PERFORMANCE STUDY OF THE PROTECTIVE CIRCUIT BREAKER OF THE FAST DISCHARGE UNIT FROM THE ITER SUPERCONDUCTING COILS [[1]](#footnote-1)\*)

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1Alekseev D., 1Karpishin M., 2Krivosheev S., 1Manzuk M., 1Roshal A., 1Semenov A., 1Soleny A.

1JSC “NIIEFA”, St. Petersburg, Russia, [manzuk@sintez.niiefa.spb.su](mailto:manzuk@sintez.niiefa.spb.su)   
2Peter the Great St. Petersburg Polytechnic University, St. Petersburg, Russia,  
 [ksi.mgd@gmail.com](mailto:ksi.mgd@gmail.com)

The operation of almost all types of existing high-current switches, except for solid-state and hybrid ones, is accompanied by an electric arcing, which appears immediately after the contact opening and exists until the quenching process is completed. The electric arc decays when its voltage exceeds the voltage of the circuit power supply in which the current breaker is installed. The arc voltage changes in proportion to the length of the arc. As the arc length increases, the arc voltage increases too, so one of the most common ways to quench the arc is to stretch it in arc quench chambers or to stretch it by dividing it into many shorter arcs, which leads to an additional increase in arc voltage by creating multiple cathode voltage drop zones. In addition, the voltage-current characteristic of an electric arc is significantly affected by electrical and thermal processes, as well as environmental conditions [1], so the more intense the cooling process, the higher the arc voltage at a given current.

The energy that is dissipated in the arc during the quenching process is a key characteristic of the DC switching process, because this energy, being a function of the inductance and the ratio of arc and source voltages, depends on the parameters of the entire external electrical circuit [2]. Therefore, for proper functioning, the DC breaker must dissipate more energy than can be stored in the magnetic field of the external inductance.

The understanding of the arc energy amount that can be dissipated without damage to the device is necessary to estimate its ultimate breaking capacity, and makes it possible to estimate the switching capacity margin for a particular application.

This paper will present the results of experiments showing a direct connection between the energy dissipated in the electric arc inside the switching part of the DC explosive circuit breaker and the nature of the current switching process. Consequently, it allows us to estimate the safety factor between nominal operation mode, which corresponds to arc energy in the range of 13...16 kJ, and the critical point, starting from which there are noticeable changes in the commuted current curves. This safety factor corresponds to a value of about 50% for the first critical point and more than 150% for the point where the arc quenching process fails.

References

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2. Shukla A., Demetriades G.D. A Survey on Hybrid Circuit-Breaker Topologies. IEEE Transactions on Power Delivery. 2015. V. 30, i. 2, pp. 627-641.

1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/L/E/ru/IM-Manzuk.docx) [↑](#footnote-ref-1)