ENERGY SYSTEMS AND ELECTRICAL NETWORKS

AUTOMATIC LOAD-FREQUENCY CONTROL
OF THE UNITED POWER SYSTEM OF SIBERIA

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A centralized system for automatic load-frequency control (ALFC) has been developed by the Siberian Division of the Central Computing Center of the Power Industry and realized on the basis of a commercial OMRON controller that performs all control functions. The algorithmic and software support of ALFC performs several new functions, i.e., helps to produce control actions on regulating stations with allowance for the specified daily output, perform second-after-second (cumulative sum) accounting for the power produced by a power station due to participation in the control, initiate combined regulation of power flow and frequency (APFR), ensure maintenance of a 1-sec archive with a depth of over 30 days for any telemetry (TM) used in the ALFC, etc. The software has been developed with the help of special language based on the IEC 1131-3 standard.

Keywords: adjuster of unscheduled power settings (AUPS), local computer networks (LCN), ganged regulator of active power (GRAP), ganged regulator of active and reactive power (GRARP), programmable logical controller (PLC), automatic load-frequency control (ALFC), hydropower plant (HPP), substation (SS), complex for processing telemechanics data (CPTD), central dispatching office (CDO), united power system (UPS), central adjuster of active power settings (CAAPS)

The united power system of (UPS) of Siberia covers the territory of East and West Siberia, four full time zones, and over 4000 km long in the latitudinal direction.

The UPS of Siberia includes 12 power pools with installed power of 46.4 thousand MW (January 1, 2004) about half of which falls to hydropower plants.

The largest hydropower plants of Russia that can participate in automatic load-frequency control with a quite wide control range enter the UPS of Siberia.

The ALFC system has been functioning in the UPS of Siberia for over 30 years. In this period the system was updated many times, and its algorithms and hardware were improved. The latest ALFC of the United Dispatching Office (UDO) of Siberia installed in 2002 has been developed on the basis of contemporary equipment (Figs. 1 and 2).

The automatic load-frequency control system regulates the operating conditions of the Siberian Power System. It ensures automatic control in the most critical sections both inside the UPS and in the section connecting the UPS of Siberia with the UPS of Kazakhstan (Barnaul’skaya SS – Rubtsovska SS – Ekibastuzskaya SS).

The ALFC system of the UDO Siberia can be connected to (one or several) regulating hydropower plants, namely, the Bratskaya, Ust’-Ilimskaya, Krasnoyarskaya, and Sayano-Shushenskaya HPPs.

All these HPP except for the Sayano-Shushenskaya one have single-type devices for ganged regulation of active power (GRAP) of the CAAPS type (central adjuster of active power settings) with adjusters of unscheduled power settings (AUPS). The Sayano-Shushenskaya HPP is equipped with a device for ganged regulation of active and reactive power (GRARP) based on microprocessors supplied by the “Promavtomatika” Company (St. Petersburg, Russia).

The ALFC system is based on the SJ1 programmable logical controller (PLC) of the OMRON Company. For visual control of the operating conditions of the AFLC system, specifying the settings and adjustment data, and archive maintenance, the controller is connected to local computer networks (LCN) of the UDO of Siberia (Ethernet). The terminals of users of local computer networks, who need com-

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Communication with the central system (CS) of the ALFC, are equipped with special software (SX-Supervisor), with the help of which the users can (in accordance with their rights) control, readjust, or watch the operation of the ALFC system. The data are archived at a server attainable for any terminal of the LCN.

For reliability, the system is equipped with two single-type controllers. Due to the high reliability of the controllers one of them is permanently operating and the other stands by as a manual reserve.

Acquisition and transmission of data for ALFC is realized through special channels of telemechanics based on UTK-1 and UTM-7 devices. The UDO employs a CPTD send-receive set. Data on the operating conditions of the UPS (telemetry, TM) and blocking signals (telesignalization, TS) are transmitted from CPTD to LCN.