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PERFORMING ADJUSTMENTS TO ADDITIONAL PROTECTION SYSTEMS OF THE SUBSTATION

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Annotation. The article describes the process of finalizing and configuring additional protection systems at substations in order to increase the reliability and stability of electric power facilities. The study analyzes the issues of a comprehensive assessment of the operability of protective devices, matching their parameters with the main relay protection circuits and ensuring proper operation in emergency or transient conditions. The main stages of the commissioning work are revealed: the study of design materials, carrying out functional and statutory tests, modeling possible emergency modes and improving protection parameters. Modern methods and software tools used to diagnose and monitor the operation of security systems are also considered. As a result of the effective implementation and fine-tuning of additional protection systems, the level of electrical safety increases, the risk of technological failures decreases, and the reliability of uninterrupted power supply to consumers increases.

Keywords. Zero circuit current protection, Gas transformer protection, Selectivity map outline, Buchholz gas relay.

Introduction

Ensuring stable and safe operation of power systems is one of the most urgent technical tasks of modern society. In fulfilling this task, substations play a crucial role, as they carry out the processes of receiving, converting and distributing electrical energy to consumers. Continuous and reliable operation of substations allows maintaining the quality of electrical energy, providing consumers with uninterrupted power supply, and ensuring the stability of the entire power system.

There is always a risk of various malfunctions and emergencies in power networks. In such cases, the main element of system protection is relay protection and automation devices. However, the main protection systems cannot always detect all possible malfunctions or may not be activated under certain conditions. At such moments, additional protection systems are activated, protecting electrical equipment from damage and large-scale system failure.

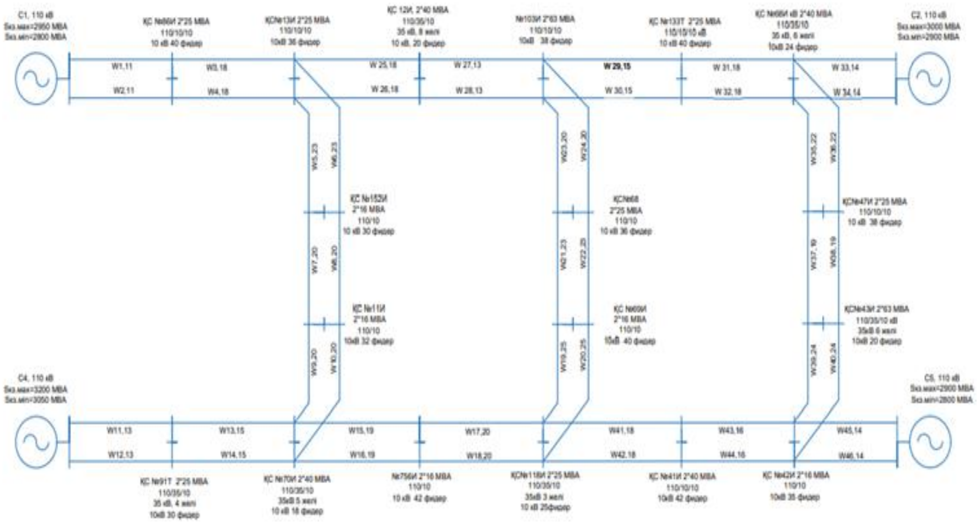
To increase the efficiency of additional protection systems, it is very important to correctly configure them and accurately determine their parameters. The correctness of the settings directly affects the selectivity, speed, and sensitivity of relay protection. When calculating the operating limits and time parameters of each protective device, the network configuration, transformer power, short-circuit current levels, and consumer characteristics are taken into account.

Currently, the process of tuning additional protection systems is carried out using automated programs and digital relay devices. This approach allows engineers to accurately simulate, test, and optimize protection parameters. However, in practice, it is of great importance to analyze the calculation and test results, taking into account the individual characteristics of each station.

This article considers the importance of additional protection systems of substations, their operating principles, and tuning methods. It is also proposed to analyze the stages and results of tuning based on specific technical parameters.

Initial data

№	Short circuit maximum power amount, MBA	Short circuit minimum power quantity, MBA	Short circuit minimum voltage size, kV
1	2950	2800	110
2	3000	2900	110
3	3200	3050	110
4	2900	2800	110



1. picture. Scheme of the distribution network

Zero circuit current protection (ZCCP)

Calculation of stage I

$I_0^{(1)} = 1,5 кА$,

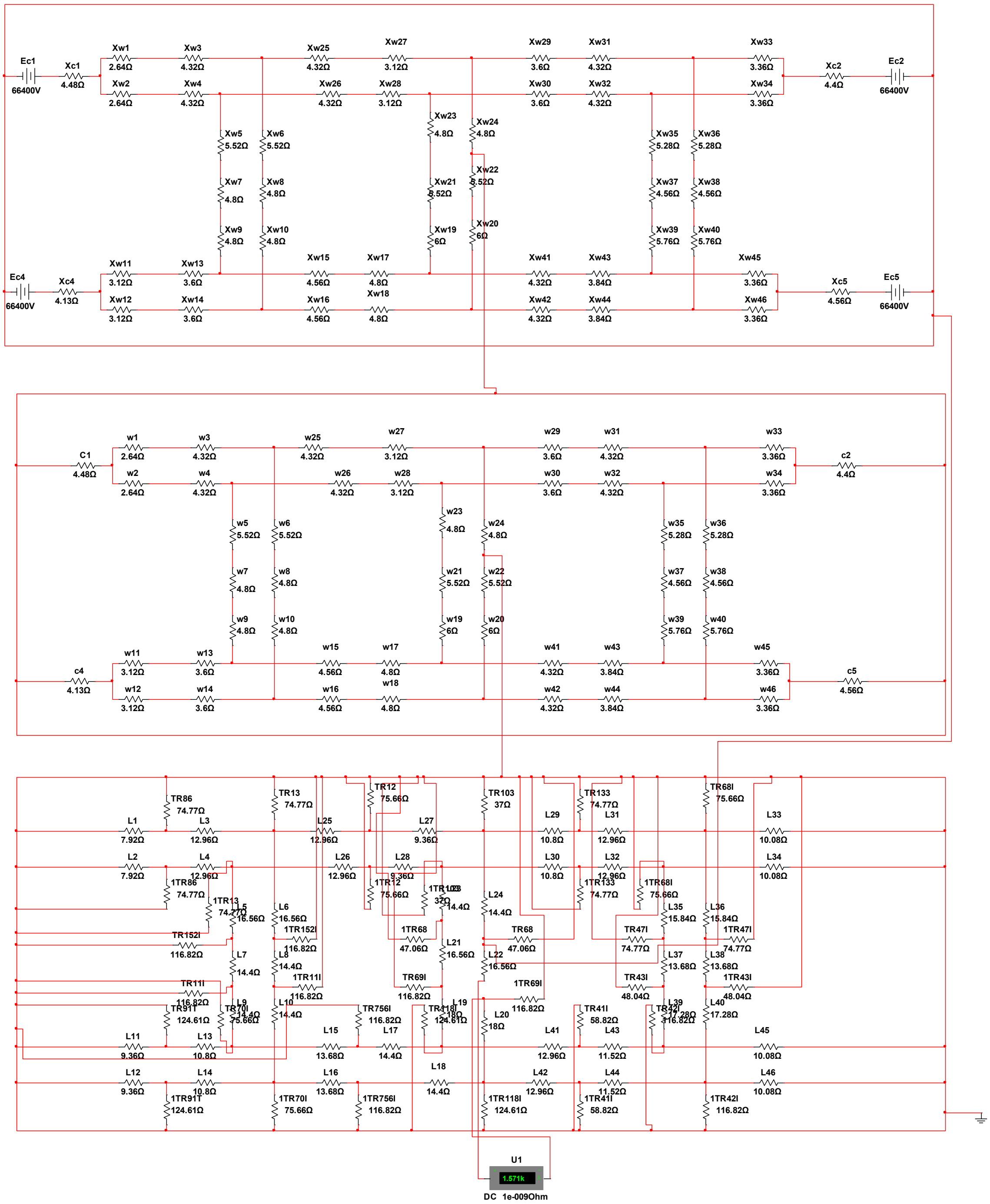
$I_0^{(1,1)} = 1,2 кА$,

$I_{Сз22}^{I} = K_н \cdot 3 \cdot I_0 = 1,1 \cdot 3 \cdot 1,5 = 4,95 кА$,

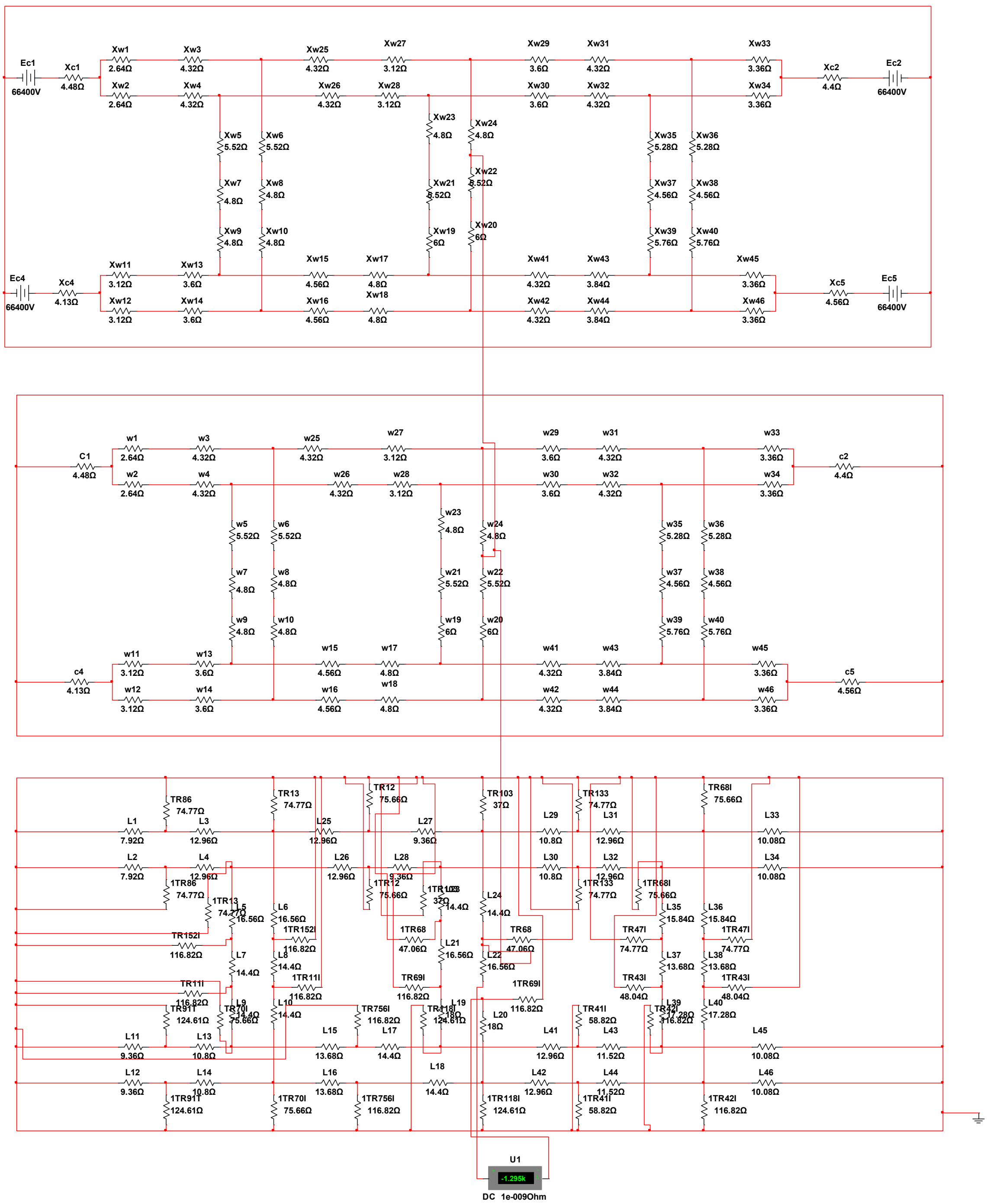
where, $I_0^{(1)}$ – single phase HF current;

$I_0^{(1,1)}$ – two-phase HF current;

$K_н$ – reliability coefficient.



1.1 picture. $I_0^{(1)}$ – single phase HF current;



1.2 picture. two-phase HF current;

Calculation of Stage II

Values of one-and two-phase KT of 20 adjacent networks

$I_0^{(1)} = 973A$,

$I_0^{(1,1)} = 801A$,

$I_{Cз20}^{I} = K_н \cdot 3 \cdot I_0 = 1{,}1 \cdot 3 \cdot 973 = 3{,}2кA$,

$\frac{I_{Cз20}^{I}}{3} = \frac{3200}{3} = 1{,}17кA$.

Reproduction of the II stage of the protected network:

$$I_0^{(1)} = 1,008 кA,$$

$$I_0^{(1,1)} = 801 A,$$

$$I_{Сз20}^{II} = K_н \cdot 3 \cdot I_0 = 1,1 \cdot 3 \cdot 1,008 = 3,32 кA.$$

Sensitivity factor:

$$K_ч = \frac{3 \cdot I_0^{(1)}}{I_{Сз22}^{II}} \geq 1,5.$$

Calculation:

$$K_ч = \frac{3 \cdot 1500}{3320} = 1,3 \leq 1,5.$$

Calculation of Stage III

Values of one-and two-phase KT of adjacent 18 networks:

$$I_0^{(1)} = 766 A,$$

$$I_0^{(1,1)} = 686 A,$$

$$I_{Сз18}^{I} = K_н \cdot 3 \cdot I_0 = 1,1 \cdot 3 \cdot 766 = 2,5 кA,$$

$$\frac{I_{Сз18}^{I}}{3} = \frac{2500}{3} = 766 A.$$

Values of one-and two-phase KT of Stage II of adjacent 20 networks:

$$I_0^{(1)} = 633 A,$$

$$I_0^{(1,1)} = 631 A,$$

$$I_{Сз20}^{II} = K_н \cdot 3 \cdot I_0 = 1,1 \cdot 3 \cdot 633 = 2,088 кA,$$

$$\frac{I_{Сз20}^{II}}{3} = \frac{2088}{3} = 696 A.$$

Elimination of Stage III of the protected network:

$$I_0^{(1)} = 639A,$$

$$I_0^{(1,1)} = 575A,$$

$$I_{Сз20}^{III} = K_н \cdot 3 \cdot I_0 = 1{,}1 \cdot 3 \cdot 639 = 2{,}1кA.$$

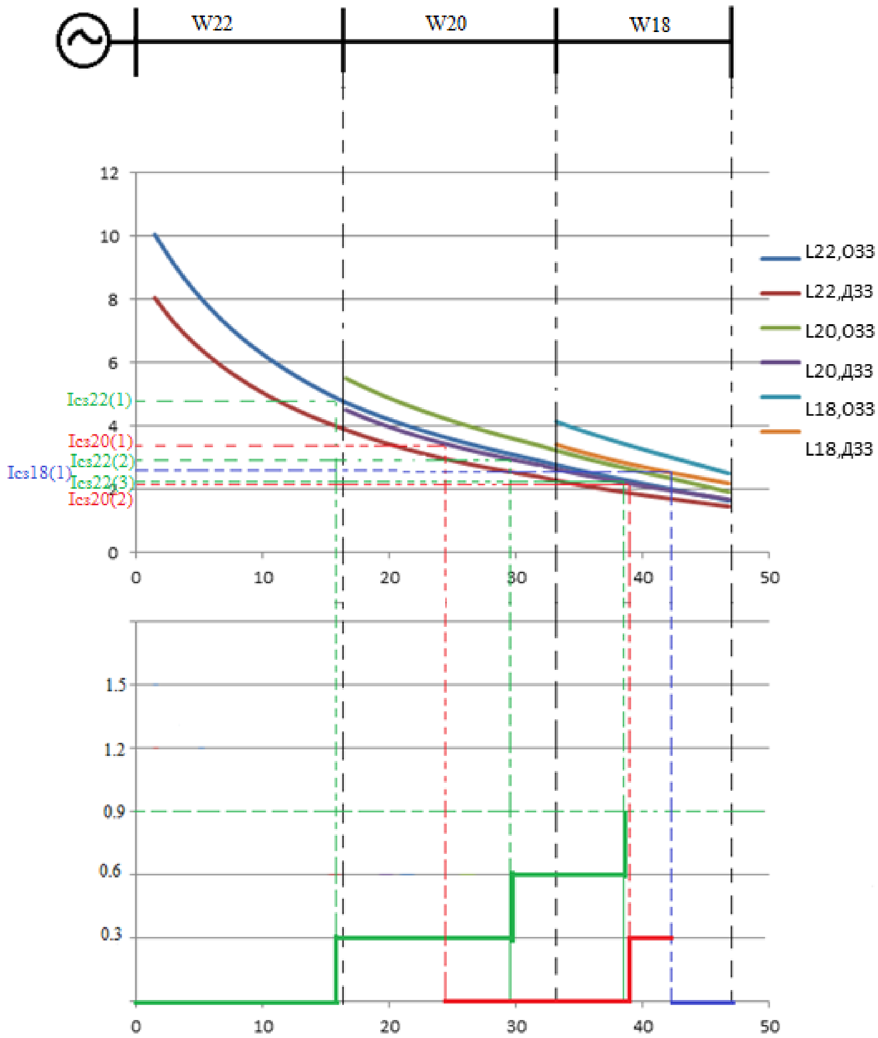
Sensitivity factor:

$$K_ч = \frac{3 \cdot I_0^{(1)}}{I_{Сз22}^{III}} \geq 1{,}5.$$

Calculation:

$$K_ч = \frac{3 \cdot 1500}{2100} = 2{,}14 \geq 1{,}5.$$

The sensitivity coefficient is satisfied.



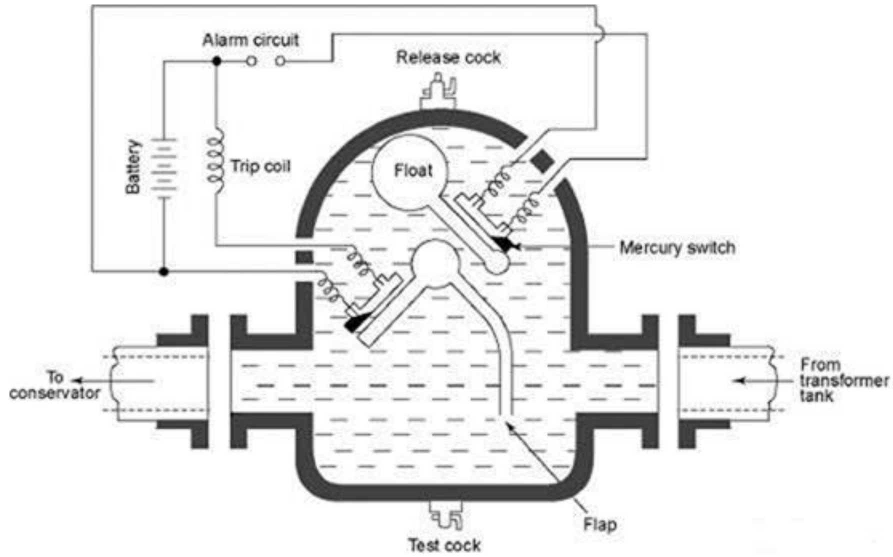
1.3 picture. ZCCP selectivity map outline

Gas transformer protection

Transformer gas protection is one of the most reliable and sensitive types of relay protection designed to detect internal damage occurring inside the transformer tank. In case of short circuits, overheating or decomposition of insulation, gases are formed in the oil, which indicate a violation of the normal operation of the equipment. The gas protection detects these processes and promptly sends a signal or disconnects the transformer from the mains, preventing the development of accidents.

The basis of gas protection is a Buchholz gas relay installed between the expander and the main tank of the oil transformer. It reacts to the accumulation of gases or the movement of oil caused by internal damage. In case of minor defects accompanied by slow release of gas, the protection issues a warning signal, which allows for timely inspection and troubleshooting. In case of serious damage, when a large amount of gas is released or an oil flow occurs, the relay sends a command to instantly turn off the transformer.

The gas protection is highly sensitive and easy to operate. It is able to detect the initial stages of malfunctions that have not yet manifested themselves in other ways, thereby increasing the reliability and durability of the transformer. However, this type of protection is used only for oil transformers and does not respond to external short circuits or overloads, so it is used in conjunction with other types of relay protection.



1.4 picture. Buchholz gas relay

Conclusion

Setting up auxiliary substation protection systems is the most important step in ensuring reliable and safe operation of power equipment. The accuracy of the protection operation, timely identification and elimination of emergency situations, as well as minimizing damage in case of possible malfunctions depend on the correctness of the settings made.

A high-quality setup makes it possible to achieve coordinated operation of all elements of protective and control devices, increase the stability of the power system and extend the service life of the equipment. During the setup process, all settings, logical relationships and operability of relay, alarm and automatic systems are checked, which guarantees their correct functioning under any operating conditions.

Setting up auxiliary substation protection systems plays a key role in creating an efficient and safe energy infrastructure. Proper execution of these works contributes to improving the reliability of power supply, reducing operational risks and the sustainable functioning of the energy system as a whole.

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ҚОСАЛҚЫ СТАНЦИЯНЫҢ ҚОСЫМША ҚОРҒАНЫС ЖҮЙЕЛЕРІНІҢ БАПТАУЛАРЫН ЖҮРГІЗУ

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Андатпа. Мақалада электр станцияларының сенімділігі мен тұрақтылығын арттыру мақсатында қосалқы станциялардағы қосымша қорғаныс жүйелерін аяқтау және конфигурациялау процесі сипатталған. Зерттеу барысында қорғаныс құрылғыларының жұмыс қабілеттілігін жан-жақты бағалау, олардың параметрлерін релелік қорғаныстың негізгі тізбектерімен сәйкестендіру және апаттық немесе өтпелі жағдайларда дұрыс жұмыс істеуін қамтамасыз ету мәселелері талданады. Пайдалануға беру жұмыстарының негізгі кезеңдері анықталды: жобалық материалдарды зерттеу, функционалдық және заңдық сынақтарды жүргізу, ықтимал авариялық режимдерді модельдеу және қорғау параметрлерін жақсарту. Сондай-ақ қауіпсіздік жүйелерінің жұмысын диагностикалау және бақылау үшін қолданылатын заманауи әдістер мен бағдарламалық құралдар қарастырылады. Қосымша қорғаныс жүйелерін тиімді енгізу және дәл баптау нәтижесінде электр қауіпсіздігі деңгейі жоғарылайды, технологиялық ақаулар қаупі төмендейді, тұтынушыларды үздіксіз электрмен жабдықтау сенімділігі артады.

Түйін сөздер. Нөлдік тізбекті токтан қорғанысы, Трансформатордың газ қорғанысы, Селективтілік картасы, Бухгольц газ релесі.

ПРОВЕДЕНИЕ НАСТРОЙКИ ВСПОМОГАТЕЛЬНЫХ СИСТЕМ ЗАЩИТЫ ПОДСТАНЦИИ

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Аннотация. В статье описан процесс доработки и настройки дополнительных систем защиты на подстанциях с целью повышения надежности и стабильности работы объектов электроэнергетики. В исследовании анализируются вопросы комплексной оценки работоспособности защитных устройств, согласования их параметров с основными цепями релейной защиты и обеспечения надлежащей работы в аварийных или переходных режимах. Раскрыты основные этапы пусконаладочных работ: изучение проектных материалов, проведение функциональных и нормативных испытаний, моделирование возможных аварийных режимов и улучшение параметров защиты. Также рассмотрены современные методы и программные средства, используемые для диагностики и мониторинга работы систем безопасности. В результате эффективного внедрения и тонкой настройки дополнительных систем защиты повышается уровень электробезопасности, снижается риск технологических сбоев и повышается надежность бесперебойного электроснабжения потребителей.

Ключевые слова. Защита от тока нулевого замыкания, защита газового трансформатора, схема селективности, газовое реле Бухгольца.