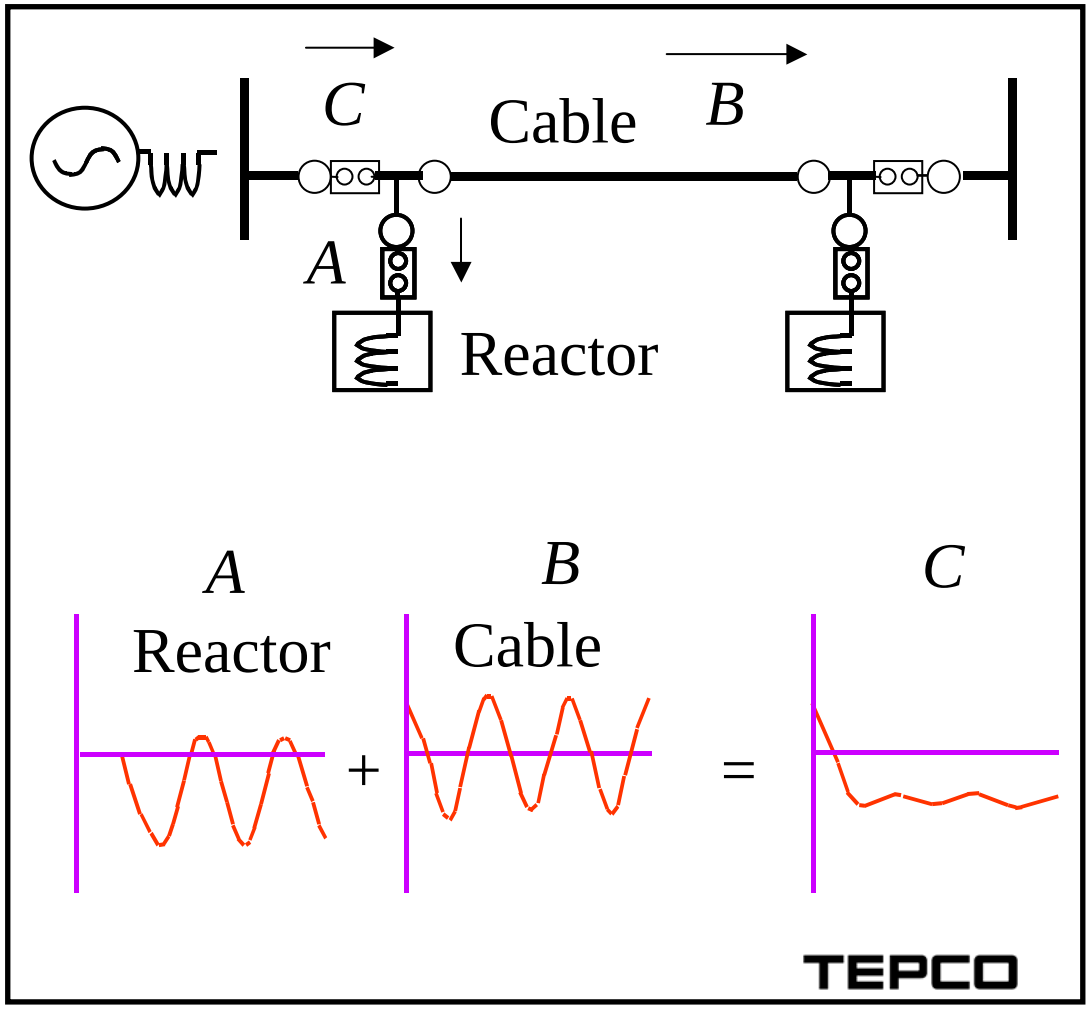
Operating condition and results

Tokyo Electric Power Company

Operational Considerations in the Cable Network

- Delayed Current Zeros
- Restrikes after Shunt Reactor Openings
- Overvoltages due to Resonance

Delayed Current Zeros



Close *C* under a no load condition with a shunt reactor

Current on *C* has dc-component for several seconds.

If a fault occurs during this periods, circuit breaker cannot interrupt fault current.

Countermeasures for Delayed Current Zeros

- To prevent CB from breaking down due to delayed current zeros
  - ➢ Switching procedure should be arranged so that current through CB can cross zero point

  (1) As an example operation sequence,

  1. Cable is energized without shunt reactor
  2. Load at the remote end is fed through the cable
  3. Shunt reactor is switched on

  (2) Sequential control of line-CB & shunt reactor-CB by line protection relay when a fault occurs (applied to 500kV cables in TEPCO)

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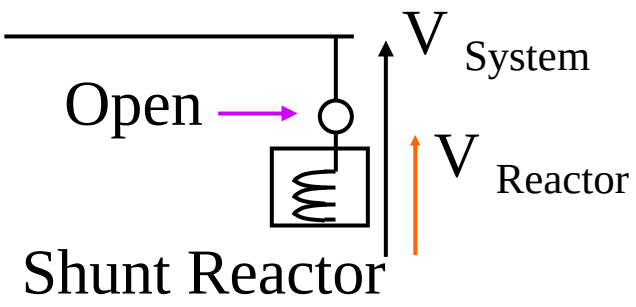
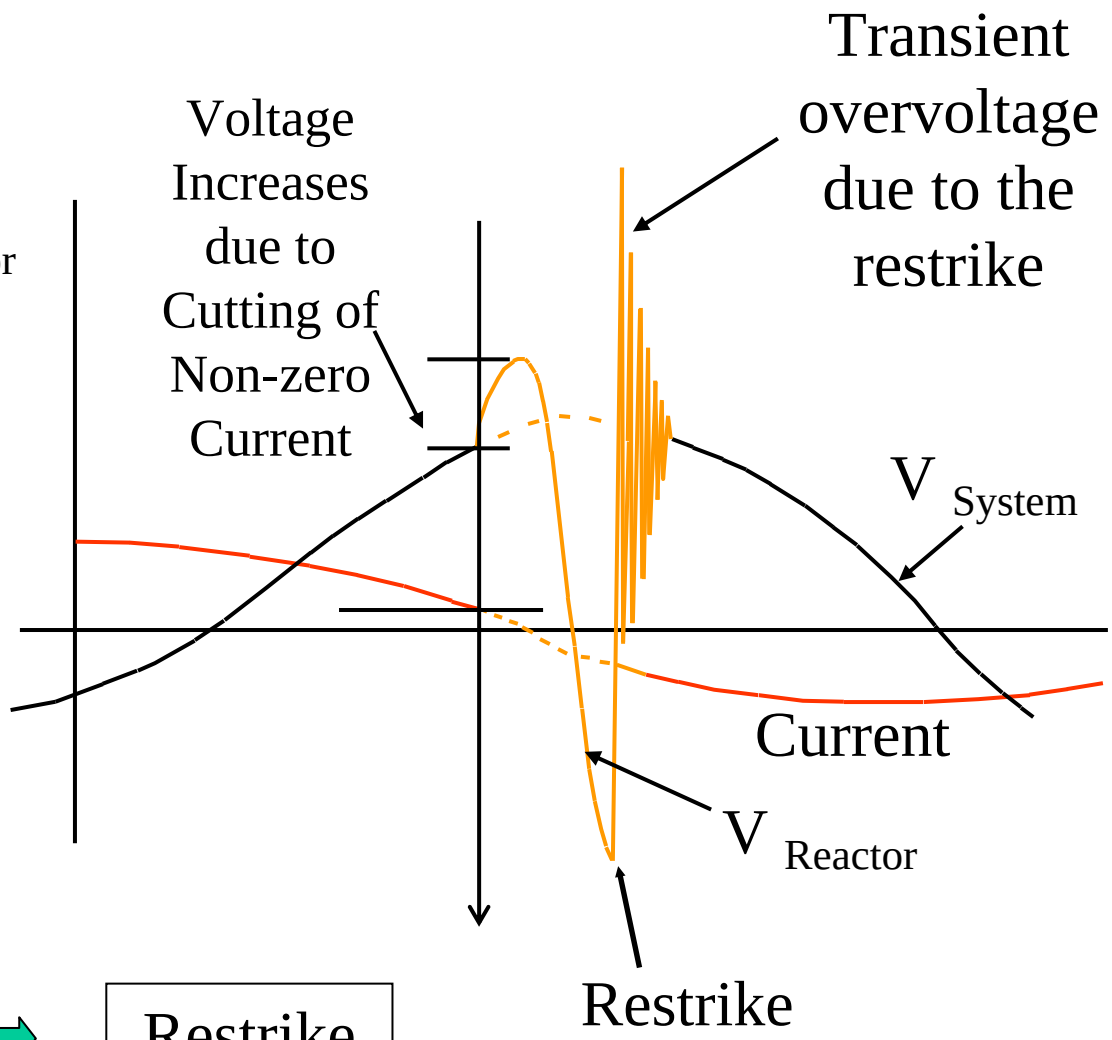
Restrikes after Shunt Reactor Openings



Sudden change in current causes overvoltage ($V_{Reactor}$)

$V_{System} - V_{Reactor}$ Imposed between terminals of the CB.



Restrike

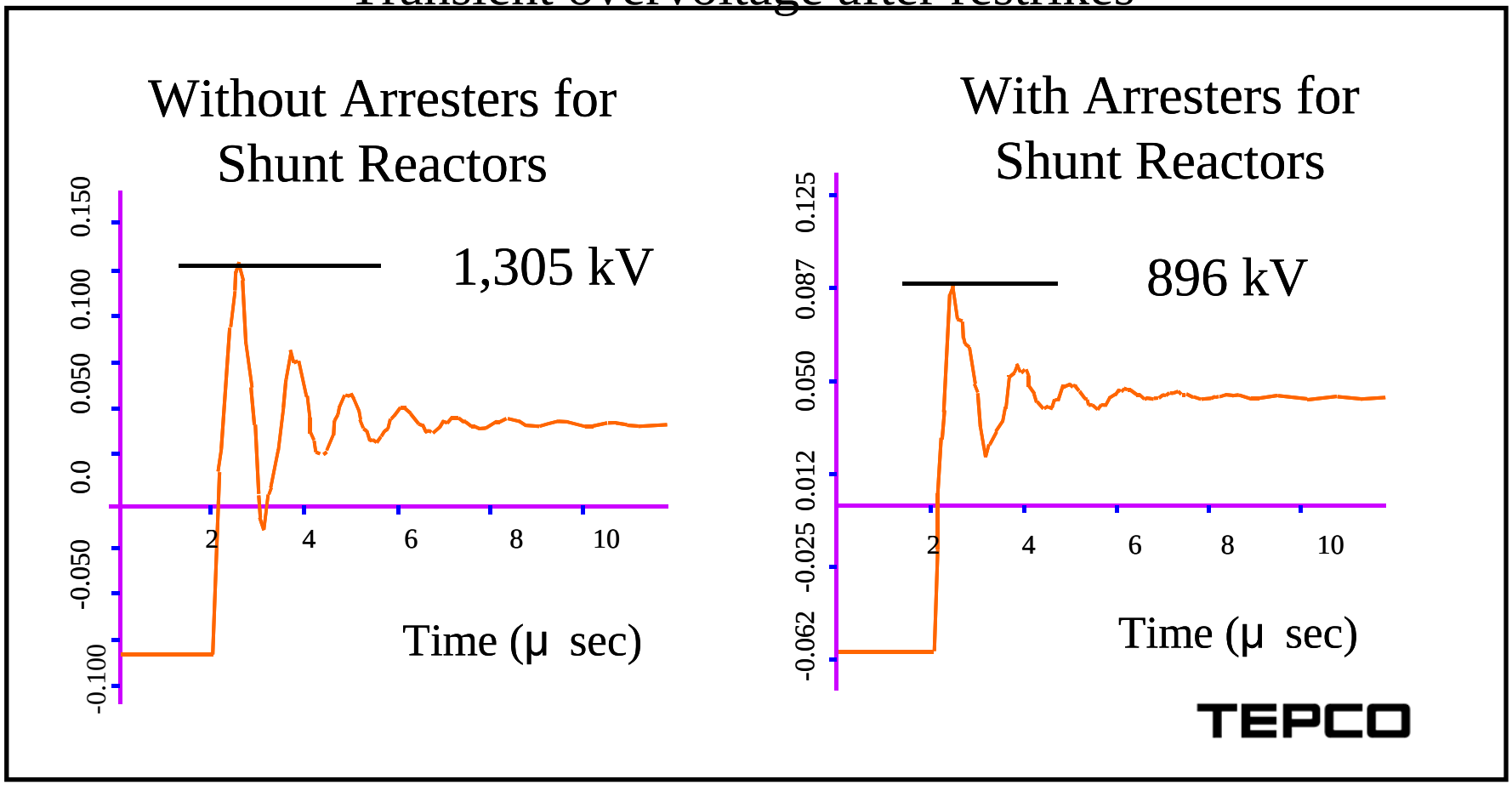
Countermeasures for the Restrikes

- Installation of Lightning Arresters
  - Restrike overvoltage can be suppressed to an allowable level.
  - Damage to CB contacts caused by arcing between contacts can not be avoided.

- Installation of Pole-Segregated CB Open Timing Controller
  - Restrike phenomena itself can be avoided; therefore, both overvoltage and damage to CB contacts are prevented.
  - Malfunction of controller can lead to ShR failure.

Restrikes after Shunt Reactor Openings

Transient overvoltage after restrikes



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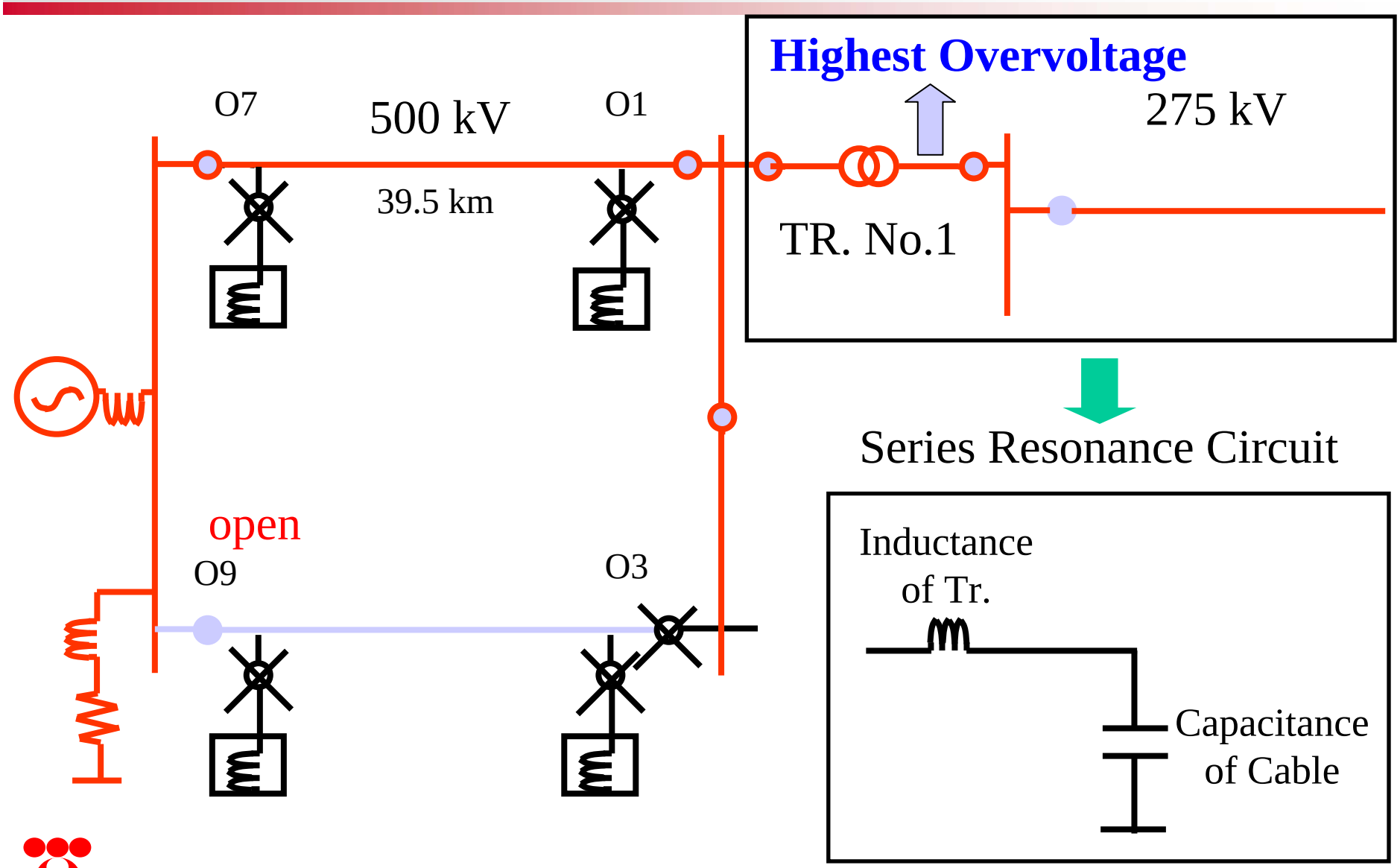
Series Resonance

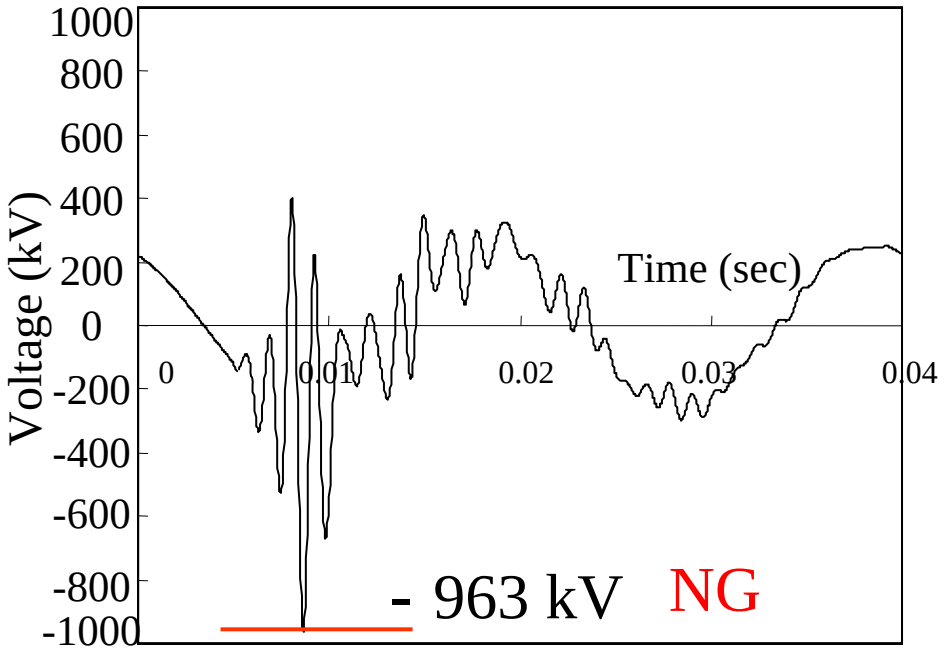


Countermeasure Taken for the Overvoltage

Voltage on the Secondary Side of the Transformer

(Switching Impulse Withstand Level : **750kV**)

Without Arresters



With Arresters