



## RESEARCH ON MEASURES TO IMPROVE THE QUALITY OF ELECTRICITY IN THE POWER SUPPLY SYSTEM OF ENTERPRISES.

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**Abstract** *The necessity of increasing the reliability and quality of power supply is substantiated, and the main methods for improving the quality of electricity in the power supply systems of enterprises are investigated. Possible technical directions for the power supply of industrial electricity consumers are explored.*

**Keywords:** *quality of electrical energy, power supply systems, measures to improve the quality of electricity, improving the reliability of power supply systems, research.*

The importance of power supply systems in modern society is hard to overestimate. The development of production and the introduction of new technologies mainly lead to a constant increase in the capacities of systems, machines, and units. At the same time, high requirements are placed on their efficiency, safety, reparability, and environmental friendliness.

One of the main disadvantages in modern power engineering is:

- Use of obsolete equipment, networks, cables, transformer points (TP), and input-distribution devices;
- Incorrect accounting of electricity;
- Low quality of electricity.

Rationally designed modern power supply systems must meet the following requirements:

- Efficiency;
- Reliability;
- Safety and ease of operation;
- Provision of the required quality of electricity.

The category of consumers determines the choice of the reliability category of the power supply system. In the event that there is at least one among the receivers or consumers that belongs to the first category, then the system must be powered from at least two sources.

According to their purpose, power supply networks are divided into distribution and feeder types. A **feeder line** is a line that supplies power to a substation (II) or a distribution point (PII) from a power center (IPI) without distributing electrical energy along its length. A **distribution line** is a line that supplies power to a number of transformer substations from a PII or IPI.

In networks with voltages up to 1000 V, lines going from transformer substations to distribution boards or points are called feeder lines, while lines going directly from distribution boards or points to power receivers are called distribution lines.

One of the main tasks of reconstruction and technical re-equipment of electrical networks is to increase the reliability of power supply to consumers and the quality of electricity, which can be achieved through the following methods:

- Replacement of uninsulated wires with self-supporting insulated wires (CIII);
- Application of technology for performing work under voltage;
- Application of 0.95 kV voltage;
- Use of booster transformers (volt-adding);
- Replacement, modernization, and installation of missing metering devices.

Let us consider some of the technical solutions mentioned above. Overhead power lines are a vital part of the power supply system. The normal life of people and the operation of industrial enterprises depend on their condition. The location of supports and wires under the open sky subjects overhead lines (HEL) to the influence of weather cataclysms. Strong winds and icing can lead to wire breaks, damage to insulators, and additional equipment suspended on the supports.

To restore damaged power lines, certain repair works are performed. Long coordination precedes the disconnection of HEL for repair, which in itself represents a large volume of work. Many consumers experience significant difficulties in their work and suffer losses during disconnections.

The application of live-line repair technology for HEL increases the reliability of power supply to consumers, as the number of planned outages is significantly reduced. This creates an economic effect in power grid organizations due to the reduction of electricity under-delivery to consumers and other factors.

However, this is not the only type of HEL repair. After all, in accidents with broken wires and other damages incompatible with normal power transmission, the transmission stops. To reduce the probability of damage to overhead power lines, a system of preventive maintenance exists. It includes technical maintenance and capital repairs, both with disconnection and without removing the voltage.

The practice of using booster transformers (volt-adding) also allows:

- significantly reducing the negative impact of neutral conductor breaks or loss of contacts in neutral circuits, as well as voltage surges in the area of the undamaged phase;
- significantly increasing the power of single-phase short circuits — this makes it possible to increase the reliability of protection triggering in power lines;
- eliminating asymmetric voltages that arise due to uneven distribution of voltage across phases;
- performing installation work of various complexity within time-limited periods.

According to leading energy experts, the share of energy resources accounts for about 30–40% of the cost of production. This figure is a strong argument for managers to seriously approach the issue of energy consumption auditing and the development of methodologies for reactive power compensation. The process of reactive power compensation is the key to solving energy saving issues.

To properly assess the advantages of СИП, one needs to have an idea of other ways of transmitting electricity over distances. In conventional systems, wires are not insulated — electricity is transmitted through bare wires. This is done to save on the braiding. Despite the need to install linear insulators made of porcelain, this method of transmitting electricity is considered quite economical. At the same time, the 50-hertz frequency is barely radiated into space, and significant interference in such electrical networks is rare.

Phase wires are most often located in the upper part of the spans above the lightning protection cable (applies to lines with a capacity of over 35 kV), and a neutral may be located under the conductors. Suspensions can be with vertical support (one unit for each support) or tension (paired with a loop between them). Vertical supports can be intermediate, and tension ones can be anchor type. In the event of a line break, the supporting suspensions move slightly to the side with a spring-like motion, resulting in the supports being protected from falling. Anchor support, in case the poles fall, prevents the transmission of deformation through the network, which is why special requirements for strength are imposed on such supports. To provide more power, the support is equipped with crossbars (rigels). Anchor support is indispensable on power line turns at an angle of more than 10 degrees.

The most popular materials for creating high-voltage power lines are aluminum and copper. Moreover, the cross-section of aluminum parts is taken with a margin to ensure sufficient strength. To achieve decent mechanical strength of high-voltage lines, the cores are made of high-strength steel. Standards for the use of metals are described in GOST 839.

The disadvantage of aluminum is the cause of corrosion, which can reach 0.8  $\mu\text{m}$  annually. To prevent metal destruction, the following measures are taken:

- special lubricant is used to fill the inter-wire space in ACKC;
- heat-resistant lubricant is used for ACKP and AKP wires;

- for ACK wires, the steel core is insulated with two layers of polyethylene terephthalate.

In the case of self-supporting insulated wires (СИИ), things are different. All cores are combined into a single whole and covered with a polymer insulation material. The neutral is usually located in the middle part of the wire. Compared to such a construction, bare wires have several significant disadvantages:

- step voltage leads to the death of birds;
  - if the neutral breaks, identifying the cause of the failure can be very difficult.
- At the same time, such cases themselves carry danger, as equipment begins to function incorrectly;
- during the installation of power lines with bare wiring, it is impossible to do without clearing the terrain of trees. In wet weather, an electrical discharge will reach the ground through the trunks and branches of trees, which will inevitably kill the living organisms below. Trees can also cause the neutral wire to break;
  - as a result of wind gusts, line crossovers (perexlyost) often occur, leading to short circuits. If an arc forms in the hot season, sparks can lead to a fire.

To avoid these problems, line insulators are installed, and the phase and neutral wires are moved away from each other at the maximum possible distances. As a result, there arises a need for the use of crossbars (rigels) in the foundation structure, which allow for expanding the support area. All these measures make the structure bulky and inconvenient.

Reactive power compensation is an important factor that allows solving energy saving issues at any enterprise. The use of capacitor units for the purpose of organizing RPC (reactive power compensation) is the most preferable. The operation of capacitor units is accompanied by low losses, they are easy to set up and operate, and it is possible to connect them to any point of the power supply system.

According to specialists, the cost of energy resources accounts for approximately 30% of the total cost of supplied products. This information is a

strong argument that pushes enterprise managers to serious measures in the field of energy resource auditing. Specialized methodologies for improving the quality of electrical energy are being developed at large enterprises, which testifies to the relevance and extreme importance of the researched topic.

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