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Development of a System for Monitoring Technical State of the Equipment of a Cogeneration Steam Turbine Unit

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Abstract—Generalized results from the work on developing elements of a comprehensive system for monitoring technical state of the equipment of cogeneration turbines are presented. The parameters of the electrohydraulic turbine control system are considered together with a number of problems concerned with assessing the state of condensers and delivery water heaters.

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Technical state of power-generating equipment is monitored in order to trace changes of its parameters, which are determined by direct measurements, by calculations carried out on the basis of physico-mathematical simulation, or estimated using diagnostic procedures. In [1–3], the principles developed by the authors are outlined, which include a technical state monitoring concept, a system of state parameters for different elements of power equipment, and procedures and models for determining these parameters.

Figure 1 shows a simplified structure of the comprehensive system for monitoring technical state of a power unit (CMS) at a thermal power station (TPS) [2].

The first level comprises data acquisition (a databank). This level is governed by principles most general for the TPS as a whole and for individual components of power unit equipment, such as process systems, equipment groups, and individual equipment items. The first level can operate as an independent one performing the functions of an information system. This level involves the following structural elements: a databank, devices and computer programs for acquiring data on the process parameters and on diagnostic indicators.

The second level comprises calculation of load parameters and diagnostic indicators; these parameters and indicators are obtained using computer programs for reconstructing the parameters of load, estimating the diagnostic indicators, and determining the calculated parameters of technological process.

At the *third level*, the parameters of state are evaluated from the measured or calculated diagnostic indicators, and from the reconstructed parameters of load.

At the *fourth level,* integral indicators are estimated by using different computer programs for evaluating quality parameters, including indicators characterizing the reliability of the facility being monitored, and the *fifth level* comprises the user interface, which is represented by models of the means through which the CMS interacts with the user.

The following data are indicated in the CMS:

—state parameters of the monitored facility obtained by direct measurements;

—state parameters calculated from measured or determined parameters of loads, or from diagnostic indicators; and

—integral quality indicators characterizing the plant ability to perform its functions (including the reliability indicators).

One of the tasks pursued by development of a system for monitoring the state of power equipment is to determine the list of parameters indicated in the CMS. The following has to be done for solving this task:

—The main function performed by the monitored facility must be formulated, the conditions of its serviceability must be defined, and the parameters characterizing the quality of its operation must be determined.

—Possible failures of the facility must be listed and united into groups according to signs pointing to the same mechanism of wear, destruction, or degradation of the technological process quality.

—The condition for the onset of failure must be mathematically formulated for each group, and rules for determining when the serviceability boundary is violated must be stated.

—The failure onset conditions must be linked with the parameters characterizing the state of the monitored facility in a generalized manner.

—Calculation and diagnostic procedures for estimating the selected parameters of state must be developed and tailored.

In this article we present a description of the parameters characterizing the state of elements used in the electrohydraulic control system of cogeneration turbines. We also present, as an example, a few proce-