



## Analysis of the Problem of Complex Technical Diagnostics of Power Transformers in Power Systems

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### ABSTRACT

The article describes the condition of power transformers that have been operating under operating conditions for a long time. The article is devoted to the issues of extending the service life of these power transformers, taking into account the economic state of the electric power system today. The analysis of scientific publications devoted to the problem of increasing the reliability of high-voltage transformers with an integrated approach to assessing their reliability is carried out. The problems of using the existing complex of high voltage transformers are analyzed. To assess the technical condition of transformers, factors leading to damage and failure of power transformers during their operation, the available regulatory materials are analyzed. The development of methods for monitoring the technical condition of high-voltage electric transformers, as well as the establishment of the boundaries of decision-making criteria for their further operation are important for improving the reliability of the complex of electric transformers operating at power plants and substations of the electric networks of Uzbekistan. Based on the best foreign experience, the necessity of conducting a number of theoretical and experimental studies with the development of appropriate methods and criteria for the Republic of Uzbekistan is substantiated.

Keywords:

Uzbekistan, electric power, power transformers, reliability, high voltage, diagnostics, chromatography, vibradiagnostics, extiej, long service life.

**Introduction.** In the transmission and distribution of electricity, a power transformer is a high-voltage electrical device that performs the main function. In the modern power supply system, power transformers of all voltage levels lead to an increase in the power of generators by 6-6.5 times due to multi-stage conversion [1]. According to modern requirements, the reliability and continuity of electrical networks, power plants and power systems largely depend on the reliability of electrical transformers and autotransformers. Reliability problems are divided into physical, hardware and informational aspects as follows.

For the present and future development of the energy economy in the Republic of Uzbekistan, the work of many existing power transformers with a service life is necessary.

Data analysis shows that the service life of working transformers exceeds the standard service life by 1.5–2 times. Given these conditions, the reliability of power supply is positively affected by such issues as improving service systems, analyzing durable transformers and ensuring their performance, and extending their service life.

[1] and [2] sources note that the necessary information to eliminate the problems of strategic planning can be obtained on the basis of a rational and correct diagnosis of operating transformers, taking into account existing work experience. The life extension of a specific power transformer is carried out on the basis of a comprehensive check. As you know, this is a labor-intensive, high-tech and costly process, the implementation of which is

associated with the performance of diagnostic operations in accordance with the requirements of industry documentation. When planning the goals of a strategic task, it is not necessary to know with absolute accuracy all the characteristics of each transformer. To determine the residual life, average data on the reliability of one or another set of transformers that have worked for 12 years are sufficient. Therefore, [1], [2], [5], [6] and [14] in the works indicate the nomenclature and methodology for obtaining diagnostic indicators regulated by regulatory documents, but insufficient to correctly determine the storage life of power transformers.

The existing fleet of long-life high voltage transformers gives conflicting results in determining residual life. Only on the basis of current regulatory documents it is impossible to obtain sufficiently reliable information about the actual state of long-lived transformers.

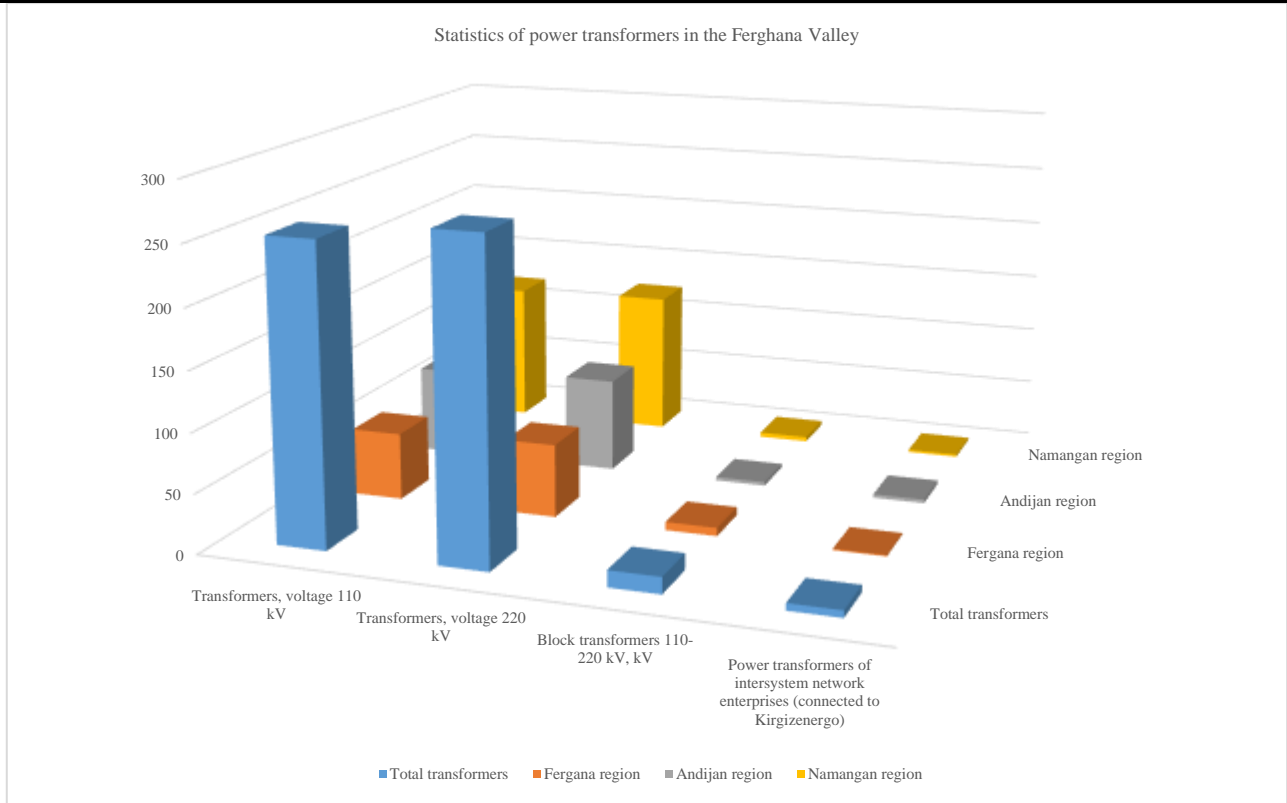
At present, despite the accumulated sufficient scientific and practical experience in assessing and predicting the resource of power transformers, there is no regulatory document regulating the procedure for extending the service life of high-voltage transformers. According to the current legislation, power transformers as technical devices used at a hazardous production facility are subject to mandatory industrial safety expertise. During the operation of power transformers, diagnostics and maintenance are required to ensure the safe and uninterrupted operation of the transformer throughout the entire operating cycle. The carried out diagnostics and maintenance should show the aging process of power transformers during the entire working time. Diagnostics, detection of defects ensure reliable operation of transformers, help determine the repair cycle, which facilitates their replacement and planning of repair work. Planning an effective diagnostic test program reduces the chance of power transformer defects and failures.

Transformers manufactured at the energy enterprises of Uzbekistan in accordance with GOST 11677-65 do not have sufficient electrodynamic resistance to increased levels of short circuit currents in electrical systems.

[3] the literature presents an analysis of transformers produced before the 70s of the last century. Basically, because of it, the specific damage of transformers exceeds 1% per year, in new ones it is about 0.2%. Analysis of work and accumulated experience indicate that the main damage to operating power transformers occurs in the following areas: windings, high-voltage inputs, on-load tap-changers. The reasons for such damage are: the development of defects under load; incorrect or insufficient performance of actions during installation, repair and operation.

[4] - [6], a study in the literature can reveal data on specific damage to power transformers abroad. Different countries have different solutions and approaches to damage analysis, as well as different approaches to the compilation of statistics, which does not allow for an accurate comparison. [4]-[6],[14] publications provide information that the proportion of damage to power transformers in developed countries does not exceed 1.5-2% per year. In the former USSR and Russia, the issues of damage analysis of electrical transformers were systematically considered by many organizations.

[6] Continuing the analysis of the Russian experience, it can be noted that in the 1990s, the high efficiency of the system for diagnosing and repairing electrical transformer equipment was revealed. In the last century, in relation to electrical transformers, the concept of transition from normative-scheduling repair planning to carrying out "according to the actual state" (according to the results of technical diagnostics) began to be implemented. In accordance with the requirements of the Rules for the technical operation of power plants and networks of the Russian Federation [9], the repair of transformers (capital and current) and their components (OLTC, cooling systems, etc.), depending on their technical condition, is determined by measurements, tests and external inspection. The assessment of the technical condition of power transformers is carried out in accordance with a set of controlled indicators and their standards.



## Organizations engaged in the diagnosis of power transformers

Деятельность в бывшем СССР и России до 2000 г. АО "ВНИИЭ" - анализ повреждений силовых трансформаторов с оценкой общих удельных повреждений за разные годы, характеристика причин повреждений и разработка мероприятий по повышению их надежности

NIC "ZTZ service" - analysis of damage to power transformers with a voltage of 110 kV and above, operating in the USSR and later in the CIS, identifying the main causes of their damage

ORGRES company - damage analysis of power transformers with a voltage of 110 kV and above, operating in the USSR, and then in the CIS, identifying the main causes of their damage

Департамент Генеральной инспекции" ЕЭС России", с 1996г. Актов проверок технологических нарушений в работе трансформаторов, где обобщены статистические данные о количестве и причинах нарушений[7]

In Russia, after 2000, since 2000, a new rule for monitoring and assessing the condition of transformers has been introduced [8]. - analysis of identified shortcomings in the organization of the work of this type of equipment with an annual expert analysis of the effectiveness of measures developed by energy enterprises to eliminate them

During the operation of power transformers and high-voltage ASP, the main document regulating the list of tests, the maximum permissible values of controlled indicators and the frequency of control are "volumes and standards for testing electrical equipment" [7]. In the sixth edition [7] "volumes and standards for testing electrical equipment" (1998) [10], the list of controlled parameters of power transformers was significantly expanded. Controlled parameters are supplemented with new ones: chromatographic analysis of dissolved gases; composition of furan compounds in oil; degree of polymerization; the composition of the antioxidant supplement; thermal imaging control.

The issues of theory and practice of assessing the technical condition of electrical transformers over the past decades have been discussed at domestic and international conferences, symposiums and seminars, sessions and materials held in CIGRA IEC. He made a significant contribution to the theory and practice of assessing the technical condition of power transformers VNIIE, ORGRES, nickname "ZTZ service", VEI, MPEI (tu), IGEU, VTs "Elektrozavod", Moscow plant "Izolyator".

To develop a maintenance and repair system (Stoir), it is necessary to adopt new directions and developments based on tracking the actual changes in the technical condition of the equipment during operation. Therefore, the most important task of operating electric power systems is the transition from preventive maintenance to repair based on the results of complex technical diagnostics. Experience shows that for the effective use of the power transformer diagnostic system, it is necessary to carry out a lot of preparatory work and determine the list of equipment to be diagnosed, the parameters to be monitored, as well as the diagnostic tools used, depending on the critical state of the equipment, and to train qualified personnel. After that, a decision can be made on the implementation of a diagnostic control system for transformer equipment with a feasibility study.

At present, together with the scientific group of GSTU, work has begun on the development of a methodology for complex technical diagnostics of power oil-filled transformers. [11] - [13] The purpose of the work is to increase the reliability in detecting defects in the operation of power oil-filled transformers by monitoring and analyzing the simultaneous changes in a certain group of diagnostic parameters during complex technical diagnostics. The scientific idea is to extend the service life, reduce the number of sudden failures of power transformers during operation, improve the quality of diagnostics by combustible gas chromatography based on the developed theory of vibration diagnostics, dynamic resistance, diagnostics of magnetic circuit oscillations in the range of 50-5000 Hz and using various methods for analyzing combustible gases and simultaneously determining their values. diagnostic parameters when self-measurement increase the number. Instead of a conclusion, we can make the following assertion.

1. To improve the reliability of the complex of electrical transformers, it is necessary to study the problem of the reliability of electrical transformers operating at power plants and substations of electrical networks, since it is of national economic importance for Uzbekistan.

2. To assess the technical condition of long-lived power transformers, the rational extension of their service life, it is necessary to conduct a significant set of studies and develop new methods and criteria. It is necessary to develop a system of technical condition of power transformers. This allows: to provide an integrated approach to assessing the technical condition; determine the state of the stock of power transformers that have worked out a long service life; reduce the number of sudden failures of power transformers.

3. To achieve practical results, it is necessary to conduct a complete analysis and a set of theoretical and experimental studies, as well as develop methods and criteria for diagnosing power transformers.

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