28th International Conference on Lightning Protection

Topic VI: Lightning Protection of Power Systems

VI-C: Lightning Transients and Surge Arresters in Power System

Moderator's Report

Chairman: H. Torres *National University of Colombia, Colombia*
Moderator: R. Thottappillil *Uppsala University, Sweden*

This session can be considered as a logical continuation of the previous two sessions VI-A and VI-B dealing with lightning protection of power systems, but now the focus is shifted to the characteristics of lightning induced transients, location of fault caused by these transients and the application of surge arrestors for limiting these transients. The session has 7 papers in the oral part and 12 papers in the poster part. Based on the topic treated, the papers can be grouped approximately under the following titles as shown in Table I, even though there can be overlaps in specific cases. In Table I, papers in the oral session are indicated in bold letters.

Even though all the papers contain some interesting and novel aspects of the lightning interaction with power system, they differ widely in the quality of presentation. Certain papers require extensive rewriting and English language correction before eventual submission to refereed journals.

Brief comments on the papers in the oral session are given below.

Paper **VI-15** investigates the influence of the rise-time of the lightning current waveform on the calculated overvoltages. EMTP program is used for the calculations. The ramp wave (1 μs, 2 μs, and 4 μs), the CIGRE-recommended wave, and the double-exponential wave were used as inputs in the sensitivity analysis of the tower top overvoltages. In general, shorter rise time gives larger overvoltages.

Development of a new device to locate the ground fault on transmission lines is reported in paper **VI-16**. The device consists of two current transformers installed on either side of a tower, which detect the direction (phase) of current flow. The fault current carried by the tower causes currents of opposite phases in the CT's.

Paper **VI-17** also evaluates the results from a device (called FAST) for locating lightning faults on transmission lines. The sensors of the device consist of wide-band electric and magnetic field antennas located at the transmission side of substations. It can detect waveforms of the surges caused by faults and by computing the difference in the time of arrival of the surges at two stations the location of fault is computed. Tests carried out in various transmission lines in Japan shows that the device has a location error (50% value) of 148 m only, a fourfold improvement in location error when compared to other methods.

The partial installation of the 275 kV line surge arrestors is the subject of paper **VI-18.** Economy dictates that surge arrestors can not be placed at every tower and therefore optimal placement of surge arrestors are to be decided by calculations taking into account specific features of the line such as distance from coast line, tower height, altitude, tower surge impedance and lightning frequency. The method is explained and applied to the 275 kV transmission line for winter lightning conditions in the Fukui Prefecture

Contact Address:
Rajeev Thottappillil
Division for Electricity and Lightning Research, Uppsala University
Box 534, 75121 Uppsala, Sweden
E-mail: Rajeev.Thottappillil@angstrom.uu.se

in Japan.

In paper **VI-19**, a review is presented on the status of application of 66kV-500 kV class surge arrestors in Japan during 1992-2002. International comparison of annual failure time of power supply presented in Fig. 15 of the paper shows that Japan has the most reliable power supply when compared to England, France and USA (Source of data and basis of comparison not given in the paper). Authors imply that basis of less power supply failure in JAPAN is the wide spread application of MOV's in Japan.

For efficient and reliable surge protection, surge protective devices applied at different stages have to be coordinated. Paper **VI-20** reports the development of a new technology that coordinates between Class 1 and Class 2 arrestors without the need for cable length or deliberate inductance connected between them. A device integrating Class 1 and 2 protections into a single SPD is presented. The spark gap (Class 1) in the SPD is electronically triggered.

Paper **VI-21** theoretically compares the transient input impedance of ground electrodes calculated using two different methods, treating the electrode as a wire antenna or treating the electrode as a transmission line. Calculations show that at early times, typically less than 1 microsecond in lightning, the input impedance predicted by the transmission line model is far in excess of that predicted by the wire antenna model. However, it should be pointed out that the transmission line model they have used is incomplete because it does not include the transient ground impedance and admittance and the R, L, C parameters are not frequency dependent.

TABLE I
GROUPING OF PAPERS ACCORDING TO THE TOPIC

Induced transients characteristics	Fault location methods	Surge arrestor Application	Grounding system	Location of lightning that causes faults
VI-15, VI-45	**VI-16, VI-17**, VI-51	**VI-18, VI-19, VI-20**, VI-41, VI-42, VI-43, VI-44, VI-45, VI-46, VI-47, VI-48, VI-49	**VI-21**, VI-52	VI-50

Note: Paper numbers in bold indicate that in oral session