Effects of Cable Models on Lightning Overvoltage Transfer From Transmission Lines to Distribution Systems

B. VAHIDI                    M. HEIDARI                                K. RAAHEMIFAR
Department of Electrical Engineering                                 Dept. of Electrical & Computer Engineering
Amirkabir University of Technology                                  Ryerson University
Tehran – Iran                                                                       Toronto, Ontario
Canada

Abstract: - The lightning surges can be transferred from one side of transformer to another side of transformer through couplings between high voltage and low voltage side of transformer. In this paper by choosing different cable model for distribution system and by aid of EMTP, simulation has been done to find effect of cable model on transfer over voltage to distribution system.

Key-words: - Lightning, Cable, Transmission line, Distribution system, Model

1 Introduction
Modern processes are more sensitive to voltage quality problems i.e. voltage sags and swells can precipitate a shutdown [1].

The most common primary distribution voltage in industrial systems in Iran is 20 kV, however for large power demands, the utility system voltage may be as high as 230 kV. The surge transfer through the transformers depends upon the voltage; turn ratio, as well as electrostatic and electromagnetic coupling of the windings [1].

A typical distribution supplies on the order of 10 MW of power to hundreds of customers [2,3]. The lightning protection method assumes that the bulk of the lightning current that strikes the primary line will be discharged into the pole ground. However, distribution transformers can be fail or be damaged during lightning storms despite being protected by a primary arrester from overvoltages. Often the cause of the failure is from a surge appearing on the secondary of the transformer [4].

2 Simulation
In order to show the effects of cable models, circuits of figs. 1 and 2 are simulated on the EMTP. Consider that a direct lightning strokes on phase of 230kV side. Surge current is 20kA, 2/50 μs.

For different cables length (100m, 10km) secondary voltage of transformer and load are show in figs. 3 to 10. In this simulation high frequency model of transformer was used [5,6], and the cables were modeled in EMTP.

Fig. 1. Simulated circuit on EMTP (cable distributed model)
3 Results

Fig. 3 shows secondary voltage of transformer for distributed model of cable (DMC) with cable length ($C_L$) of 100m. Load voltage for DMC ($C_L=100m$) is shown in fig. 4.

Fig. 5 shows secondary voltage of transformer for lumped model of cable (LMC) for $C_L=100m$. Load voltage for LMC ($C_L=100m$) is shown in fig. 6.

Fig. 7 shows secondary voltage of transformer for distributed model of cable (DMC) with cable length ($C_L$) of 10km. Load voltage for DMC ($C_L=10km$) is shown in fig. 8.

Fig. 9 shows secondary voltage of transformer for lumped model of cable (LMC) for $C_L=10km$. Load voltage for LMC ($C_L=10km$) is shown in fig. 10.
4 Conclusion

From results can be concluded that for short length of cable, there are not much difference between the results of DMC and LMC simulation. But for long length of cable results of simulation are different and model has great influence on the wave shape even the amplitude is the same.

References: