

Estimation of the Probability of Lightning Hazard on Railway Signalling Systems by Observing Induced Overvoltage

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As electronization progresses for railway signalling systems, components that are intrinsically prone to overvoltage are often damaged by lightning strikes. Little knowledge is available so far, however, on the relation between the damage caused to a signal system having arbitrary anti-lightning performance and the magnitude of the lightning strike relative to the distance from the striking point. A technique is described below to estimate the probability of the occurrence of damage to a signalling system due to a lightning strike based on the observed overvoltage when the system has been subjected to an impact.

1. Observation of lightning overvoltage

In the summer of 2010 to 2012, we observed the lightning overvoltage caused in the basic components of signalling systems on the ground, such as rails, signal cables and overhead power supply wires, and determined its correlation with the "condition of the lightning strike" defined as I/r , the ratio of the lightning current (I) to the distance (r) from the striking point. Data points corresponding to this relationship are shown in Fig. 1. As a result, we are now able to use the formula for estimation in Fig. 1 to determine the condition whereby a lightning strike may damage signal systems connected to overhead power supply lines. (Other formulae can be determined from Fig 1 for signal cables and rail.)

As an example of the use of the formula, for a signal system having anti-lightning performance of 30kV being connected to overhead power supply wires, the formula predicts that a lightning strike will take place when the lightning condition is 195.7kA/km or greater (point A in Fig 1). This is equivalent to a case where a lightning strike of 31kA, which is an

average magnitude, strikes the system in the area within a radius of 158m. We have confirmed that this estimation is approximately in agreement with survey results of actual lightning damage.



2. A technique to estimate the probability of the occurrence of lightning strikes on signal systems

We are able to estimate the probability of the occurrence of lightning strikes on a signal system by taking into account the number of lightning strikes and the condition to cause lightning to hit the area where the signal system is installed. This methodology is outlined in Fig. 2.

The example in Fig. 2 is for a signal system with anti-lightning performance of 30kV located in a heavily stricken area where the frequency of lightning strikes within a radius of 10km is 1,000 times a year. In this case, the probability of the occurrence of lightning strikes is estimated to be 0.37 times a year under the assumption that the lightning attacks are uniformly distributed. This technique allows estimation of the anti-lightning performance required for signal systems to reduce the frequency of lightning strikes to the targeted level and makes it possible for signal system engineers to discuss effective measures against lightning hazard.

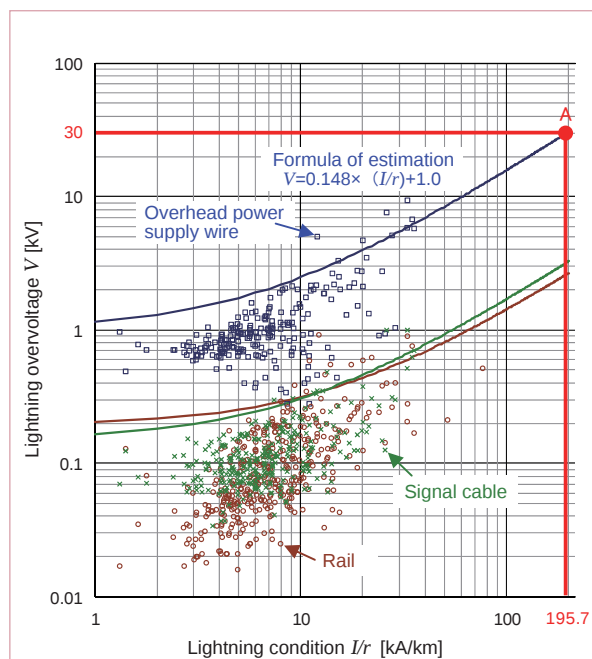


Fig. 1 Estimation of the condition of lightning strike to cause damage

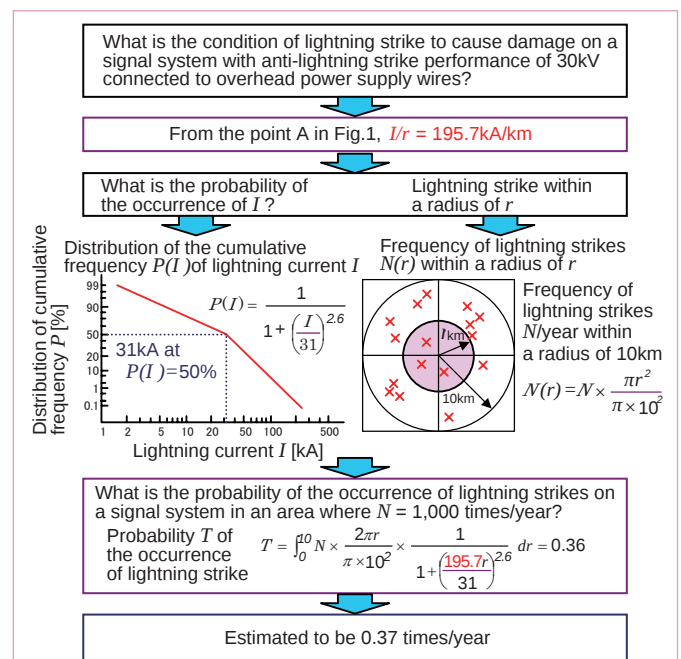


Fig. 2 A methodology to estimate the probability of the occurrence of lightning strikes