EXPERIMENTAL EVALUATION OF THE RELIABILITY MEASURE OF ITER FAST PROTECTIVE SWITCHES [[1]](#footnote-1)\*)

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A significant leap in the development of tokamaks occurred as a result of the transition from resistive to superconducting windings, which allowed to considerably reduce the energy consumption for the formation and maintenance of magnetic fields. To continuously maintain the current in the superconducting windings for a long period of time almost no additional power from an external source is required. Limited power is needed only to compensate for the insignificant losses in the busbars, switches connected in series with the coils, and the contact joints outside the cryostat. Taking into account the advantages described above, most modern large-scale tokamaks, including the ITER tokamak, have a superconducting magnetic system.

In the power supply system of any superconducting winding is provided a fast discharge unit, the main task of which is to protect the superconducting winding in the case of a superconductor quench, which can lead to serious and even irreversible consequences for the whole facility. To prevent a negative scenario, it is necessary to extract the energy stored in the magnetic system (in the ITER tokamak ~51 GJ), and, at the same time, the current discharge time should be such that overheating of the damaged section does not exceed the permissible value. On the other hand, the rate of current output, directly related to the voltage applied to the coil, must be limited to prevent damage to its insulation.

Taking in consideration the above, there are extremely high requirements for the reliability of fast discharge units. To increase reliability, the fast discharge unit consists of two switches connected in series - the main and the backup. As a backup, high-speed device with explosive actuator, developed in JSC "NIIEFA" and protected by a patent of the Russian Federation [1], in which mechanical destruction of current-carrying structural elements and quenching of electric arc occurs in an aqueous environment due to energy resulting from the detonation of an explosive charge, are used.

To confirm the protective switches’ reliability, an experimental company was conducted to confirm the reliability of the protective devices at the level of at least 0.96, which gives the reliability of the entire system at the level of 0.9955. The experimental company consisted of 72 experiments conducted at rated currents and voltages in the switched circuit.

References

1. Patent RU 275 54 54 C.
1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/L/E/ru/JX-Semenov.docx) [↑](#footnote-ref-1)