Development of algorithms for control and control of electric power parameters based on information-measuring system data

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Abstract. The article describes the operation of the information-measuring system and the algorithms for the control and management of electric power parameters developed by the authors. This is an algorithm for controlling energy parameters for the stable operation of an industrial facility. The basic principles of monitoring, control and regulation of energy parameters of an industrial facility for the uninterrupted operation of technological processes are described. Recommendations are given for the creation of special software and algorithmic support and its implementation at the enterprises of the Russian Federation.

1. Introduction
The authors have developed an information-measuring system patent of the Russian Federation No. 139157, the structure of which is illustrated by a block diagram in accordance with Figure 1.

The proposed information and measurement system for efficient operation at power facilities should be equipped with special software and algorithmic support. Algorithms should provide for various cases of abnormal operation, including emergency modes of equipment operation, and provide for the development of management solutions to eliminate them. This publication will be devoted to the development of algorithms, methodology for their application.

2. Materials and methods
The issues of eliminating emergency situations during the operation of technological processes of industrial enterprises caused by an unplanned change in energy parameters are relevant, taking into account such major accidents as at the Sayano-Shushenskaya HPP.

The authors of the article, based on a retrospective analysis of existing information-measuring systems, domestic and foreign experience in their development and application of automated control systems for technological processes [1–4, 23], identified a number of problems, the solution of which made it possible to determine the optimal layout and mutual operation of the blocks of the algorithm for the control of energy parameters for the stable operation of an industrial facility.
These are tasks such as:
– mathematical models for optimal operating modes of power equipment of industrial enterprises;
– guidelines for the comprehensive monitoring of the state of electrical equipment, including relay protection systems.

In the proposed structure of the algorithm shown in Figure 2 using GIS technologies, the following was first proposed and developed:
– a new GIS model for monitoring and predicting the energy parameters of an industrial facility, taking into account abnormal operating modes, including emergency;
– software of the information system to improve the efficiency of information processing on remote sensing of power systems and visualization of emergency modes of operation, including phase-to-phase faults and ground faults, with geo-referencing in real time;

If the proposed algorithm is introduced into the structure of the automated system for commercial metering of electricity in parallel with the automated control system for technological processes, the shortcomings in the control of energy parameters for the stable operation of an industrial facility with further visualization and geographic referencing of monitoring results will be almost completely eliminated. Provided that the appropriate databases and software for the individual energy parameters of the industrial facility under study are included in the structure of the algorithm, the system can work with confidence in all territorial districts of the Russian Federation.

Currently, there is a contradiction between the presence of information monitoring systems of various directions for further analysis of the stable operation of an energy facility and the lack of a universal concept of organization in them, for the possibility of ranking the importance of technological processes depending on their impact on the uninterrupted production process [11]. To eliminate the existing problem, it is necessary to solve the problem of creating a new concept for the organization of complex problem-oriented information monitoring systems [12-14].
Figure 2. Algorithm for monitoring and controlling the energy parameters of an energy facility for its stable operation.

The author, who heads the team, worked on the development of a new information system for monitoring the parameters of power facilities of a universal organization, which would improve the efficiency of the analysis of power quality indicators and reduce the likelihood of emergency situations at power facilities.

3. Results and discussion
In the course of the research, an analysis of existing technical means [5, 17, 18] was also carried out for monitoring the electric power parameters of industrial enterprises, modeling various emergency situations at all levels of the information system, and primarily at points tied to a specific place of collection of information on the power object. On the basis of studies of existing automated systems for commercial metering of electricity and technical means for monitoring electrical energy parameters [6-8], directions for innovative developments were identified and a new structure of the system for monitoring the parameters of energy facilities was proposed, see Figure 3 below.
Figure 3. The structure of the monitoring system for the parameters of energy facilities.

In addition, the sequence of the formation of the system was determined depending on the complexity of the components of each of the subsystems, their content, and the scientific justification of the developments [19-22]. The practical significance lies in the fact that at the end of the process of forming the system, its approbation was carried out in the existing power system from several dozen industrial enterprises, which showed the reliable operation of the system for analyzing, managing, and maintaining the stability of the power system, for which online monitoring is used.

Figure 4. Subsystem for online monitoring of an energy facility.

Figure 4 shows a subsystem for online monitoring of an energy facility operating according to the following principle. In the developed structure, there is a controller element that receives information via radio channels or, for example, GSM signals, then analyzes and evaluates the mode. If you deviate from the necessary parameters, a notification will be received from the service responsible for this event and the shutdown of a section of the enterprise that may be dangerous, in order to avoid accidents [6–10].

4. Conclusion

The developed concept for organizing the structure of the monitoring system for the parameters of energy facilities served as a starting point for the creation of new information monitoring systems of a universal orientation for subsequent analysis and management of complex energy facilities. The presented structure makes it possible to increase the efficiency of monitoring the parameters of power
facilities, thereby reducing the likelihood of emergency situations and emergency operating modes and ensuring the stable operation of power facilities.

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