## A.9.5.

### Determination of Cables Dynamic Rating Using a FEM

Hong Jie Li, Kee Choon Tan and Qi Su, PowerGrid, Singapore
su_qi@powergrid.com.sg

There are several factors determining the ampacity (current carrying capacity) of a cable circuit, namely, the cable construction, the cable surrounding soil, the ambient temperature and sheath bonding method. Of these factors, the thermal properties of soil are always varying while the others are relatively stable. For example, long time no rain can dry out the soil, resulting in as high thermal resistivity as 1.2 °C m/W, while a short time rainfall can make the soil thermal resistivity as low as 0.4 °C m/W. In this sense, the cable ampacity are dynamic. Therefore, dynamically assigning proper rating to the cables can maximize the cable ampacity without causing overheat of the cable, so that a high-efficient operation of underground cable system can be achieved.

Nowadays, more and more power utilities have recognized the importance of thermal condition monitoring of buried cable circuits and installed temperature measurement systems to monitor the surface temperature of cables. One way to reveal the thermal status is to directly measure the cable surface temperature. The earlier systems are implemented with thermocouples, which are buried at some locations of interest along the cable route, and currently, with the more advanced optic fiber distributed temperature sensing (DTS) systems. Such systems are being installed extensively in HV cable networks. But the problem of real-time monitoring cable thermal condition is not completely solved.

The investigations have shown that under dynamic loading conditions, the temperature difference between the cable surface and the conductor is very complicated, particularly when the loading currents vary significantly in amplitude within a short-time, e.g. under emergency conditions. Therefore, how to infer the conductor temperature from the surface temperature is the first problem needed to be solved so that the cable can be assigned with as high load as possible without exceeding the rated conductor temperature. The second problem, which is more difficult, is to evaluate the thermal parameters of the surrounding soil, with which the maximum ampacity can be predicated so that dynamic rating of HV power cables can be realized.

This paper addressed the problems stated above. First, a thermal model is built to determine the conductor temperature from the cable surface temperature and load current. To confirm the validity of the model, numerous lab tests were performed under various loading conditions and it was proved that the results calculated using the model are in good agreement with the measurements.