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Increasing the Reliability of Cable Plant Production Workshops

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ABSTRACT. The article deals with the issues of improving the reliability of the production workshops of the cable plant. The aspects of reducing the technical condition of engineering networks of cable enterprises and ways to improve the reliability of production units are analyzed. The problems of distribution of electric energy through networks are studied and the conclusion is made about the feasibility of creating a new generation of networks that meet all modern requirements in the distribution of electricity among consumers. The analysis of technical solutions and the theory of technocenosis has been carried out, which allowed to identify promising areas for improving and modernizing the power supply systems of the cable enterprise, which shall ensure an increase in the reliability of electricity and heat supply to production facilities, as well as a reduction in the number and duration of their outages.

I. INTRODUCTION

Since the 90s, there has been a tendency to reduce the reliability of power supply to cable enterprises. This negatively affects the quality of cabling and wiring products, because there is a specificity of cable production, namely the presence of a closed technological cycle for the manufacture of cabling products. The issue of increasing production capacity and connecting new technological equipment is usually associated with a number of technical difficulties: the cost of performing work on the technical requirements for the reconstruction of networks and the connection of new, declared capacities. All these factors lead to the maximum reduction of electricity losses intended for the efficient operation of the enterprise (actual losses). The losses under consideration consist of technological losses for the transportation of electricity through the network (heat); losses for the own needs of substations; instrumental losses (errors), as well as commercial losses (inconsistencies in the monetary payment for electricity and meter readings) of late payment, non-payment of receipts, etc. in the field of the formation of monitoring the consumption of electricity. In Fig.1, the structure of electricity losses in the power grids of a cable enterprise is presented.

Fig.1. Generalized structure of electricity losses at a cable enterprise

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Потери электроэнергии	Electricity losses
Технологические потери	Technological losses
Коммерческие потери	Commercial losses
Технические	Technical
Недоучет электроэнергии	Underestimation of electricity
Расход на собственные нужды подстанций и плавку гололеда	Consumption for own needs of substations and ice melting

To date, the technical condition of electrical networks inside the cable enterprise is deteriorating significantly every year: more than 50% require reconstruction, restoration or replacement, because their operation has been carried out without repair and beyond the service life. In addition, most of the power lines are outdated, because they have moral and physical wear and tear, and are not subject to automation. Considering the issue of reconstruction is a very costly solution and for many is an impossible task due to large capital expenditures.

II. INCREASING RELIABILITY IS A TIME REQUIREMENT.

Increasing the reliability, stability, and, consequently, the efficiency of power supply to production facilities can be solved in various ways, the choice of which is determined for each specific production facility, depending on the conditions of its operation, significance in the technological cycle, the level of possible damage during interruptions in power supply, the state of the current power supply system and possible directions for its modernization.
One of the ways to improve the operation of the power system of enterprises is the introduction of an Automated Electricity Metering System (AEMS) (Fig.2).

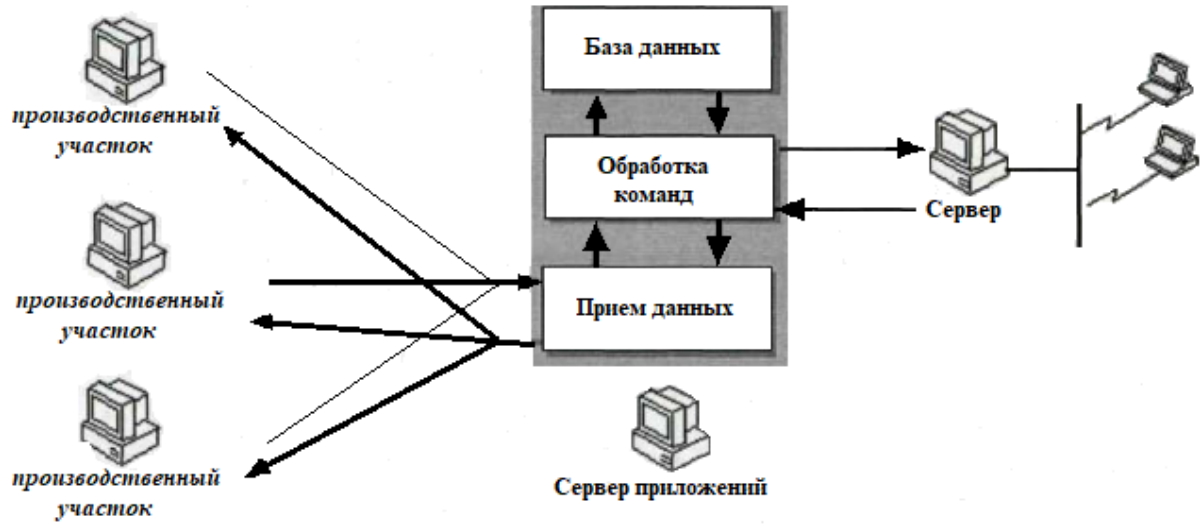

Fig.2. General structure of the classical AEMS

Производственный участок	Production area
База данных	Database
Обработка команд	Command processing
Прием данных	Data reception
Сервер приложений	Application Server
Сервер	Server

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The ways to increase the reliability of power supply to production workshops and sites include: improving the power supply system and the network economy of a cable enterprise with an additional installation of a backup power supply system based on an autonomous source for responsible industries, where interruptions in power supply cause significant damage; organization of a self-supply system with electricity generated by an autonomous installation using local energy resources or renewable energy resources; construction or conversion of existing boiler houses for autonomous power supply with electricity and heat to production facilities [4].

Since 2006, there has been an increase in the electricity consumption of cable enterprises, mainly due to an increase in the volume of construction of industrial, social facilities and the residential sector. The current structure of the plant's power supply includes three voltage levels: 35-110 kV, 6-10 kV and 0.4-0.22 kV [4]. The current state of electrical distribution networks within the enterprise is characterized by a constant decrease in technical and economic indicators and their aging (Fig.3). Currently, about 30% of overhead lines and transformer substations have fulfilled their regulatory deadline, and the level of automation of distribution networks is low – modern linear electrical equipment is not used everywhere in 10 kV networks, which complicates the process of their automation [4]. In this regard, the task of restoring networks that have spent their life, the reconstruction (modernization) of existing networks to cover increasing loads and connect new units of technological equipment, as well as production lines under construction, has been defined for the energy service [4].

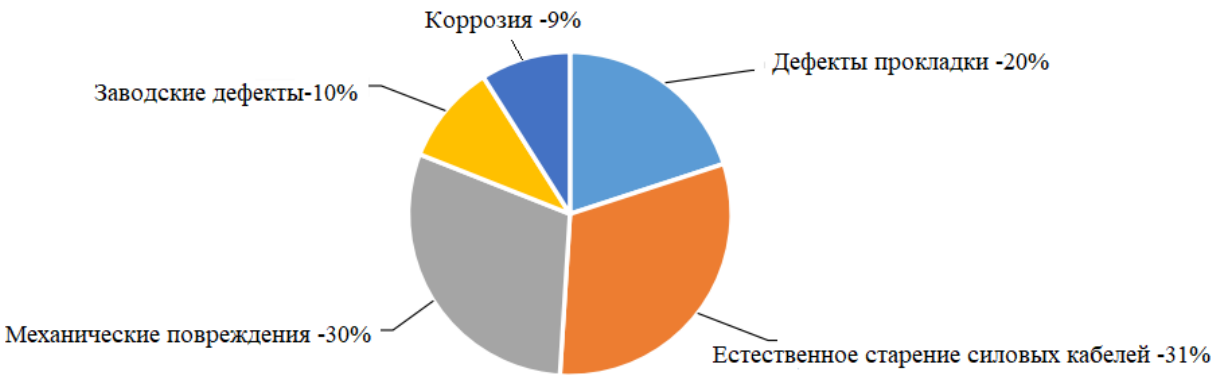

Fig.3. Causes of damage to 0.4-110 (220) kV cable lines

Коррозия	Corrosion
Заводские дефекты	Factory defects
Механические повреждения	Mechanical damage
Естественное старение силовых кабелей	Natural aging of power cables
Дефекты прокладки	Defects in laying cable lines

The study of the problem of distribution of electric energy through networks allowed to conclude that it is advisable to create a new generation of networks that will meet all modern requirements in distribution among consumers (workshops, sites, technological equipment) and meet economic and environmental challenges, the world technical level and regulatory and technical documentation for modern distribution electric networks.

The main purpose of the reconstruction of the power grid is to choose the priorities of the technical development of the cable plant, and hence the principles of construction, the level of technical equipment of new generation distribution networks, taking into account international and domestic experience. In this case, the power supply systems of both the enterprise and individual workshops and sites shall meet the following requirements: for the reliability of power supply and the quality of electrical energy; to ensure the standard service life of power lines (at least 40 years); to adapt to increasing electrical loads; on electrical and environmental safety; on technological and technical susceptibility to automation and telemechanization; on economic efficiency with a minimum of electricity losses. The task is being solved by increasing the volume of restoration of internal power grids that have spent their resource and ensuring reliable

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operation of the plant's distribution power grids, carrying out reconstruction and technical re-equipment of internal networks with the replacement of technically obsolete substation equipment and lines that have exhausted their resource, compliance with new technical requirements.

The issues are well covered in the theory of technocenoses, which was created by Professor B.I. Kudrin of the MEI (TU). Its subsequent development was carried out by: V.I. Gnatyuk, V.V. Fufayev, B.V. Zhilin, A.N. Kuzminov, O.A. Kuchinskaya, M.G. Oshurkov, Yu.V. Tchaikovsky, Yu.V. Matyunina, R.V. Gurina, S.V. Zhichkin, A.S. Isayev, A.I. Kudrin, O.E. Lagutkin, V.K. Lozenko, Yu.K. Orlov, A.I. Polovinkin, M.Kh. Popov, V.V. Prokopchik, L.D. Fufayeva, S.D. Khaytun, B.S. Shornikov, Yu.A. Schreyder, Yu.L. Shchapova, A.E. Yakimov, M.I. Bozhkov, etc. The diagram, shown in Fig. 3, demonstrates the possibility of managing the technocenosis of the CL.

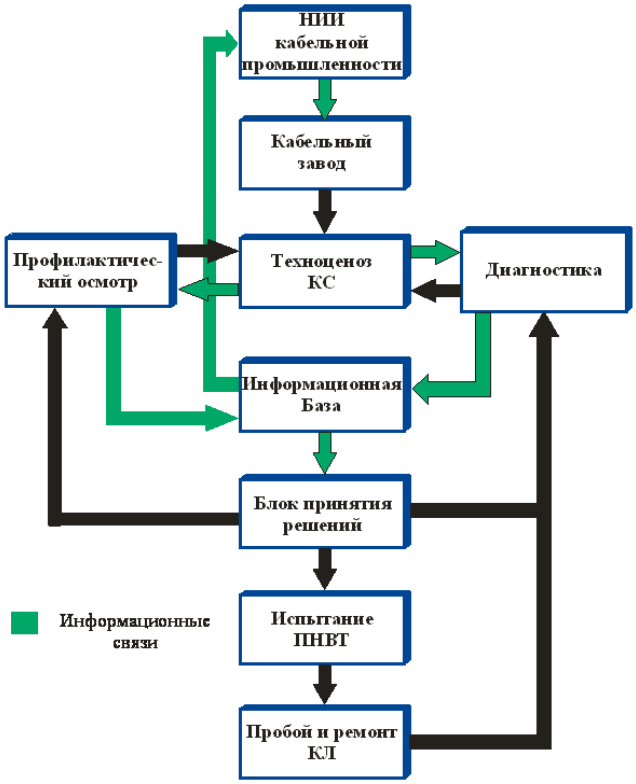

Fig. 3 Control scheme of CL technocenosis

Профилактический осмотр	Preventive inspection
НИИ кабельной промышленности	Research Institute of the Cable Industry
Кабельный завод	Cable Factory
Техноценоз КС	Technocenosis of CS
Информационная база	Data base
Блок принятия решений	Decision-making unit
Испытание ПНВТ	PNVT test
Пробой и ремонт КЛ	Breakdown and repair of CL
Диагностика	Diagnostics
Информационные связи	Information links

Thus, the cable network, where the technocenological approach is used, will allow [3]:
1) to assess the structure and condition of the CL;
2) to optimize the data for the subsequent stable operation of the CL;

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3) to develop a forecast for the accident rate of CL to rationalize planned repair and restoration work.

III. MATERIALS, METHODS AND PERSPECTIVES.

The results of the analysis of technical solutions made it possible to determine the most promising direction in the field of power supply development of cable enterprises, such as the introduction of new transmission methods and power storage systems, including the use of a resonant single-conductor system [5, 6]. The issues of improving the reliability of power supply of cable machines and the quality of electricity transmission are provided through the reconstruction of centralized power supply networks of the parent enterprise, reducing their radius, using network and autonomous redundancy, the introduction of new resonant power transmission systems for individual production workshops and sites, the introduction of new reliability standards in design and operation, as well as improving operational maintenance. All this will create conditions for reducing the damage to the production of cabling and wiring products from emergency shutdowns of centralized power supply [5, 6]. The design of new workshops and production sites, construction and reconstruction of existing production units shall include requirements for the basic provisions of power supply systems: self-supporting insulated wires (SSIW) with the same section along the main line shall be used on 0.4 kV overhead lines, and mandatory automatic partitioning, network redundancy of the main line and branches by switching devices shall be introduced; transformer substations 35-110/10 kV shall be equipped with automation and remote control devices with modern switching devices [7].

The issue of increasing the capacity of electric networks of a cable enterprise can be solved by using a new generation overhead line with insulated and protected wires, as well as using a conductive core with improved operational characteristics [8, 9], which will increase the technical and technological parameters of the technological process and reduce accidents. The solution of the problem of technical and technological susceptibility to automation and telemechanization is reduced to the use of an Automated Dispatch Control System (ADCS) within the production service by step-by-step Management Information and Control System (MICS) of electrical networks. All this will create conditions for a quick and prompt solution of issues of automated control and management of distribution and sale of electricity inside the cable plant. In this regard, the plant's energy service needs to constantly improve electricity metering to determine losses in order to ensure the required percentage of technology reliability, since almost all technological operations are focused on a long production cycle that requires strict compliance with technological and technical standards.

It is also necessary to pay attention to the direction that will help ensure the sustainability of the power supply of the cable plant - the use of local and renewable energy resources. The development of the energy self-supply system of production units is borrowed from foreign enterprises that are focused on the use of new advanced technologies with the construction of combined power supply systems [10, 11, 12]. The introduction of this direction will increase the reliability of the enterprise's energy supply, reducing the number and duration of forced breaks by 2 times. It should be noted that the presence of its own (autonomous) source of electricity and heat supply will create conditions for increasing the fuel utilization factor, i.e. the energy efficiency of the enterprise, by ensuring independence in energy supply and increasing its reliability [10, 11, 12].

IV. CONCLUSION

Thus, reasonable promising directions for improving and modernizing the power supply systems of a cable enterprise shall also include measures to improve the reliability of electricity and heat supply to production facilities (workshops, sites, technological machines and production lines) - reducing the number and duration of their outages. These measures will create conditions for increasing the stability and reliability of the power supply of the entire plant – reducing the duration and number of power outages, as well as significantly reducing the damage from interruptions in the power supply of the plant.

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