ISSN 0040-6015, Thermal Engineering, 2013, Vol. 60, No. 10, pp. 745–751. © Pleiades Publishing, Inc., 2013.
Original Russian Text © I.Z. Chernomzav, A.D. Melamed, A.A. Morozova, K.A. Nefedov, T.N. Rumyantseva, S.Yu. Pomelov, 2013, published in Teploenergetika.

AUTOMATION AND HEAT CONTROL IN POWER ENGINEERING

Experience of Development and Implementation of New Electrohydraulic Turbine Control Systems of the Leningrad Metal Plant for Nuclear Power Plants

I. Z. Chernomzav[a], A. D. Melamed[a], A. A. Morozova[a], K. A. Nefedov[a], T. N. Rumyantseva[a], and S. Yu. Pomelov[b]

[a] *Interavtomatika, Avtozavodskaya ul. 14, Moscow, 115280 Russia*

[b] *Silovye Mashiny– Leningrad Metal Plant, ul. Vatutina 3A, St. Petersburg, 195009 Russia*

Abstract—An experience of development and implementation of electrohydraulic control systems with the application of microprocessor systems is considered by the example of a K-1000-60/3000 turbine of plants nos. 3 and 4 of the Kalininskaya nuclear power plant (NPP). The long-term operation of the electrohydraulic control system on power generation unit no. 3 of the Kalininskaya NPP, which encloses the electronic part of the control system (EPCS), confirmed wide possibilities of the system. Modern requirements to the power control of power generating units were a basis for the development of the control system with the extended functions of the microprocessor part and with the individual control of control valves with the use of a hydroelectric drive. The system was developed and implemented on the K-1000-60/3000 turbine of plant no. 4. Test results for power generating unit no. 4 allowed one to make a decision of putting into commercial operation of the mode of the total primary control of frequency (TPCF). For the first time, the possibility of the operation of the power generating unit of the NPP with the water-moderated water-cooled power reactor (WWPR) was tested and proved in the mode of the normalized primary control of frequency (NPCF) with the power errors up to ±2% of nominal without the displacement of control rods of the reactor only due to the use of the self-control effect of the reactor plant.

Keywords: turbine, nuclear power plant, electric-to-hydraulic converter, microprocessor system, control system, frequency, mode of total primary control of frequency, mode of normalized primary control of frequency, control valves

DOI: 10.1134/S0040601513100030

Tendency of the development of modern automatic control systems (ACSs) of steam turbines of the thermal and nuclear power plants is characterized by the sequential elimination of hydraulic elements fulfilling "intellectual" control functions because of the realization of these functions in the electronic part of the control system (EPCS). This is connected with the constant development of microprocessor control having a high degree of reliability, self-diagnosis, and wide possibilities for realization of the control algorithm in the free programming environment [1, 2]. An example of such development of electrohydraulic ACSs of the Leningrad Metal Plant (LMZ) for steam turbines is the ASC of the K-1000-60/3000 turbines on the power generating units of plants nos. 3 and 4 of the Kalininskaya nuclear power plant (NPP).

The powerhouse hall of power generating unit no. 3, which was set in operation in 2004, is equipped by the full-scale ACS for technological processes (ACS TP), which was developed by Interavtomatika. This system was realized on the TPTS-51 made by the All-Russia Research Institute of Automatics. It encloses also the EPCS of the K-1000-60/3000 steam turbine (Fig. 1). The ACS of the steam turbine is electrohydraulic. The hydraulic part of the control system (HPCS) encloses a speed relay of the turbine rotor, intermediate amplifiers forming the controlling pressure to servomotors of control valves of a high-pressure cylinder (CV HPC) and a low-pressure cylinder (CV LPC), turbine protection subsystems, disengaging clutch, and electromagnetic switches. For input of control signals forming in the EPCS into the HPCS, there are the high-speed electric-to-hydraulic converter (EHC) and relatively low-speed inputs—electric motor of a turbine control mechanism (TCM) and electric motor for a single-turn servomotor of a control valve of the heating steam (CV HS) to a separator-steam superheater (SSH).

The low-speed control circuit (LCC) of the EPCS operates on the basis of algorithms providing the turbine control in the following operation modes:

—swivel of the turbine rotor up to the nominal speed of rotation;

—gain of the initial load;