Fault Case:
How the Arc Eliminator saved an AIS Switchgear

Technical information
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Summary
A fault case has occurred in field service where the arc eliminator system (AE) has saved the switchgear. The AE system tripped by optical open arc signal from an internal magnetic voltage transformer (VT) fault. The AE shorted out the arc and the up-stream breaker cleared the fault. Photographs taken right after the fault at the actual fault location show a clean and intact switchgear interior.

Fig.1 Open arc failure, with Arc Eliminator

Live fault case
The actual fault level was 200 MVA on 22 kV level. Due to ferro-resonace involving core saturation, high winding current and extra heat losses, the PT epoxy housing opened up and scattered. The picture in fig.1 shows the clean intact AX1 cubicles with the scattered epoxy parts at the bottom. The pressure relief flaps opened up.

Sensor technology is generally used in order to provide a closed and protected HV space, a signum for AX1.

Voltage Transformers (VT's) are still used when required by the customer usually to provide sufficient revenue metering class. VT's although applied in accordance with common standards are subject to higher failure risk in high impedance grounded systems, especially in areas with significant ceuronic level, or other types of disturbance. [1] [2]

Background
The new AIS switchgear namely AX1 from ABB is based on a safety philosophy keeping the complete High Voltage (HV) space for several incoming and feeder cubicles as one common metal enclosure with no access to man under service conditions. In order to enhance the safety against human hazard and to reduce the restoration time in case of failures, a device namely "Arc Eliminator" has been developed, type tested and applied.

Open arc faults are known to occur most likely by manipulation. By reducing the access to the HV space the risk of open arc failures is reduced accordingly. Another likely cause of open arc failure is magnetic VT. Sensor technology is preferred in AX1 unless other requirements are specified, e.g. revenue metering standard.

Open arc faults are still handled with the arc eliminators, however the AX1 switchgear is fully type tested and approved also without the arc eliminator function, provided a special pressure relief outlet in the end of a cubicle arrangement.

The Arc Eliminator hardware.

The arc eliminators are released by the integrated ABB optical arc guard detection system. Three phase contacts closes simultaneously in less than 5 milliseconds measured from light pulse to contact. The three contacts are connected to a common copper bus also grounded to the enclosure. Typical ratings are 24 kV system voltage and 40 kA rms. , 1sec, 125 kA peak current.

The operating energy is stored in dc-type capacitors, one for each phase. Internal functions such as storage capacity, charge voltage, circuit continuity and insulation of operating system main circuits are continuously and automatically supervised. Any variation in excess of pre-set limits for the supervised parameters will cause an alarm classified in two levels, warning and fatal.

System functions with the arc eliminator.

The arc eliminator acts like a "fault thrower" with high speed in terms of just a few milliseconds elapsed time from arc fault ignition to a fully effective short. As a result of the fast function, the arc eliminator:

1. provides arc extinction.

2. reduces the pressure wave.

3. eliminates the after-effects in terms of prolonged arc with hot poisonous and contaminating gas flow.

Optional system function

With a fast fault detection system, even downstreams faults can be handled using the AE system as Current Diverter(CD)

4. reduces the effective fault current peaks down-streams from the AE location. Consequently all severe mechanical stress down-streams from the location of the active eliminator is prevented.

As a consequence, sets of self-standing eliminators alias "Current Diverter" (CD) can divert the fault currents from individual in-feeders back to respective sources. The result is reduced stress by reduction of the total sum of all fault power sources.

The firm and controlled operation provides full phase-symmetrical balanced short. This type of balanced fault is beneficial with respect to electrical machine and transformer tertiary windings. The same windings could be damaged in case of unbalanced faults with less magnitude.

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References

[1] Sune Rusck, "Ferroresonans i spänningstransformatorer", Särtryck av ASEA's Tidning 48 (ABB Tidning) (1956) nr. 7-8 In Swedish.

[2]IEEE PAS Winter meeting summary 2001.

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