ASSESSMENT OF THE TECHNICAL CONDITION OF THE POWER AUTOTRANSFORMER AT THE "YUKSAK" SUBSTATION

[1]Pirmatov Nurali, [2]Abdullabekova Dilafruz

[1]Tashkent State Technical University named after Islam Karimov, Department of power

[2]Tashkent University of Architecture and Civil Engineering

https://doi.org/10.5281/zenodo.7820920

Abstract. *Currently, timely comprehensive diagnostics and analysis is the most important condition for the reliable operation of power autotransformers. Continuous monitoring of power autotransformers during the entire service life allows you to detect possible damage after a short-circuit (emergency) situation, because during a short-circuit, the relay protection does not immediately turn off the autotransformer, and shock currents flow through it. windings that subject the elements of the autotransformer to mechanical overloads, as a result of which displacement and deformation of the core and winding of the autotransformer can occur.*

Two modes are considered in this article: normal mode and abnormal (emergency) modes of the power autotransformer at the "Yuksak" substation located in Yakkasaray district, Tashkent city, Uzbekistan. Diagrams of voltage and current changes on three phases of the line and three phases of the autotransformer, as well as information on activated protections and their response time were obtained. Diagrams were obtained using Ekra microprocessor panels.

Keywords: *power autotransformer, diagnostics, analysis methods, thermal imaging control, service life, monitoring.*

Introduction

At the moment, the most important issue has become the assessment and analysis of electrical equipment in the entire power system. This is due to the fact that the main fleet of power autotransformers are operated at the limit of their capabilities, due to an overdue service life. To diagnose and assess the state of power autotransformers at power stations and substations, monitoring is used using several software and hardware installations. Thanks to this method, extensive information is recorded about the parameters of power autotransformers and components, based on the data obtained, diagnostics and analysis of the state of the equipment are performed. Taking into account the cost of the power autotransformer monitoring system, which is approximately 10% of the cost of the power grid facility. The payback period of the system does not exceed 5 years, taking into account the cost reduction associated with planned and emergency equipment repairs.

Despite such payback periods and low cost, the technical and material basis for installing this monitoring system is not available in all substations, in Uzbekistan they are not available outside of Tashkent. In such cases, a data analysis system can serve as a way out of the situation. any information available about electrical network equipment obtained during technical diagnostics and testing or during its operation. From year to year, one can notice how the approaches to the problem of ensuring the working condition of power autotransformers have changed: forced repairs were used, that is, repairs after a failure or any breakdowns, routine and condition repairs. At the moment, an individual approach to strategies for technical repair and maintenance has already been formed. Based on the production experience gained, it can be seen that the uninterrupted operation of power autotransformers is ensured by modern, high-quality maintenance in accordance with the actual state.

The monitoring system should provide information for monitoring and adjusting operating modes, timely taking the necessary measures and emergency modes, analyzing emergency modes to reduce operating costs and predicting the technical condition of the reactor equipment. The purpose of a continuous condition monitoring system is to increase reliability and reduce operating costs.[1].

The monitoring system should be based on a three-level scheme. Level I includes primary sensors and measuring systems (sensors for temperature, oil gas content, oil moisture content, etc.). Level II - monitoring unit (hereinafter referred to as BM) is a set of controllers that provide collection and processing of signals received from primary sensors of level I. In addition, BM carries out information exchange with level III of the subsystem. Hardware combination of levels I and II is allowed. It is allowed to use one BM to monitor the condition of three single-phase transformers of a three-phase group. A complete list of the input information used is given in Section 4 of this Standard. Level III is performed in the form of a single centralized PTK for all transformer equipment of the substation and is intended for: - mathematical processing; - calculation and analytical tasks; - remote configuration and serviceability check of lower level equipment; - gateway functions; - communications with the upper management level (APCS), if these functions are not provided with APCS resources. For substations not equipped with automated process control systems, level III should also provide visualization of the state of monitored and calculated parameters of transformer equipment, display of alarm and warning alarm signals, accumulation of parameter databases, provision of work with accumulated archives and logs and transmission of information to remote upper levels of management . Communication between Layer II and III devices must be performed using digital channels using wired (shielded twisted pair) or fiber optic links. According to the standards of data exchange protocols and requirements for resistance to electromagnetic interference, communication channels must comply with the requirements of these technical requirements. [2].

Data were taken from the AT autotransformer of the ATDCTN type, with a capacity of 125 MVA, it was manufactured in 1981 by the ZTZ plant number 114434. The AT was put into operation in 1981, the last major overhaul was carried out in 2010. The tests were carried out at the Yuksak substation. Passport data of the autotransformer are given in table 1.

Table 1.

Rated U (kV)			Rated I (kA)			$U_к$ (%)			I_{XX} (%)	P_0 (kVt)	Losses short circuit (kVt)		
HV	MV	LV	HV	MV	LV	HV-MV	HV-LV	MV-LV					
230	121	10,5	313	595	3464	9,97	31	19,4	0,39	95,3	302	246	235
weight (T)													

General	Active parts	oils	Shell	type of drive		Oil protection	Connection group diagram	
186	82	63	11	ПДП-4У	РНОА	Пленоч.	Yo авто/Δ-0-11	

Fig. 1. Power autotransformer PS Yuksak.

These diagrams were obtained using special Ekra microprocessor panels, which are installed by the manufacturer in the power autotransformer. These EKRA microprocessor panels are designed to measure AC voltage and strength, frequency, active, reactive and apparent power, active and reactive electrical energy, DC voltage and strength, event registration, oscillography of processes, the formation of unified output electrical signals, the issuance of control actions on executive mechanisms.

The operating principle of the terminals is based on analog-to-digital conversion of input signals, their digital processing and display of measurement results on an LCD display and transmission of measurement results via digital communication interfaces to information systems and higher-level control systems. Microprocessor panels are installed for protection and automation of a power autotransformer, as well as for the creation of local emergency control systems (local PA), as well as emergency control systems for modes; for recording analog and discrete signals during disturbances accompanying normal modes in the power system; to control the circuit breaker and switching devices of connection, the organization of operational interlocks, the collection and processing of analog and discrete information.[1].


Fig.2. Microprocessor panel Screen.

This panel serves as the black box of the autotransformer, which stores data for 6-9 months. The data is opened using a laptop, in which a special program for reading information is installed.

In Fig.3. a diagram of the change in current strength on phases A, B and C is presented. The X-axis shows the value of the current strength on phases A, B, C, and the Y-axis shows the value of time. There is a transition from the normal mode to the emergency mode, then again it goes from the emergency mode to the normal one. It can be seen from the diagram that in some millisecond a short circuit occurred on two phases A (blue) and C (green) there are sharp current surges, then after the protection was activated, the short circuit was eliminated and the abnormal mode switched to normal. There was no short circuit on phase B (yellow line), so the sinusoid is the same.

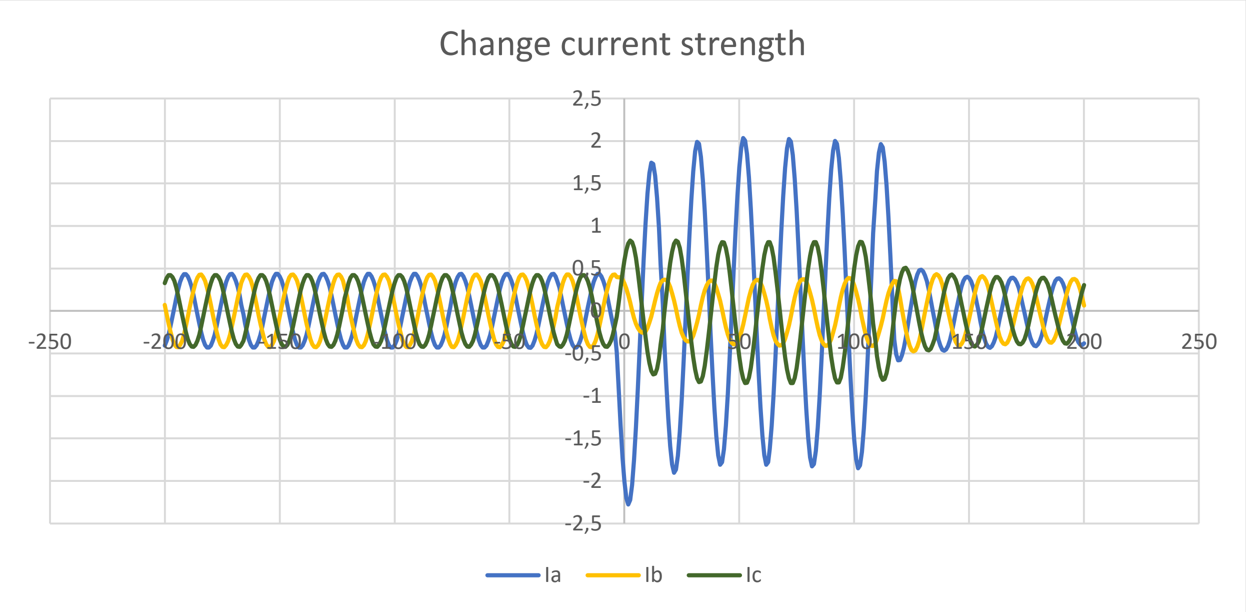

Fig.3. Change in current strength on phases A, B, C.

In Fig.4. the change in voltage on phases A, B and C is shown. The diagram shows that due to a short circuit that has occurred on two phases A and C, the voltage drops, this happened due to sharp current surges in these phases. After the accident was eliminated, the sinusoid returned to normal. In phase C, no short circuit was observed, the sinusoid is monotonous.

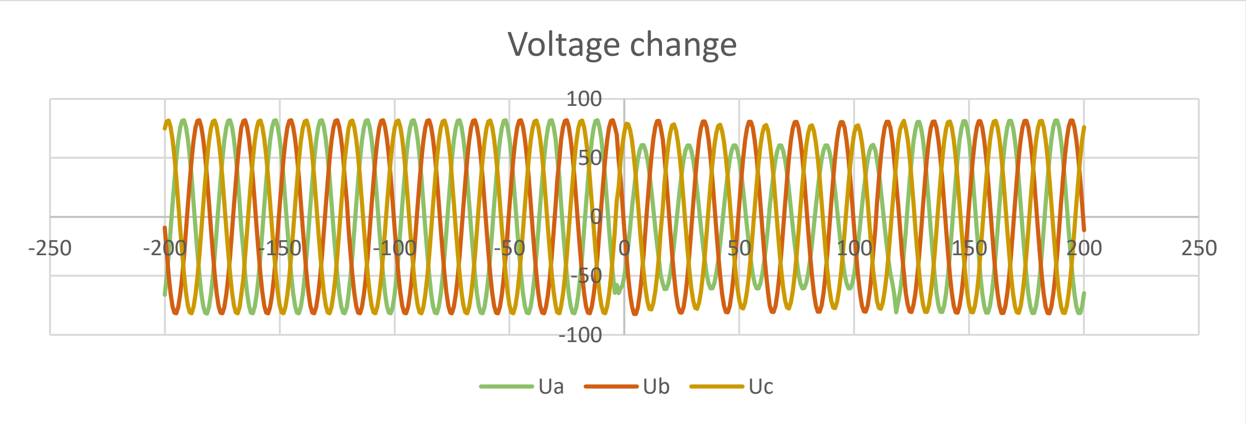

Fig.4. Voltage change on phases A, B, C.

According to the diagram in Fig.5. it can be seen which protection worked during the accident on phases A and C, namely the distance protections of the second stage.

Due to a short circuit on lines A and C, the DZ of the lines themselves worked, as a result of which the DZ of the first zone worked without delay, but the autotransformer did not turn off, but despite this, the DZ of the autotransformer felt a short circuit and therefore it was not the first DZ that worked instantly, but the second DZ made a start without turning off the autotransformer for 128 ms.

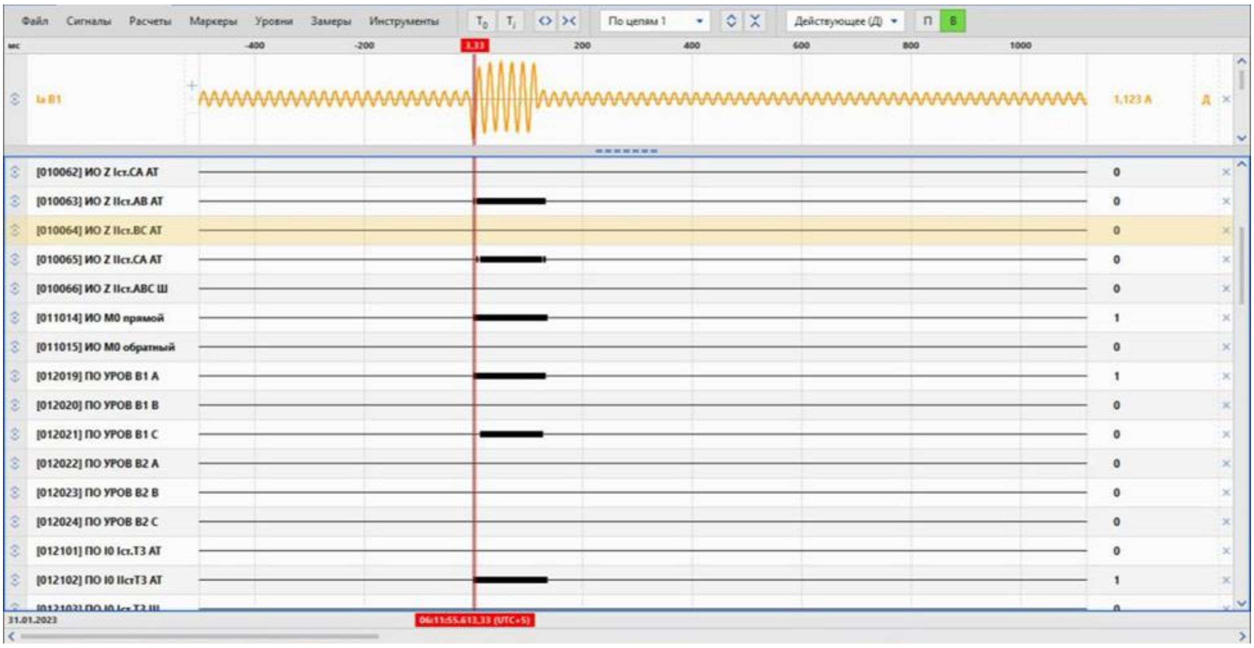

Fig.5. relay protection activated during a short circuit.

Conclusion

Based on the data obtained, this method is effective for detecting damage and short circuits. The advantage of this method is that it is possible to obtain data not only on the strength of current, voltage, and time, but it is also possible to identify the time of the actuated protection and the type of relay protection, it is also possible to obtain data on the voltage and current of the three phases of the power autotransformer and the three phases of the line . The main disadvantage is that the monitoring is carried out offline, the staff must come to the PS to connect the panel to a laptop and take the analysis.

REFERENCES

1. Monitoring systems for power transformers and autotransformers. General technical requirements / Mordkovich A.G., Tsfasman G.M., Daryan L.A., Margulyan A.M.; Department of Electricity Transmission and Conversion Systems of JSC FGC UES, 2014 - 121 p.
2. Monitoring systems for power transformers and autotransformers. General technical requirements / Mordkovich A.G., Tsfasman G.M., Daryan L.A., Margulyan A.M.; Department of Electricity Transmission and Conversion Systems of JSC FGC UES, 2014 - 121 p.
3. Tang W.H. Condition Monitoring and Assessment of Power Transformers Using Computational Intelligence / Tang W.H., Wu Q.H.; Department of Electrical Engineering and Electronics. The University of Liverpool, 2012 - 87 p.
4. Prokhorchik M. Continuous monitoring of the state of power transformers / Prokhorchik M.; VGTU Transporto engineering fakultetas, 2015. - 55 p.
5. Sparling B. Power transformer life extension though better monitoring / Sparling B., Aubin J.; GE Energy Management. 2015. - 45 p.