SC A3 – Transmission & distribution equipment
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Fault current limiters for electrical grids 220 kV on the base of the fast-acting high-voltage explosive commutator

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One of the important tasks to ensure the power system reliability is the need to limit the levels of short-circuit currents in electrical networks. The increasing of short-circuit current levels is due to the development of electric power systems (the construction and commissioning of new transmission lines and generation objects, an increase of the consumer loads). When short-circuit currents in electrical grids exceed the short-circuit breaking capacity of the electrical switches, the power failures in electrical networks and the damages of substation equipment can occur. The task of short-circuit current limiting is particularly acute for the megalopolis electrical grids.

The main measures to limit levels of short-circuit currents are the following: the sectioning of the electrical network and the use of fault current limiters of different types. An alternative measure is the reconstruction of substations (or power stations) with the replacement of short-circuit breakers to increase short-circuit breaking capacity. The disadvantage of the network sectioning is a decrease of the power system reliability levels, due to a decrease in the ability to backup the consumer loads. In addition, the use of the network sectioning can lead to non-optimal power flows associated with an increased level of power losses in electrical networks. Implementation of substations reconstruction (with the short-circuit breakers replacement) does not decrease the short-circuit currents. This leads to high levels of peak short-circuit currents and increases the requirements for ensuring the resistance of the power equipment (primarily transformers) to electrodynamic forces. In some cases, short-circuit breaking capacity is not sufficient to disconnect the faults in the electrical network. An effective measure to limit the levels of short-circuit currents is the use of various fault current limiting devices. In order to effectively limit the peak short-circuit currents, the operation of fault current limiters should occur on the first wave of current rise, i.e. the operation time of the fault current limiter should be no more than 2-3 ms.

One of the innovative devices to limit short-circuit currents in electrical networks is the fault current limiter designed for 220 kV and based on fast-acting explosive commutator (TOU-220). At present, the advanced prototype of TOU-220 has

been manufactured. The explosive commutator of TOU-220 is actuated from autonomous control modules when the instantaneous current value exceeds the TOU-220 breaking capability. Within 1 ms, the explosive energy destroys the commutator conductor, which transmits currents of up to 2 kA. Then, within 1.5 ms, the current is redistributed in a resistor and a special current-limiting reactor. The resistor limits the overvoltage in the network that occurs due to the fast switching of large currents (40-60 kA). The resistor is disconnected after 2-3 ms. The reactor implements the function of a fault-current limiter with an operating time of up to 10 s. The level of short-circuit current limiting is defined by the specific conditions of the circuit and can be in the range from 5 to 20 kA.

The full cycle of the manufacturing and laboratory tests of the TOU-220 was performed. Element-by-element testing of the TOU-220 for electrical strength and resistance to electrodynamical forces was carried out. The results of these tests have confirmed the compliance TOU-220 with the functional and technical requirements (defined by the project). TOU-220 technical characteristics:

- the transition time to the current limiting mode – 1.5 ms;
- the level of current limiting (determined by the reactor) – 10 kA;
- the maximum voltage when switching to the current limiting mode – less than 240 kV;
- the electrical strength of the explosive commutator (after operation) – not less than 500 kV.

According to the results of TOU-220 complex tests, a decision was made to implement a pilot project for the commissioning TOU-220 at the 500 kV Kaskadnaya substation (Moscow). The project for the installation of TOU-220 at the substation was developed by R&D Center FGC UES together with JIHT RAS (Joint Institute for High Temperatures of the Russian Academy of Sciences). At present, the comprehensive test and pilot operation program of TOU-220 at SS 500 kV Kaskadnaya has been developed. Installation of TOU-220 at the substation has been completed.

Taking into account the results of the study, fault current limiters based on fast-acting explosive commutator are promising current-limiting devices with a number of advantages and can be widely used in electrical networks of various nominal voltages. There are at least eight pilot objects in the power system of Moscow for the implementation of TOU-220.