Physical Installations of Surge Arresters

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Surge arresters are commonly used in switchgear today to clamp transient voltages at levels below the allowable BIL of the equipment being fed and the switchgear feeding it. The arrester plays a special part for motors and generators in extending the equipment life under certain system configurations. Metal Oxide Varistors (MOV) are commonly used in switchgear and medium voltage motor control centers (MV MCC). The metal oxide arresters offer smooth turn-on and turn-off at lower surge current levels than the older valve type silicon-carbide technology. To install MOV surge arresters in switchgear and MV MCC there are several physical aspects to be considered to assure reliable operation. The most significant of these are ambient temperature, the lead length of the conductor connecting the arrester to the equipment being protected, and the spacing between the arrester in two separate phases.

Ambient temperature — The Metal Oxide Varistors are rated for a -40°C to 40°C ambient with a temporary maximum air temperature of 60°C. As the temperature of the device increases – the leakage current continues to climb. The increase in leakage current causes the surge arrester temperature to exceed the temperature rating of the MOV. The internal resistance of the surge arrester begins to drop off and the device turn-on voltage is lowered. If the temperature exceeds the thermal capability of the arrester, thermal runaway occurs and the arrester turns on at the system operating voltage and will not turn off, thus resulting in a line to ground fault.

Cable connection tail length – It is critical that the length of the leads connecting the surge arrester to the protected equipment and the arrester to the ground bus must be minimized. The wave continues to travel down the system past the surge arrester near the speed of light at the original surge voltage until the arrester turns on to clamp the voltage at the arrester discharge voltage. The voltage drop of the lead wire connecting the arrester to the equipment being protected and the arrester to the ground plane adversely effects the discharge voltage of the surge arrester. A rule of thumb is that the arrester discharge voltage is decreased by 1.6 kV/ft. for every foot of lead length between the phase conductor and the ground bus. The decreased discharge voltage becomes more important in systems above 15 kV where BIL coordination margin is reduced below the 20% protection margin recommended by ANSI.

Skirt to skirt distances – The surge arrester is made up of two dielectric materials in parallel. The outer surface is typically a polymer insulating material that creates a voltage gradient along the length of the arrester. This surface distance is commonly referred to as the creepage distance. The second part is the inner portion of the arrester, the MOV disk, an insulator at nominal voltage and a conductor at higher voltages. To prevent conduction across the surface (tracking), adequate phase to phase and phase to ground spacing must be maintained. A skirt to skirt spacing of 1 inch/30 kV of BIL is recommended.
Conductor to conductor distances -- In addition to skirt to skirt spacing, it is important that phase spacing be maintained between the conductors throughout the lineup. The conductor connected to the lug on top of the arrester is at line potential and must maintain the same phase spacing as the bus phase conductors (see PTB #59 for distances). If the switchgear spacing is based on insulated phase distances, the lug connection on top of the arrester must be booted. The boot fit should barely cover the first skirt ring, and should form a continuous path from the conductor to the first ring of the arrester. To keep from "shorting out" the creepage distance, the boot may not make contact with more than the first skirt.

These physical considerations play an important part in assuring that the arresters are able to function properly.

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