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Smart Grid technologies at nuclear power plants

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The problem of ensuring the required level of quality of electrical energy in the electric power systems of consumers of electrical energy has always been relevant and today has not lost its importance. Nuclear energy in Russia is part of the country's overall energy system. The share of nuclear generation in the total energy balance of Russia has been steadily growing over the past five years and at the end of 2019 amounted to 20.35%.

A large number of electrical equipment is connected to the NPP electrical network. This equipment can become a source of harmonic distortion and affect not only each other, but the entire power system as a whole. As a result of such an impact, fluctuations and deviations in the characteristics of electricity can occur in the electrical network, which can lead to short circuits, and subsequently to fires and associated severe emergency situations.
To minimize the consequences of the negative impact of electrical equipment on each other and the power system as a whole, it is necessary to use the latest technologies, tools, methods and digital intelligent solutions of world science and technology. One of such modern and rapidly developing solutions are smart grids, which have received the name "Smart Grid" abroad. "Intelligent" power grid management provides automation, monitoring and control of the state of the electrical grid in real time. Intelligent grids are able to perform online tasks of collecting and analyzing large amounts of data. At a nuclear power plant, such data are the values obtained from the corresponding sensors of technological and noise characteristics of the power system equipment.

Currently, the process of introducing intelligent power supply systems begins to develop rapidly. In Russia, there are already many examples of the introduction of smart grids and the associated positive effects. But among all these examples, there is not a single one related to nuclear energy. That is why the current task is the implementation of smart power supply networks at the enterprises of the nuclear industry. The introduction of such systems at nuclear power plants can significantly improve the overall energy efficiency of the entire nuclear industry.

As a result of research work, an experiment was carried out in which, using a laboratory stand, data were collected from current and voltage sensors from several different consumers of electrical energy. Using the methods and algorithms of intellectual and spectral analysis, the method of principal components and modern machine learning technologies, an algorithm for identifying the consumer of electrical energy by the characteristics of current and voltage was developed.

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