Lesson Learned
High AC Voltage Can Lead to Remote Terminal Unit (RTU) Failures

Primary Interest Groups
Generator Owners (GOs)
Generator Operators (GOPs)
Transmission Owners (TOs)
Transmission Operators (TOPs)

Problem Statement
High ac voltage delivered to remote terminal unit (RTU) control cards can cause RTU failures. The RTU failure mode caused by this high, applied ac voltage can cause random trips and closure of circuit breakers connected to the RTU, which could lead to large outages on the bulk power system. Three instances of this type of failure have been reported through the NERC Event Analysis process.

Details
If ac voltage is being switched by an RTU control output card, moderately high ac voltage for a prolonged period or very high ac voltage for a short duration can cause the metal oxide varistors (MOVs) on the control card to break down. This varistor breakdown can lead to the equivalent of a control output contacts being shorted. This shorting of output contacts can lead to random operation of devices that are connected to these RTU control outputs. In addition, the breakdown of the varistors can lead to excessive heating, which can melt ribbon cables, leading to random trips and closure of circuit breakers connected to the RTU. This failure mode is not exclusive to one RTU vendor, and the reports submitted identifying this failure mechanism have not been exclusive to one vendor.

Research indicated that most RTUs are susceptible to this type of failure due to high voltage applied to the control board. The cause of the high ac voltage can be varied. For example, a CCVT delivered high voltage for approximately three minutes before failing catastrophically. In another instance, an EHV transmission line conductor fell across a lower-voltage transmission line, causing momentary high voltage from the potential transformer at the lower-voltage substation. Yet, in another case, a programmable logic controller delivered high ac voltage to an RTU, which caused the random trips.

Corrective Actions
The corrective actions implemented by the affected entities are dependent upon the specific situations each event presented. One solution is to apply high voltage protection (i.e., MOVs) on the ac circuits connected to the control boards, external to the RTU. Another solution is to use an external interpose relay for all ac control switching to eliminate any ac on the RTU control output board.

In most instances, RTUs are limited to a certain number of control points per output card. One solution was to try to isolate the ac voltage inputs from the dc control voltages—commonly used for breaker controls—by not having dc and ac signals on the same control output card. In this solution, if high ac voltage were to...
cause a breakdown of the MOVs, the shorted MOVs would not be shorting out contacts that had dc (breaker control) on them. In effect, isolating the high ac voltage from dc control voltages would alleviate erroneous breaker trips and closures.

**Lessons Learned**

If an entity employs a station RTU to switch ac voltages via the RTU control functionality, the entity should consider researching the effects that high ac voltage may have on the RTU control. If random trips and closures are a possible effect of high ac voltages, the entity should consider preventive mitigation if the entity’s Station also interacts with dc control voltages.

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