Lightning Protection for an ICT Oriented Society

Background and Objective

Recently highly sophisticated society systems have been constructed using information and communication technologies (ICTs). These systems, however, are vulnerable against external disturbances such as lightning. Once social infrastructures such as information networks and power supply systems will stop, extraordinary confusion may occur in society.

In this project, we will further develop lightning protection methods constructed so far and will establish novel lightning protection technologies to construct robust power supply systems in society with information and communication technologies, taking the concept of the lightning risk management into consideration.

Main results

1. Enhancement of the lightning database

We have constructed an enhanced lightning database based on the data for 17 years obtained with lightning location systems in cooperation with electric power companies in Japan. Using the database, we have clarified lightning characteristics such as annual, seasonal and regional variations in lightning occurrence, the relationship between lightning occurrence and climate conditions [Fig. 1].

2. Development of lightning risk assessment method for an ICT oriented society

We have constructed lightning risk assessment program to evaluate various lightning risks such as the occurrence of instantaneous voltage drops [Fig. 2]. In the program, the concept of lightning hazard, which is an index of severity determined by not only the number of lightning flashes but other factors such as the distribution of lightning current peaks and striking characteristics, is used.

3. Development of technologies of lightning protection and EMC for control, information and communication equipment in power systems

We have been carrying out basic research into the effects of lightning surges on low-voltage circuits of substations both experimentally and theoretically [H08004, H08017]. Using a model GIS circuit which simulates actual substation equipments [Fig. 3 (a)], we have measured voltages induced in the control circuits by surge currents flowing into the bus of the model GIS. The experiments clarified several important characteristics as follows.

1) Capacitors set at the entrance of the relay system effectively reduce the induced voltage.
2) The peak values of induced voltages do not depend on grounding methods of the sheath of control lines. This characteristic is different from a case where a surge current flows into the grounding mesh of a substation.

These results will be used as fundamental data to establish a calculation method to predict induced voltages.

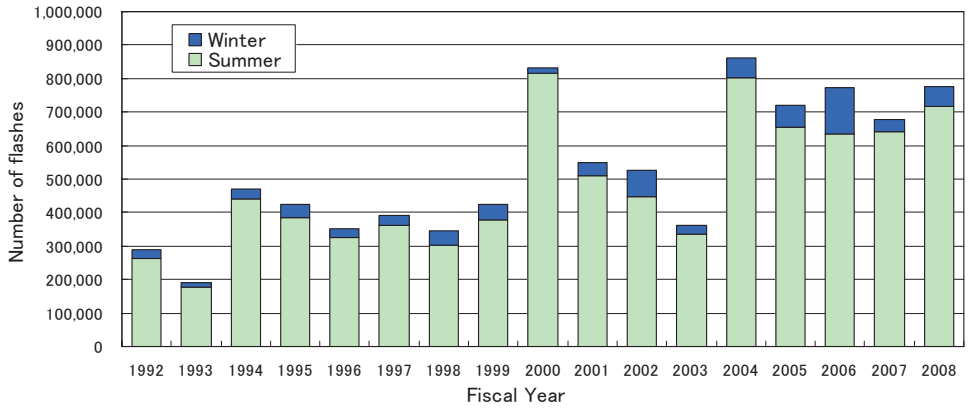


Fig. 1 Annual variation of the number of lightning flashes in Japan

Numbers of lightning flashes all over Japan are shown for summer (Apr. to Oct.) and winter (Nov. to Mar.) About 0.7 million of cloud-to-ground flashes have recently occurred.

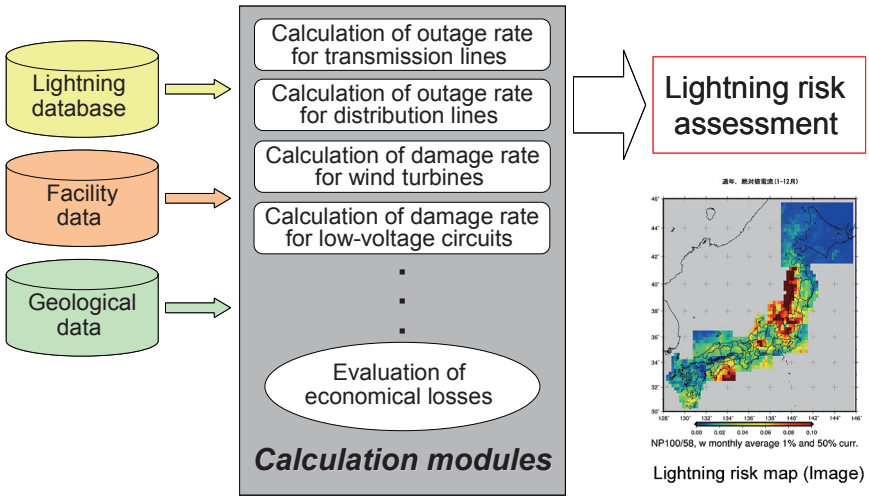
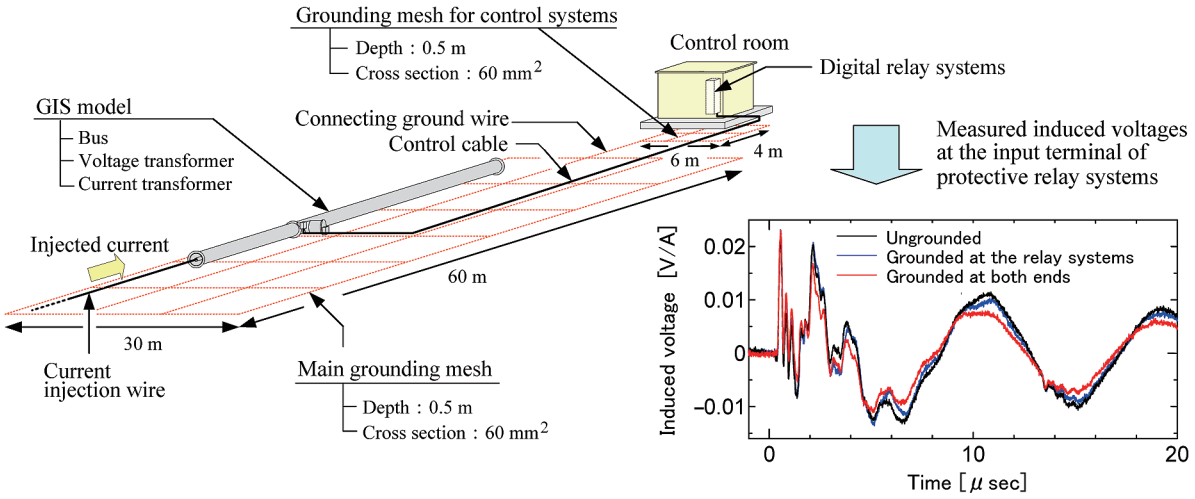


Fig. 2 Concept of lightning risk assessment program



(a) Experimental arrangement

(b) Effects of grounding position of the sheath on the induced voltage

Fig. 3 Voltage induced on a control circuit when a surge current flows into the bus of a GIS

Voltage waveforms shown in Fig.3 (b) are obtained when a surge current flows into the bus of the model GIS (Gas Insulated Switchgear) shown in Fig.3 (a). The voltage waveforms are almost the same and it indicates that effects of grounding method on induced voltages are negligible.