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PROBLEMS AND SOLUTIONS OF RELIABILITY ISSUES FOR EXTERNAL POWER SUPPLY IN THE COAL MINES

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Restructuring of the energy sector and liberalization of the electricity market resulted in separation of a single industry into a multitude of generating companies, federal and interregional distribution utilities, regional power providers and energy suppliers. For a number of reasons, related to the process of managing separate companies, faults in the laws and regulations, and unsatisfactory technical state of the energy equipment both on the part of distributors and consumers, reliability of energy supply faces increasing negative trends, which potentially can lead to big problems. Up to this day the energy sector does not have a developed database on the state of equipment and results of its maintenance, nor has it defined criteria to actually assess technical conditions of the equipment. The authors propose to develop and implement a mechanism aimed at technical auditing and monitoring of the engineering state of external power supply system, whose results can help in the development of more efficient and economically sound measures to improve reliability of energy supply.

In recent years, a lot of attention has been paid to the issues of enhanced security of industrial power supply. However, specific characteristics of underground coal mining and enormous work load of the production process limit the applicability of developed methods and algorithms.

Existing research does not address economic issues of reliable energy supply, either direct (economic damage from power interruptions, contractual security of supply, tariff regulation) or indirect (charges for utility connection with a required level of reliability). There is no explicit definition for the term «autonomous energy source», nor is there a list of power receivers falling into the first and «special» categories according to their reliability. The paper contains a range of urgent problems and solutions that will increase reliability of external power supply in the coal mines.

***Key words*:** reliability, external power supply, technical audit, coal mine

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Current state of Russian energy sector is defined by processes of restructuring and liberalization of the electricity market. As a result, a single industry has been separated into a multitude of generating companies, federal and interregional distribution utilities, regional power providers and energy suppliers. Due to lack of a unified management system in the energy sector, reliability of energy supply faces increasing negative trends, which potentially can lead to big problems.

There is a lot of ambiguity in the laws and regulations concerning Russian energy industry. Absence or incompleteness of legislation acts, which regulate reliability of energy objects and interaction arrangements between the subjects of energy sector, lead to subjective interpretation of the law. Basing on their scope of activity, a number of independent enterprises have been separated from vertically integrated energy companies. This caused a distribution of responsibility for the security of power supply, which has not been properly formalized.

Rates of development, approval and amendment of technical norms and regulations fall behind the rates of reforms in the energy sector: existing norms and legislation acts do not meet modern development objectives of the industry and require an update.

High risks of serious accidents are caused by the ageing of energy equipment, both on the part of distribution network and consumers. Prolonged use of power grid facilities compared to their standard operation time results in increasing maintenance costs and higher technological risks of their failure, in case all the necessary renovations and updates are not carried out on time and to the full extent.

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Up to this day [8] the energy sector does not have an explicit database on the performed repairs, nor does it have full and reliable information on the state of equipment and results of its maintenance. The industry lacks criteria for the assessment of equipment conditions, decommissioning of the facilities, extension of their lifespan, modernization or replacement with new and more productive machinery.

There is a need to create an analytic information system to assess technical conditions of equipment, buildings and constructions, and to develop a database of their accident risks. In order to attain this goal, there is a need to develop and implement a mechanism aimed at technical auditing and monitoring of the engineering state of external power supply system, including analysis of equipment lifespan, its physical and moral depreciation, information about accident risks. Measures, recommended in the course of technical audit, will help to identify «bottle necks» in the system and to arrange for the most productive and economically efficient ways to enhance security of energy supply.

Reliability of power supply in the mines is defined by probability and frequency of faults in the operation of coal mining equipment, which can occur due to prolonged power interruptions or short-term voltage dips.

Power supply systems of coal mines are characterized by a large share of obsolete equipment and automation systems, which contributes to the increasing frequency of failures and extended duration of power interruptions.

The choice of measures and technical solutions to enhance reliability of external power supply depends to a great extent on the independence of energy sources. Assessment methods of power source independence and means of its reservation, as well as algorithms and programs of substantiating the choice of external power supply schemes taking into account reliability characteristics, are described in a scope of research publications [1-7, 8-10]. However, existing scientific developments are not applicable to the analysis and improvement of reliability in the coal mines due to certain distinctions of the consumer – working load of the coal extraction process, reaching several hundred kilowatts; gas hazard and danger of flooding; risk to life of the workers.

Furthermore, above mentioned studies do not address the following issues:

• Not a single publication examines the need to assess technical conditions of the external power supply system: physical and moral depreciation of the energy grid, operating conditions, number of repairs.

• The problem of secure energy supply for utility connection with a required level of reliability remains untouched. Connection of coal mines can be carried out on the second level of reliability [11, 12], but the mines also have both first-category and special-group power receivers.

• There is no cross-industry list of power receivers falling into the first and «special» categories according to their reliability. Coal extracting companies do not have a shared range or practice of identifying power receivers for technological or emergency reservation of energy supply.

• Issues of contractual supply security are examined only superficially: tariff regulation, adjustments and allowances for the provision of required reliability level etc.

• There is no developed mechanism of evaluating economic damages from power interruptions in the coal mines.

• Neither legislative acts nor regulations offer an explicit definition for the term «autonomous energy source», especially for consumers with a high reserve capacity.

• Despite the fact that most publications are dedicated to methods and algorithms of selecting and substantiating the use of autonomous energy sources, approaches to implementation of autonomous power supply for large coal enterprises with high reserve capacity have not been developed yet.

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Today solution of all these reliability problems of external power supply is a highly relevant issue for Kuzbass coal mines Coal extracting companies are hazardous industrial objects. Even in case of short-term emergency shut-downs, fire and explosion risks create hazard to the lives of workers, destructive effect on the environment and the facilities themselves. Hence, issues of secure and uninterrupted power supply of coal mines are a matter of prime concern not only for the companies (prevention of accidents, fatalities and economic damages), but for the whole region. Considering that a part of the extracted coal is meant for other regions of Russia and export purposes, economic development of these territories also depends on sustainable operation of Kuzbass coal enterprises.

To sum it up, the following objectives have to be met in order to assess and increase reliability of external power supply in the coal mines:

• to review laws and regulations, harmonize their provisions, and clarify their wording and terminology;

• to review the procedure of supervisory interactions among the subjects of energy sector from the position of reliable energy supply, especially in case of emergency;

• to identify responsibilities of consumers and different subjects of the energy sector for reliable energy supply. These responsibilities have to be captured in bilateral contracts between the power supply company and the consumer, based on principles of mutual benefit;

• to develop technical norms associated with energy supplies to first-category and special-group consumers – specifically, to clarify the definition of autonomous energy sources and to develop methods of assessing their capacity;

• to compile a list of coal mine energy receivers that fall into first and «special» categories of power supply, to develop a method of identifying the scope and capacity of receivers for emergency and technological reservation of energy;

• to develop and approve the method of technical audit for external power supply in the coal mines.

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