

**SC C1 Power system development & economics  
PS 1 Power system resilience planning**

**Software and hardware complex for making decisions on the impact on power grid equipment, taking into account its technical condition and importance index using modern methods of diagnostics and data processing**

**A. Voloshin, A. Gusarova\*, V. Smekalov  
R&D Center @ Federal Grid Company of Unified Energy System  
Russia**

**\* gusarova.nastya.1991@mail.ru**

One of the most priority areas in the power industry at the moment is the reliability and stability of the transmission of electricity. The solution of these problems requires large financial expenditures. In addition, a significant part of the power grid equipment has exhausted its standard service life, but continues to be used due to the limited amount of funds to replace it. Thus, the task of optimal allocation of monetary resources with the provision of quality indicators of the technical condition of electrical equipment is particularly acute.

In 2016, in order to solve the problems described above launched the scientific research on the development of a software and hardware complex to make decisions on the impact on power grid equipment taking into account its technical condition and importance index using modern methods of diagnostics.

The following subsystems are the basis of the software and hardware complex:

1. Evaluation of the technical condition of power grid equipment.

As part of scientific research, a methodology was developed for assessing the technical condition of power grid equipment. Evaluation of the technical condition of power grid equipment is carried out using algorithms for calculating the technical condition index [hereinafter referred to as ACTCI], presented in the form of Microsoft Excel tables, which allow calculating the technical condition index using logical and mathematical formulas on the basis of a set of measured parameters and defects. According to the results of ACTCI calculation, for each piece of equipment a technical condition index is formed in a numerical form [where 0 is the worst condition, 100 is the best] and the impact on the equipment [flag].

In the process of implementing scientific research, ACTCI was developed for the entire list of equipment.

2. Distribution of impacts on power grid equipment, taking into account the technical condition index, importance and unreliability indexes.

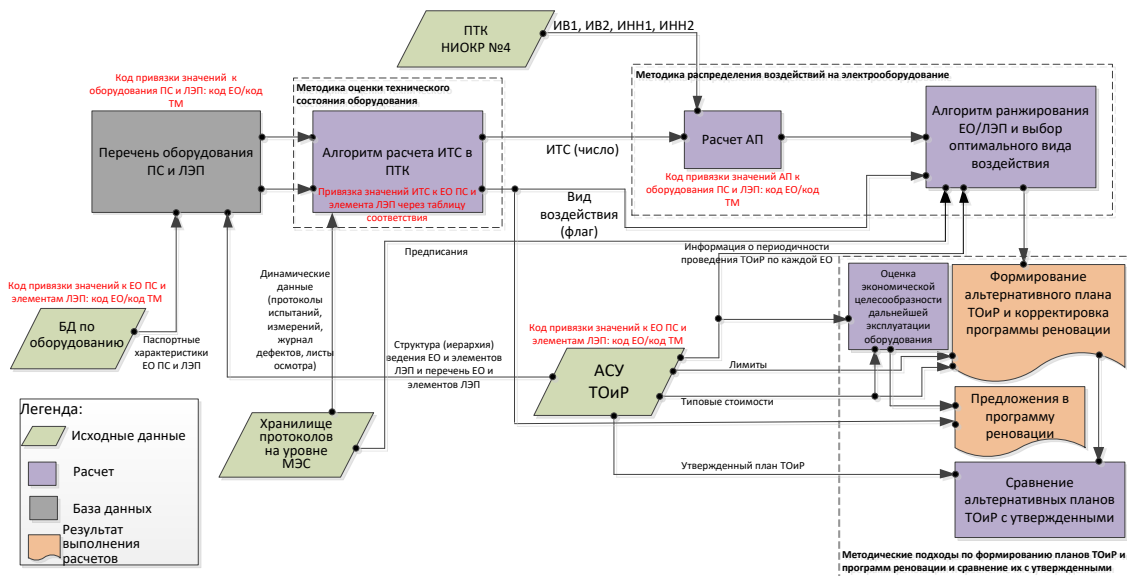


Fig. 1 - Data flow model

In order to make a decision on the impact on power grid equipment and optimal planning of maintenance and repair in addition to the technical condition index are taken into account the importance indexes and the unreliability indexes of this piece of equipment [or power line section] and the switchgear.

Importance index (II 1) - the importance of equipment as part of a switchgear II1equip, the importance of a power transmission line site as part of a network II1line and a transformer as part of substation II1trans.

II1equip characterizes the degree of influence of equipment failure on the number of disconnected connections. II1line characterizes the degree of influence of failure of the transmission line section on the total power across all transmission lines. II1trans characterizes the degree of influence of transformer failure on the total transmitted power through the substation.

The index of importance (II2) - the importance of objects [switchgear, line, transformer] as part of the electrical network.

II2switchgear characterizes the degree of influence of the refusal of the switchgear on the undersupply of electricity to the consumer [similarly, II2line and II2trans].

The unreliability index (IU1) is the unreliability of equipment as part of the switchgear IU1 switchgear, a section of power transmission lines as part of a network IU1line or a transformer as part of substation IU1trans. IU1 is determined by its own electrical equipment reliability indicators.

The unreliability index (IU2) - the unreliability of objects [switchgear, line, transformer] as part of the electrical network.

IU2 switchgear is characterized by the probability of failure of the whole switchgear. IU2line is characterized by the probability of failure of power lines, taking into account the possibility of failure of adjacent cells and excessive work of the relay protection [similar to IU2trans].

Also, for making a decision on the impact on power grid equipment and the priority of including in the maintenance and repair plan [further - plan] were taken into account the objects of FGC UES, PJSC, the occurrence of technological

disruptions which can lead to negative social and technological consequences, the periodicity of maintenance, testing and repair of electrical equipment.

Based on the information about the importance and unreliability of equipment, as well as its technical condition index and priority category, equipment is ranked according to the priority of inclusion in the plan (where 0 is the highest priority level, 1 - n - priority level in descending order).

3. Formation of alternative maintenance plans and renovation programs.

Formation of the plan is carried out on the basis of data on:

- the cost of maintenance and repair;
- financial constraints (funding limit);
- economic feasibility of further operation of electrical equipment, which has developed a standard service life.

The choice of the impact on the power grid equipment and the section of the power lines is carried out on the basis of the impact recommended by ACTCI (flags), the frequency of maintenance, testing and repair of electrical equipment and the regulations of the supervisory authorities with a list of works on the equipment of the substation or the power lines.

The hardware and software complex underwent pilot industrial operation. An optimized plan was obtained, the planning efficiency of which is achieved by using the proposed approaches (more unreliable and important equipment with a deteriorated state fell into the plan).

The implementation of hardware and software complex will improve the safety, reliability and quality of power supply to consumers, reduce operational costs through more efficient planning.

## **BIBLIOGRAPHY**

- [1] Order of the Ministry of Energy of 26.07.2017 №676 « On approval of the method of assessing the technical condition of the main technological equipment and power lines of power plants and electrical networks»