

Reignition and Restrikes

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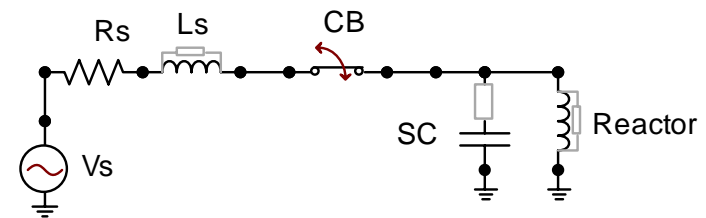
- Normal and Abnormal Transients
- Reignition
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- Restrike
 - Capacitor switching
 - Three phase capacitor switching
 - Grounded vs. Ungrounded banks

Normal and Abnormal Transients

- Normal Transients
 - Transients during energization
 - Up to 2 p.u. voltages
 - No trapped charges assumed
 - Capacitor Energization inrush currents and voltages
- Abnormal Transients
 - During deenergization
 - Trapped charges
 - Very high voltages and currents
 - Current Chopping
 - Interruption of currents
 - Restrikes and Reignitions

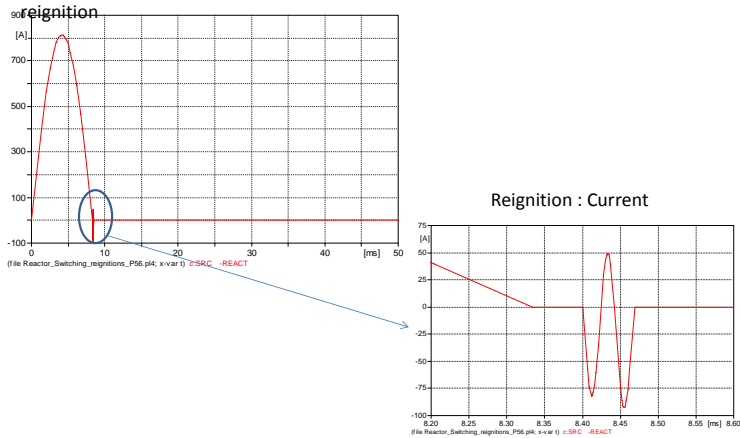
Reactor Switching

- Trapped Energy
- High Frequency oscillations of reactor voltage
- Dielectric Breakdown

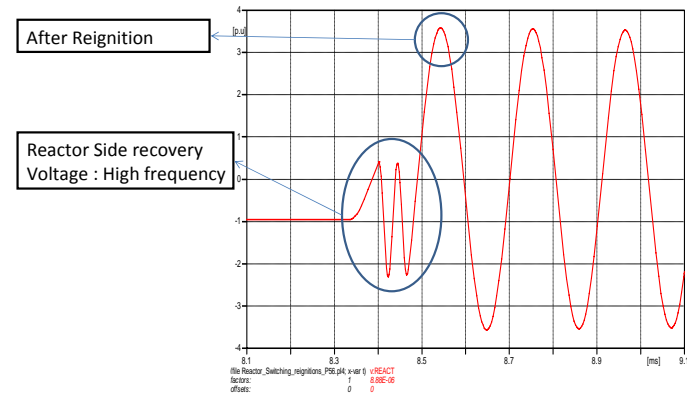


Circuit Breaker Current : Reignition

Interruption of circuit current with

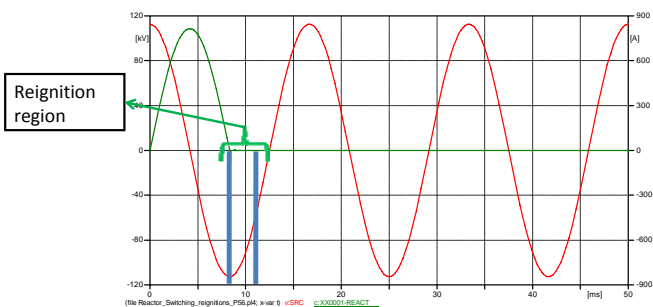


Reactor Voltage :Reignition



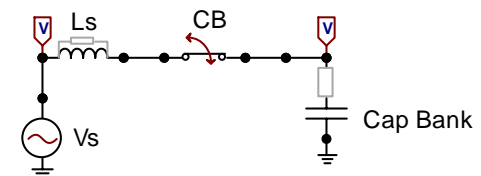
Reignition : Definition

A reignition occurs when a current is interrupted at current zero and then re-establishes itself within one-eighth of a power frequency cycle [2].



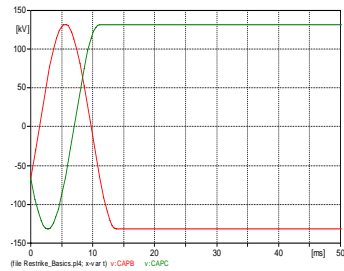
Capacitor Switching

- Switching of normal load current
- Deenergization at system peak voltage
- Trapped charge on the capacitor

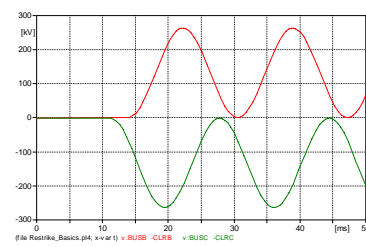


Capacitor Bank Trapped Voltage and TRV

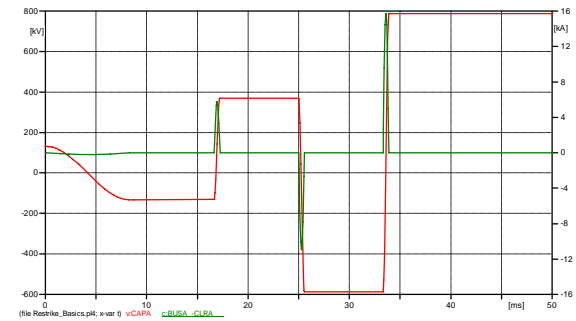
Trapped Voltage on Capacitor Bank after deenergization



Circuit Breaker TRV

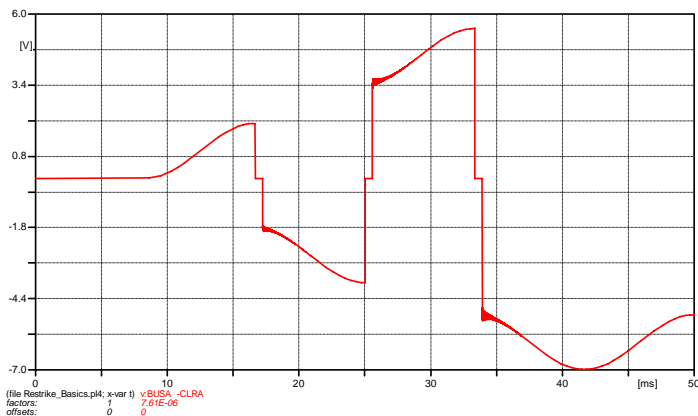


Restrikes and Voltage Escalation

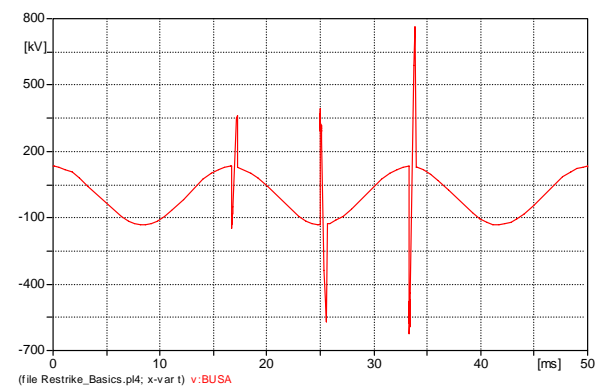


- Voltage escalation with multiple restrikes
- Stored Voltage on Capacitor Bank increase with each restrike. (1st - 3.p.u. 2nd - 5 p.u)
- Very high transient current spikes

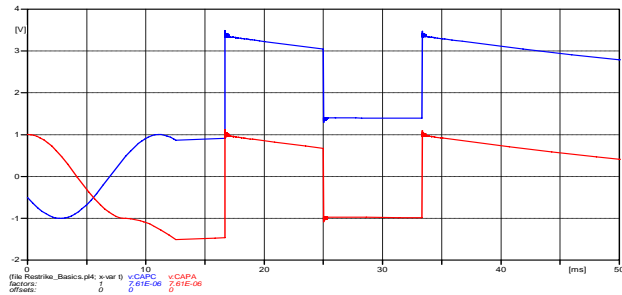
Restrikes : TRV



Restrikes :Bus Voltage

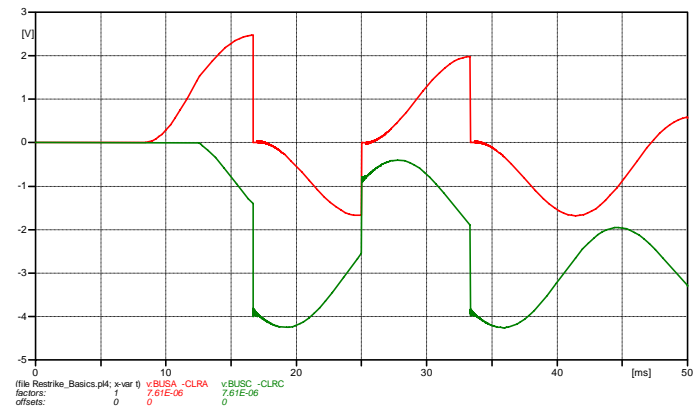


Restrikes :Ungrounded banks Capacitor Bank Voltage



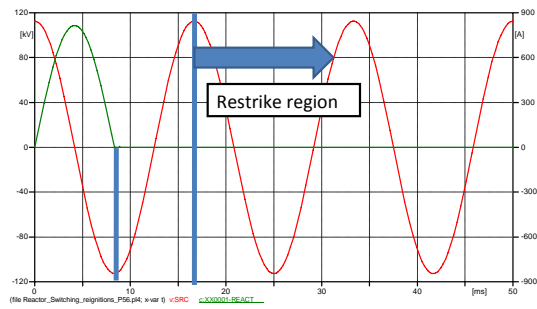
- Higher trapped voltages than the case of grounded banks.
- Restrike on phase A results in escalation on phase c.
- First restrike trapped voltage increases to about 3.5 p.u

Restrikes :Ungrounded banks Circuit Breaker TRV

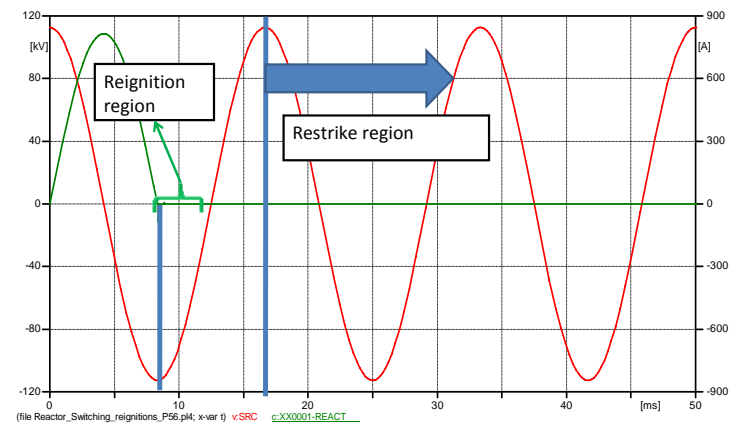


Restrike : Definition

The term “restrike” is defined as a re-establishment of the current, one-quarter cycle or longer, following interruption of a capacitive current at a normal current zero [1].



Restrike and Reignition: Comparison



Conclusions

- Abnormal transients are a result of trapped charges and energy.
- Reignitions and restrikes can lead to very magnitude transients.
- Multiple restrikes can damage circuit breakers and other equipments.
- Ungrounded Banks result in higher magnitude of transients than grounded banks.
- Can controlled with use of surge arresters.

References

1. N. E. Dillow, I. B. Johnson, N. R. Schultz, and A. E. Were, "Switching Capacitive Kilovolt-Amperes with Power Circuit Breakers," AIEE Transactions, pp. 188--200, 1952.
2. R. D. Garzon, High Voltage Circuit Breakers: Design and Applications: Marcel Dekker, Inc., 1996.
3. Shui-cheong Kam "Modelling of Restriking and Reignition Phenomena in Three-phase Capacitor and Shunt Reactor Switching".
<http://www.itee.uq.edu.au/~aupec/aupec06/htdocs/content/pdf/77.pdf>
4. Allan Greenwood. Electrical Transients in Power Systems. Wiley, New York, NY.