Thesis I

Secondary arcing is a critical event of the successful Single and Three Phase Reclosing (SPR and TPR) in High Voltage (HV) transmission lines.
Different nominal voltage transmission lines can run in common length on same or different towers. In the first case the probability of the secondary arc on the lower nominal voltage system evolving and long-time surviving in dead time of SPR or TPR caused by enlarged coupling between systems is significantly greater than in the second case (see Chapter 4.1 of the dissertation).

According to computer simulation results in Chapter 4.2.2 of the dissertation in case of voltage escalation – owing to secondary arc with succession of short-time, high current impulses – the potential to earth on phase(s) disconnected in lower voltage system can increase to a critically value at which successful automatic reclosing can be prevented with high probability. This process is named self-maintaining long-time secondary arc.
Simulations are verified by HV test circuit measuring. Detailed analysis of latter can be found in Chapter 4.3 of the dissertation.
Statements based on computer simulation and measuring results are as follows:

- *In case of systems running on same towers potential escalation and unsuccessful automatic reclosing in lower voltage system occur with greater probability not only in SPR but also in TPR.*
- *Secondary arc develops as well on that nominal voltage systems (220, 120 kV) where it is no such a danger in case of different towers running.*

Thesis II

On base of analysis of results in HV testing circuit for self-maintaining long-time secondary arc such a HV testing circuit has been designed which can produce numerous, capable for statistical treatment results (see Figure 5-2 of the dissertation). Dissertation covers details of the arcing, measuring equipment and simulation as follows:

- *Arc-producing methods and visual recording of arcing process including analysis of its dependence upon wind velocity (arcing time, arc expansion, observing of moving of high-resistance arc-parcels).*
- *Influences of the measuring transformers (inductive potential transformer and capacitive divider) on the registration and influence of the supply transformer on arcing process.*
- *Determination of the minimal sampling rate of the measuring signals for registration.*
- *Elaboration of the HV circuit-components for exact and almost real mapping of the wave process.*

From arc-producing methods and registration possibilities showed by Chapter 5.6 of the dissertation next statement is stood: measurements made in HV test circuit suggested by this Thesis open the door for systematic studying of the self-maintaining long-time secondary arc and for statistical analysis of the results as well.
Test circuit simulates real transmission lines with a coupling between systems made by a capacitor and with the lower nominal voltage system realized by 5 Π units. Using equations of this chapter parameters of the condensers and of the coils, which build HV components, can be calculated for different line length. Dissertation study is based on a 400/120 kV double-

circuit line, for another configuration (nominal voltages, towers shape) values requested can be determined by means of equations above.

Thesis III

The greater escalated potential is on the lower voltage disconnected phases (see Figure 7-9 and Equation 24 of the dissertation) the greater is the chance it can reignite sequentially ionized gas cloud remained. So it extends secondary arcing time and increases probability of the unsuccessful automatic reclosing.

Surge arresters and potential transformers are required on transmission line for reliable electric supply of proper quality. Switching off circuit-breakers of a phase conductor at both ends of the transmission line primary components mentioned above would not be disconnected.

From Figures 6-4 and 6-7 of the dissertation it could be determined evolution of the potential escalation introduced in Thesis I cannot be defeated by transmission line surge arresters. But by them it can be limited evolving voltage values increasing successful automatic reclosing probability. By comparing figures in Chapter 6 it can be shown that limitation degree is determined by nominal voltage difference between the systems, the tower shapes and the built-in surge arrester characteristics.

By author's investigation it is declared that discharging effect of the inductive potential transformer located on transmission line cannot disappoint come-off of the potential escalation introduced in Thesis I. However, evolving potential maximum is decreased by them it raises in this way successful automatic reclosing probability. After arcing end charge cumulated on disconnected phase will be discharged by them diminishing in this manner arc reignition probability after a greater arcing break (2-3 periods).

At opposition reclosing on the transmission line balancer voltage wave caused by potential difference between two sides of circuit breakers produces pregnant overvoltage according to [16] in dissertation.

Floating-point potential decreasing generated by influence of the surge arresters and the inductive potential transformers (see Chapter 6 and 8 of the dissertation) mitigates voltage on the transmission line side. On this wise smaller balancer voltage wave starts at both opposition and non-opposition reclosing on the transmission line generating lesser reclosing overvoltage.

Thesis IV

Multi-circuit, different nominal voltage transmission lines three phase systems can run on same towers by a length (calls S_{common}) then they can course on different towers possibly at different route. Lower nominal voltage system length where run on different towers from the higher one calls S_{alone} (see next Figure).

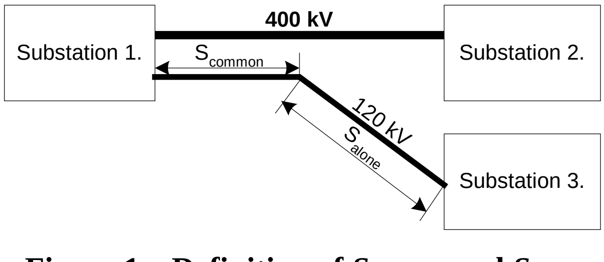

Figure 1 – Definition of S_{common} and S_{alone}

In Chapter 9.1 and 9.2 of the dissertation potential and energy conditions evolving during escalation introduced in Thesis I are studied. From these it declares that successful automatic reclosing probability depends on the determinant ratio of

$$A_{DM} = \frac{S_{alone}}{S_{common}}.$$

On basis of HV test circuit measuring showed in Thesis I, on literature data and simulation results a statement below can be stood:
If

$$U_{higher\ nominal\ voltage} = 400\ kV,\ U_{lower\ nominal\ voltage} = 120\ kV,\ S_{common} = 60\ km$$

and

$$A_{DM} > 1$$

terms are true danger of the self-maintaining long-time secondary arc evolving prospectively disappears and unsuccessful automatic reclosing probability decreases significantly.

We can define two similitude invariants:

$$\Pi_{Ex} = \frac{E_{xs}}{E_{xend}} \text{ and } \Pi_S = \frac{s}{S_{whole}}$$

where:

- E_{xs} *= energy of reignition No. x at a distance s from end of the lower nominal voltage system,*
- E_{xend} *= energy of reignition No. x at either end of the lower nominal voltage system,*
- $S_{whole} = S_{common} + S_{alone}$

Representing energy of self-maintaining long-time secondary arc reignitions according to function as follows,

$$\frac{E_{xs}}{E_{xend}} = f\left(\frac{s}{S_{whole}}\right)$$

depending of curves having got on tower geometry, on length of the lower nominal voltage system and on A_{DM} *is negligible.*