DEVELOPMENT OF THE CONTROL SYSTEM FOR SWITCHING NETWORK UNITS OF THE ITER SUPERCONDUCTING COILS

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Switching network units are used in the ITER power supply system to produce the voltage necessary to generate the plasma at the beginning of each cycle of the tokamak operation. For this purpose, direct current of the superconducting coils of the magnet system is transferred into the discharge resistor. The plasma is initiated by eight units built by the multi-stage scheme and consisting of the following key components:

* fast mechanical switch consisting of a circuit breaker, the contact system of which is shunted by thyristors, and a disconnector required to provide electric strength;
* high-voltage pulse switch ensuring blocking of the shunting thyristors and capable of conducting the current within the time necessary to recover electric strength of the disconnector;
* make switch bringing into the winding circuit an additional resistor section with the aim to control the process of plasma generation;
* make switch shunting the resistor after plasma generation and providing current passage in the coil during plasma burning.

Ideologically, the ITER control and diagnostics system is divided into the central control level including human-machine interface and the level of tokamak functional systems. The following subsystems are distinguished in the architecture of the control system: control, data acquisition and communication; equipment protection; personnel and environmental protection.

To control the switching equipment according to the plasma generation scenario the control system has been developed, which is architecturally divided into several levels, namely, upper level, level of switching network units and local level. All units composing the system are connected using tree topology concept and integrated into the central control system of the tokamak.

The upper-level cubicle synchronizes operation of all eight switching network units, generates commands according to the state of the tokamak control system and scenario timing, processes diagnostic data from the lower control level, forms the data blocks for the ITER control system and performs protective actions by its command.

The control cubicles of the switching network units execute commands of the upper level, coordinate operation of the key units (circuit breakers and make switches), process and translate the diagnostic data into the upper level cubicle, as well as perform protection actions for a separate switching network unit by self-diagnostics data or by a command from the upper level.

The local cubicles generate control commands directly to the switching equipment, as well as process and transmit the diagnostic information received from the data acquisition units installed on the switches frames.

The control cubicles use programmable logical controllers to implement control loops and data acquisition slower than 100 Hz and FPGA-based controllers for faster processes.