Switching impulses of overvoltage phenomena of power system in 220 KV transmission lines inter between substation case analysis

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This paper illustrates of switching impulse over voltage due to changing of the load condition to the existing 220 KV transmission lines as well as substation system. The study of performed by computer based method using ATP simulations. The details of the system modeling represented for various equipments designs and selection of the power system. These phenomenons are effects on the shunt reactor and loads on or off over condition will investigate. This analysis of the overvoltage occurrences under the transients small optimal determining from the overvoltage withstand in the equipments and continuous supply as well as less disturbance of the power system[1].

Keywords: ATP Simulation, Switching overvoltage, Transmission Line, Shunt Reactors, Surge Arresters.

I. INTRODUCTION

This effects on has been established depends on mathematical techniques or statistical process. This overvoltage transient like a non linear characteristics and scenarios introduced as well as waveform identified, to determine of BIL and BSL parameters accurately.

The generating station is distributions through the transmission lines has comparatively (I^2R) high losses. If the voltage is increasing times by times then overall losses will more and all equipments life times becomes less. It interruption during state condition and minimizes transient over current as well as voltage with well economically condition of the power system.

The equipments design and selection should be used accordingly electrostatic field [2]. The analysis to determine of the probability and flashover overvoltage. The transmission lines and station must be proper margins and probability before entrance to the station.

The overvoltage phenomena will occur networks ether or internally. The selection of overvoltage will be based on equipments strength for during operation [3].It is essential reduce to preserve of continuity of service and number of the outages .This discipline aiming to achieving for techno-economic compromise of protection of the equipments and public person from overvoltage.

II. METHODOLOGY AND PROCEDURE

A. STEP1: CALCULATION PROCEDURE DUE TO LIGHTNING OVERVOLTAGE

The insulation coordination of procedure according IEC 60071-1 shown Figure 1.1 has consists of 4 Steps.

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B. POWER FREQUENCY VOTAGE AND SOURCE OF NOMINAL VOLTAGE

The simulation model, the nominal voltage source($U_{s(p-p)}$)220KV is set as 1.0 p.u or 179.63 KV (crest). The maximum operating voltage ($U_{m(p-e)}$) of the equipment as 245KV is selected for voltage of nominal system according to[1]. The U_s and U_m are used further simulation and calculating model of an proper LIW and SDW voltage from Table I for HV equipments . The voltage of Power frequency or nominal sources is 220KV,

$$(Us(p-p)) = k_{PF} \times Us(p-e)), \tag{1}$$

k_{PF} is the horizontally configured of line is 0.70 and configuration of vertical phase is 0.40 Here, Us(p-e) is crest nominal of line to voltage of neutral , i,e,

$$Us(p-e) = \frac{\sqrt{2}}{\sqrt{3}} Us(p-p) = \frac{\sqrt{2}}{\sqrt{3}} 220KV = 179.63KV \tag{2}$$

Us=220kV and the maximum operating voltage (Um(p-e)=179.63KV.

C. TEMPORARY OVERVOLTAGE ($U_{rp,t}$)

The overvoltage of temporary for load rejection and earth fault condition are determine by load rejection is 314.35KV line to line or 1.75 multiplier of power-frequency voltage from figure 2. The earth fault overvoltage is 180.05 KV (line to earth).

$$Urp(p-e) = 1.75 \times (U_s).), \tag{3}$$

load rejection is 314.35kV (line to line)=1.75 x voltage of power frequency (U_s)=1.75 x 220KV=314.35kV.

TABLE I: The overvoltage of shapes and classes of overvoltage, standard voltage based withstand tests and shapes.

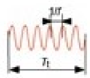
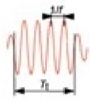
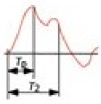
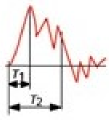
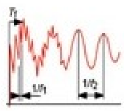
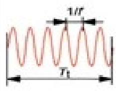
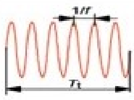
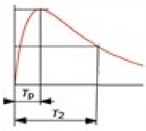
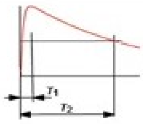
Class	Low frequency		Transient		
	Continuous	Temporary	Very front	Slow front	front of Very fast
Shapes of Voltage or Overvoltage					
Range of shapes for overvoltage or voltage	f = 50 Hz or 60 Hz $Tt \geq 3$ 600s	10 Hz < f < 500 Hz 0,02 s ≤ Tt ≤ 3 600 s	20 µs < Tp ≤ 5 000 µs $T2$ ≤ 20 ms	0,1 µs < $T1$ ≤ 20 µs $T2$ ≤ 300 µs	Tf ≤ 100 ns 0,3 MHz < $f1$ < 100 MHz 30 kHz < $f2$ < 300 kHz
shapes of Standard voltage	 f = 50 Hz or 60 Hz Tt a	 48 Hz ≤ f ≤ 62 Hz Tt = 60 s	 Tp = 250 µs $T2$ = 2 500 µs	 $T1$ = 1,2 µs $T2$ = 50 µs	a
voltage test of Standard withstand	a	Power of Short-duration frequency test	Test of Switching impulse	Test of Lightning impulse	a
a - specified by committees of relevant apparatus.					

TABLE II: Standard levels of insulation for range I (1kV < Um ≤ 245 kV) IS/IEC 60071-1 : 2006[1].

HV equipment (Um) kV (r.m.s. value)	Short duration Standard rated Voltage of power-frequency withstand in kV (r.m.s. value)	withstand voltage of lightning impulse in kV (peak value)
245	275	650
	325	750
	360	850
	395	950
	460	1050
Note: Additional of Line to Line withstand voltage are needed for considered insufficient of brackets values of line to lines voltage.		

D. SLOW-FRONT OVERVOLTAGE ($U_{rp,s}$)

The summarized from Table II that substation 1^{st} and substation 2^{nd} slow-front overvoltage are 311.13KV and 295.45KV for the entrance times of capacitor bank and re-energization during conditions. The re-energization and energization of substation slow front overvoltage times are obtained as 224.89KV.

TABLE III: THE SIMULATION PARAMETERS

Voltage types	Simulation cases		p(p-e)KV	p(p-p)KV
Power-frequency voltage (Us)				220
Temporary Overvoltage (Urp,t)	Earth -fault		180.05	-
	Load rejection		181.45	314.35
Switching Overvoltage($U_{rp,s}$)	Sub-2 from Overvoltage switching	Re-energization		311.13
		Switching of Capacitor banks		295.46
	Sub-1 from Re-energization and Energization		224.89	389.52
Selected				
`Fast –front Overvoltage($U_{rp,f}$)	Voltage of Switching impulse (U_{ps})			796
	Voltage of Lightning impulse (U_{pl})		550	

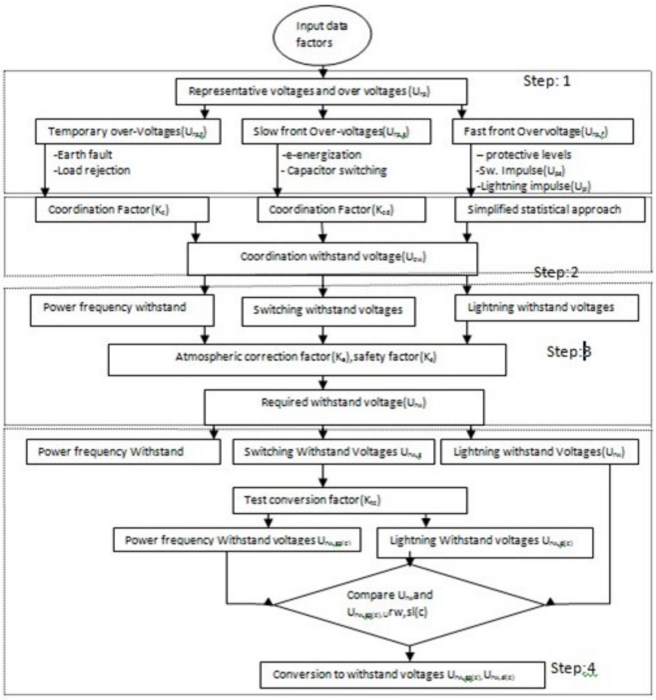


FIG. 1: To determination of flow chat for standard or rated of an insulation level for transmission lines and substation..

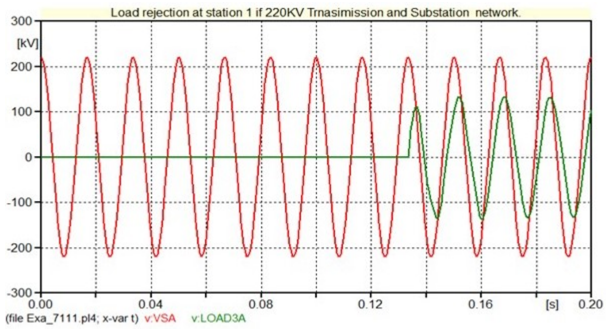


FIG. 2: The simulation of Overvoltage waveform for load rejection condition.

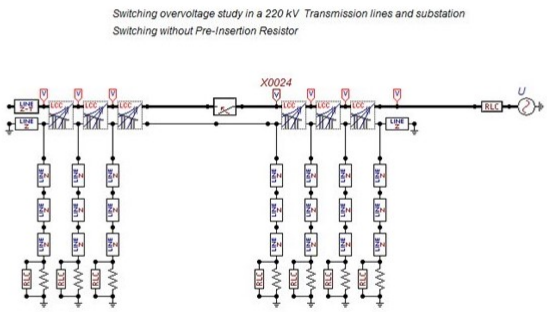


FIG. 3: Switching without of Pre-Insertion Resistor.

E. FAST FRONT OVERVOLTAGE ($U_{rp,f}$)

The lightning arresters rating against fast-front overvoltage at entrance of the substation 1st is consider by overvoltage of switching impulse (U_{ps}) and overvoltage of lightning impulse(U_{pl}).The $U_{pl(L-L)}$ is 796KV and $U_{ps(L-e)}$ is 550KV . The 2 times of voltage of switching impulse for 398KV from manufacturer of the surge arrester for substation 1^{ST} and 2^{nd} .

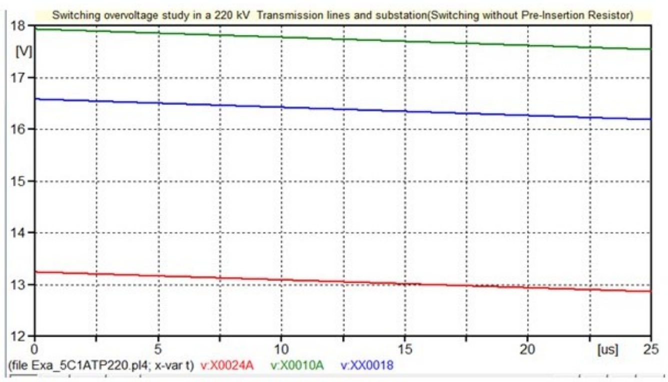


FIG. 4: Switching in transmission line without of the pre - insertion resistor

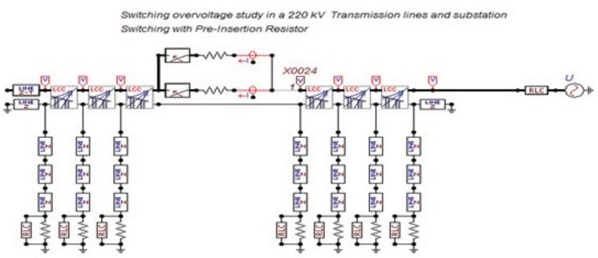


FIG. 5: Switching with Pre-Insertion Resistor.

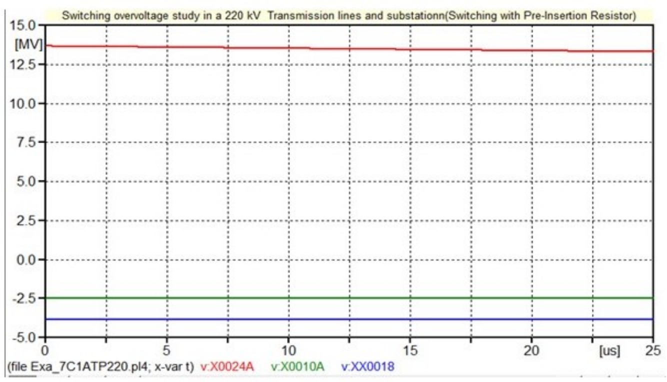


FIG. 6: Voltage Waveform of Switching with Pre-Insertion Resistor.

III. RESULTS AND DISCUSSIONS

A. Implementation of an ATP process of power System

This fault becomes from switching phenomena and due to overvoltage from circuit breaker and load switching operation times. This overvoltage creates the maximum stress on the transmission system and substation[5]. The major two categories are following bellow that: 1. The HV transmission lines without PIR of switching overvoltage 2. The HV transmission lines with PIR of switching overvoltage

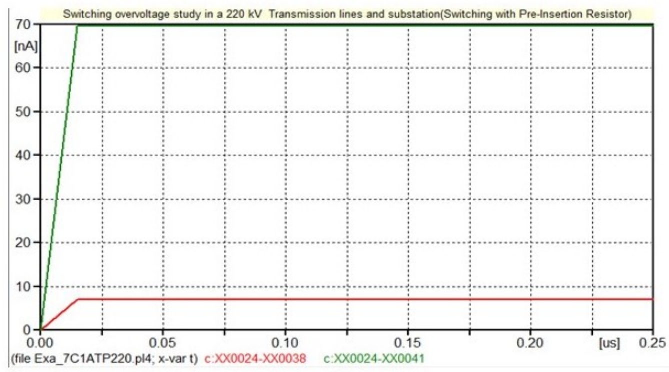


FIG. 7: Current waveform switching in Transmission line with of pre-insertion resistor.

Step 1: Switching without of pre-insertion resistor.

The switching overvoltage transient upto 1.4 P.U or voltage is 400KV is much higher. To compared of HV equipments and required protection while switching open or closing times of circuit breaker and Isolator. The without pre-insertion of resistor (PIR) of the switching transients peak and delay overvoltage occurs up to 13 P.U. This stress can control by transmission line BSL and BIL rating is upto 1850KV. This high magnitude base over voltage 400KV is problem for transformer as well as load terminal point[6].

Step 2: Switching with of Pre-Insertion Resistor

Result: Switching with of the Pre-Insertion Resistor

The prevent inrush current of the switching closed for pre-Insertion resistor (PIR) is used. The designs of switch for reduce losses against the PIR values of the switch are considered of negligible resistance to take over the main switch voltages waveform from steady state links[5]. The switch 1 closing times is 0.001s PIR value of switch 1 is 200Ω The closing times of switch 2=0.0011s Internal resistor value of switch 2 is 10 Ω

IV. CONCLUSION

The 220KV transmission lines and Substation equipment should be 395KV r.m.s for voltage of frequency withstand and 950KV r.m.s for voltage of impulse withstand for external and internal insulation level. The minimum clearance and safety distance two things the entrance equipments are 1.10 meters. The HV equipments strengths are minimum stress and difference gives of reliability of system. The disturbance happens during the switching and lightning condition. To abnormal and overvoltage occurs by various fault periods it. The aim is minimum and optimal design for insulation coordination.

The design is deterministic, optimization, strengths minimum distance for surge and lightning charge for civil structures. The strategies are depends on breakdown voltage, withstand voltage, surge limiting vales and positions.

The civil structure will be proper design by ice strengths, parallel lines, line exposure (L-L or L-N) and overvoltage calculation based.

[1] IEC Standard 60071-1, Insulation Co-ordination part 1 Definitions, Principles, and Rules, 1996.

[2] Hileman, Andrew R. Insulation coordination for power systems. CRC Press, 1999.

[3] Allan Greenwood, Electrical Transients in Power Systems, Second Edition Substation." IECON 201238th Annual Conference on IEEE Industrial Electronics Society. IEEE,2012.

[4] EN Insulation Co-ordination part 1: Definitions, principles and rules, EN 60071-1 Standard, 1996.

[5] Abbasi, Ehsan, Heresh Seyedi, and Kai Strunz. "Simulation and analysis of the effect of Single pole auto reclosing on HV transmission lines switching over voltages." Power & Energy Society General Meeting, 2009. PES'09. IEEE . IEEE, 2009.

[6] Sood, Ms Dimpy. "Reduction of Switching Over Voltages in HV Transmission Line."