability of the disks. This conclusion suggests that alternate test methods should be developed and included in the relevant standards.

Keywords: Metal-oxide surge arresters, varistors, energy absorption capability, failure modes, ANSI standard tests, electrical nonuniformity, current pulses.

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A Statistical Approach to Prediction of ZnO Arrester Element Characteristics

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Abstract: ZnO arrester elements consist of ZnO grains with dimensions in the range of 10 to 100 μm, the boundaries between which form double Shottky junctions with conduction voltages in the range of 3.5 V. A fraction of the grains contain no conducting boundaries with other grains, which results in the percolation path for current across the ZnO element being a statistical parameter that is a function of the fraction of nonconducting grains, which also affects the nonlinear properties of the element. In this paper, we use a simple statistical approach to predict the effect of the fraction of nonconducting grains on the nonlinear properties of the element. This computationally simple approach gives results that are comparable to far more complex approaches, which require solving a network of nonlinear resistive elements.

Keywords: ZnO, arrester, nonlinear materials.

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Switchgear

Verification of the Short-Circuit Current Making Capability of High-Voltage Switching Devices

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Abstract: Switching in of short-circuit current leads to pre-arcing in the switching device. Pre-arcing affects the ability of switchgear to close and latch. In three-phase systems, making is associated with transient voltage phenomena that may have a significant impact on the duration of the pre-arcing period. An analysis of these transients is presented. It was found that pre-arcing times in three-phase systems can be considerably prolonged with respect to a single-phase situation. On the other hand, it is demonstrated that the three-phase interaction has a moderating influence on the peak value of asymmetrical current. A test circuit is described, able to perform three-phase synthetic make tests up to 245 kV at current up to 63 kA, representing all transient phenomena. Specific tests are described requiring the maximum available laboratory power: one with a circuit breaker subjected to direct test and one with a high-speed grounding switch subjected to synthetic tests.

Keywords: ac circuit breakers, arc discharges, circuit breaker testing, circuit transient analysis, short circuit currents, switchgear testing, switching transients.

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Benchmark Systems for Digital Computer Simulation of a Static Transfer Switch

IEEE PES Task Force on Simulation of FACTS and Custom Power Controllers of IEEE PES WG on Modeling and Analysis of System Transients Using Digital Systems

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Abstract: This paper presents two benchmark systems for time-domain simulation of a thyristor-based static transfer switch (STS). The objectives are: (1) to provide guidelines for digital simulation of STS systems, (2) to provide a basis for performance evaluation of simulation programs used for STS analysis, and (3) to benchmark performance of various detection/control strategies adopted for STS systems. Each benchmark system is composed of: (1) a supply system, (2) STS, and (3) sensitive load. The two benchmark systems are referred to as STS-1 and STS-2. Simulated performances of the two systems, based on the use of the PSCAD/EMTDC software package, are provided. Simulation results corresponding to STS-2 are also compared with the corresponding measurement results.

Keywords: FACTS, custom power, static transfer, switch, digital simulation.

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PD Signal Propagation Characteristics in GIS and Its Location System by Frequency Components Comparison

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Abstract: Propagation characteristics of partial discharge (PD) signal in gas-insulated switchgear (GIS) were investigated in a laboratory and at a 300 kV underground substation. The laboratory test indicates that signal damping can be attributed to two major mechanisms: reflection due to irregularity of characteristic impedance such as spacers and the mode shift from TEM to TE or TM. Tests at the substation show that the signal damping phenomena are independent of propagation direction and the mode shift gives rise to a large signal damping. The major higher mode seems to be TE_{11}. Amplitudes of observed waveforms using narrow-band filters that agree well with the corresponding frequency components observed with a spectrum analyzer show irregular or random behavior depending upon their observation point. This indicates that narrow-band filters do not seem to be suitable for a PD location system by a frequency component comparison, and the reliability of the system using broadband filters instead is discussed.

Keywords: GIS, PD, insulation monitoring, insulation diagnostics, UHF method.

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Frequency Characteristics of Electromagnetic Waves Radiated from GIS Apertures

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