Fuseless Capacitor Bank Protection

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Other Papers of Interest
Presented at Western Protective Relay Conference, Oct. 26, 1999

• Protection of Fuseless Shunt Capacitor Banks Using Digital Relays, by M. Dhillon and D. Tziouvaras.
Types of Capacitors

- Internally Fused
- Externally Fused
- Fuseless

Internally Fused Capacitor
Internally Fused Capacitors

- Element shorts blow internal element fuses
- Can continue to operate with blown element fuse(s)

Failure Mode of Internally Fused Capacitor:
- Blown Internal Fuse
- Shorted Element
- Voltage Increases on Remaining Elements in the Group
Externally Fused Capacitors

- First element short raises voltage stress on remaining element groups
- Additional elements cascade fail
- External fuse blows for 2 or 3 element groups shorted
Failure Mode of Externally Fused Capacitor (Initial Element Failure)

- Can Current Increases Through Fuse
- Shorted Element
- Voltage Increases on Remaining Element Groups

Failure Mode of Externally Fused Capacitor (Cascaded Element Failure)

- External Fuse Blows After 2 or 3 Element Failures
- Original Shorted Element
- Cascaded Element Failures
Fuseless Capacitor

Element

Fuseless Capacitors

- Element shorts raise voltage stress on remaining element groups
- Can continues to operate with shorted element(s)
- Cascaded element failures are not necessarily in same can
Failure Mode of Fuseless Capacitor

Voltage Increases on Remaining Element Groups

Typical Capacitor Bank Installations

- Externally Fused
- Fuseless
Externally Fused Capacitor Bank

- First blown fuse raises voltage stress on remaining cans
- Cans can cascade fail after exceeding 110% of can nameplate
Externally Fused Capacitor Bank Failures

Voltage Increases Across Other Cans in the Group

Fuseless Capacitor Bank

Capacitor Cans

Protection Module (single capacitor element)
Fuseless Capacitor Bank

Fuseless Capacitor Bank with Neutral Protection Module
Fuseless Capacitor Banks

- First failed element raises voltage stress on remaining elements in series group
- Elements can cascade fail after exceeding 110% of element nameplate
- Element failures do not necessarily occur in same can
Protection Objectives

• Short circuit protection for phase and ground faults
• Overvoltage protection resulting from excessively high power system voltages
• Overvoltage protection resulting from element failures

Short Circuit Protection

• Phase overcurrent relaying (50/51) on breaker phase CTs
• Overlapping bus differential relays (87B)
• Residual overcurrent relaying (50/51G)
• Trip and lock-out bank
System Overvoltage Protection

- Phase overvoltage relaying (59B) connected to bus PTs.
- Trip bank for 110% of nameplate voltage (no lock-out)

Element-Failure Caused Overvoltage Protection

- Voltage differential (87V)
- Neutral overvoltage (59N)
- Neutral overcurrent (51N)
Voltage Differential (87V)

Monitors the voltage difference between the bus and the protection module

Alternate Voltage Differential (87V)

Monitors the voltage difference between the protection modules on each series group
Voltage Differential Objectives

- Alarm for 2 or 3 failed elements (4 - 5% element overvoltage)
- Trip and lock-out bank for 10% element overvoltage

Neutral Overvoltage (59N)

Operates on the voltage across the neutral PM caused by phase unbalances
Neutral Overvoltage Objectives

- Alarm for 2 or 3 failed elements (4 - 5% element overvoltage)
- Trip and lock-out bank for 10% element overvoltage
- Calculations assume all failed elements are in the same phase

Neutral Overcurrent (51N)

Monitors the neutral unbalance current to detect failed elements
Neutral Overcurrent Objectives

• Alarm for 2 or 3 failed elements (4 - 5% element overvoltage)
• Trip and lock-out bank for 10% element overvoltage
• Calculations assume all failed elements are in the same phase

Questions
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