Fault Current and High Power Arc Technology for Establishment of Secure and Reliable Power Equipment

Background

When a short-circuit fault occurs in transmission and distribution systems due to lightning strike, high current, several to dozens of times as load current, flows to the fault point. In case a high power arc occurs due to the fault current with dielectric breakdown, it is necessary to protect power equipment and ensure public security.

CRIEPI has promoted research for limiting and interrupting the fault current to establish secure and reliable power systems.

High power arc (Current : 30 kA)

Various materials around a short-circuit fault point are decomposed to molecules, atoms, ions, and electrons, and finally reach a plasma state. High power arc produces enormous heat, blinding flash and detonating sound.

Principal results

(1) Development of technology for limiting fault current immediately

Arc driven type fault current limiter for 6 kV class distribution lines has been developed by joint research with Tohoku Electric Power Co., Inc. and Sankosha Co., Ltd.

(2) Development of arcing horns for interrupting fault current instantaneously

Fault current interrupting arcing horns for 66/77 kV transmission and 22 kV distribution lines have been developed by joint research. A simulation model of the fault current interrupting arcing horns applicable to EMTP (Electromagnetic Transients Program) has also been developed to analyze power system conditions.

For 66/77 kV transmission lines	Maximum interruption current : 10 kA_{rms} (Peak current value : 25 kA) by Kansai Electric Power Co., Inc., Tokyo Electric Power Co., Inc., Nippon Katan Co., Ltd. and CRIEPI
For 22 kV distribution lines	Maximum interruption current : 15 kA_{rms} (Peak current value : 37.5 kA) by Kansai Electric Power Co., Inc., Nippon Katan Co., Ltd., Nihon Network Support Co., Ltd. and CRIEPI

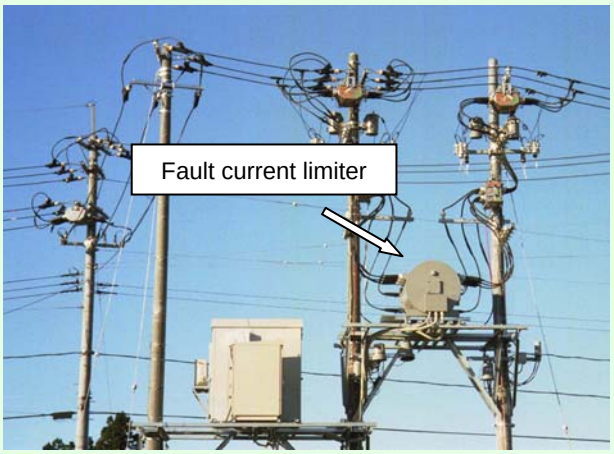
(3) Elucidation of high power arc phenomena due to fault current in power equipment

We have elucidated that the temperature of an arc jet due to a high current of 50 kA reached around 10,000 K in the vicinity of electrodes.

Future Developments

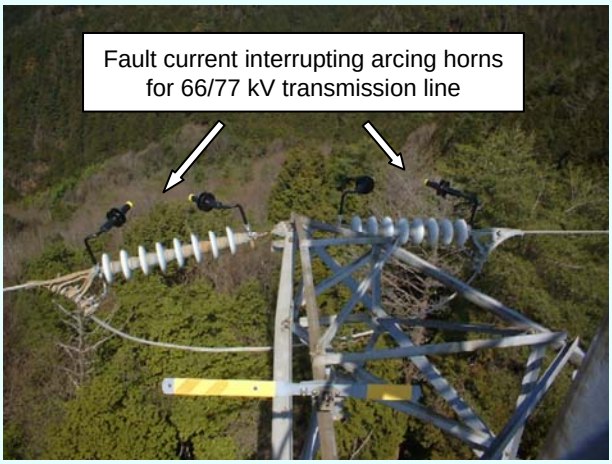
(1) Develop low-cost and effective technology for limiting and interrupting fault current.

(2) Develop digital short-circuit test tools to compensate full-scale short-circuit tests, and promote rational and efficient research for fault current and high power arc technology.



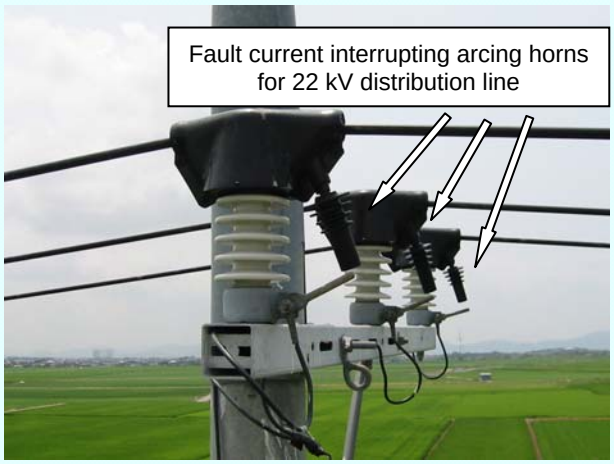
Demonstration of arc-driven fault current limiter

The figure shows the verification test of an arc-driven fault current limiter on a 6.6 kV distribution system by joint research with Tohoku Electric Power Co., Inc. and Sankosha Co., Ltd. We have confirmed that any malfunction did not occur.



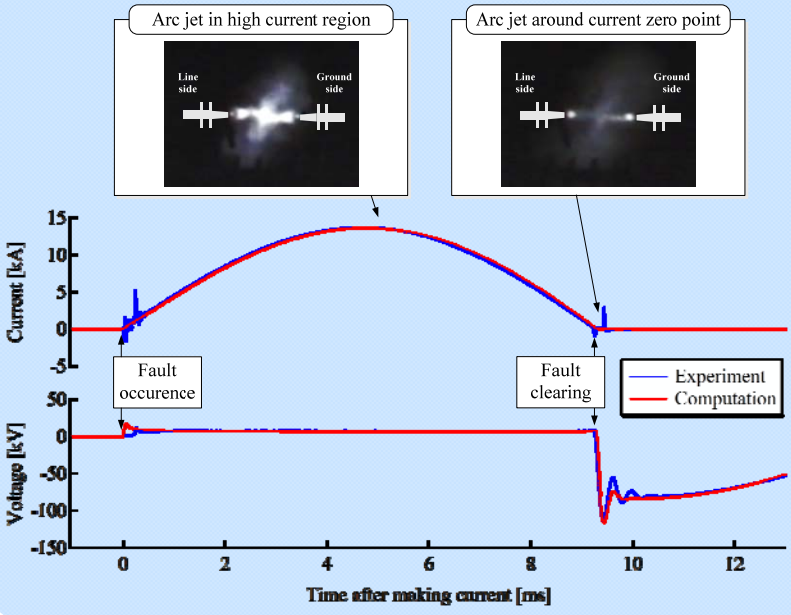
Fault current interrupting arcing horns for 66/77 kV transmission lines

Maximum interruption current 10 kA, around 35,000 installations in Japan.



Fault current interrupting arcing horns for 22 kV distribution lines

Maximum interruption current 15 kA, under verification test



Development of simulation model of fault current interrupting arcing horns

Calculated waveforms using the simulation model are accurately consistent with experimental waveforms obtained from full-scale short-circuit test. We could simulate the entire process from fault occurrence to fault clearing.