PRINCIPLES OF EVALUATION OF RELIABILITY OF THE EQUIPMENT OF THE POWER ELECTRICAL DISTRIBUTION SYSTEMS

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Abstract. The Power electric distribution systems (PEDS) possess a great dynamics of development. Thanks to this phenomenon in the power electric distribution systems (PEDS) the probability of apparatus of asymmetrical regimes increase monotonously. As a result of this reliability of the functioning of the power electric equipment installed in the electric knots changes. The asymmetrical regimes in the power electric distribution systems (PEDS) accompanied by the short circuit current are a function of a row determinate is a vague factor of probabilistic nature.

Coming from it follows that the investigation of the influence of the asymmetrical regimes accompanied by the current of the short circuit on the reliability of the power electric distribution systems (PEDS) is one of the most important problems of the development the power electric distribution systems

The short circuit currents influence the structural and functional reliability of distribution networks and at the reliability of electrical equipment installation

Keywords- Power electric distribution systems reliability of electrotehnical equipment, asymmetrical regimen, accompanied, current of the short circuit

1. INTRODUCTION

Power systems and power distribution have a pretty dynamic development highlighted.

This phenomenon is due to more extensive use of electricity in various branches of national industry (industry, agriculture, and social sector), etc. Following the installed generating nodes and continuously growing system entirely.

The electrical distribution systems monotonically increasing continuously and discretely short-circuit current (SC), which brings to the variation of operating reliability of equipment and electrical equipment installed in knots.

This paper is the study and analysis of the influence of short circuit currents on equipment reliability and electrical equipment installed at bus power distribution systems.

2. MATERIALS AND METHODS

Power equipment reliability problems are some of the most pressing issues of forecasting and of operating the electric power industry and depend on a number of factors so determined and undetermined.

Therefore this problem requires special attention. Known methods of analysis and evaluation of reliability indices (both of networks, nodes and electrical equipment and the systems of power and distribution in full), in some cases do not meet these requirements because it does not take into account all factors that influence the reliability of equipment and electrical machinery.

Short circuit currents power electrical systems probabilistic in nature and takes on values determined at different stages, which depend so installed as well as the state power and the electrical components to short-circuit timing. Therefore the study and research of the influence current values of sc the reliability of networks, nodes and electrical equipment installed in power systems is one of the most pressing issues on power systems and power engineering development in full.

To determine the influence of an electric power system was studied for 25 years every 5 years. In each period were calculated values of short circuit current and expected level of reliability.

Analysis of the results gained indicates that node reliability as the reliability of distribution systems components, wiring diagrams in the systems of nodes and the expected values of short circuit currents.

Dependence was established reliability elements and transport nodes mainframe systems and power distribution depending on the short circuit current values $R = f(I_{SC})$.

In the process of calculating and assessing the reliability of elements and nodes mainframe systems of electricity transmission and distribution was determined that short-circuit currents have a primary influence on the reliability of equipment. It was found that the status of these elements depends not only reliable nodes as they are installed, but a large part of the mainframe systems reliability of electricity transmission and distribution connected with given node. Analysis of operating the equipment indicates that reliability depends on the following factors:

a) expected values of the short circuit currents which may occur in the system;
b) frequency of occurrence of short circuit currents;

c) transient recovery voltage $U_{TR}(t)$ that appears to breaker bars, and their variation.

Reliability of operation of circuit breakers and disconnect their ability is directly proportional to the cube of short circuit current given node. Ability to disconnect switches any circuit is characterized by exchange rate (variation of electricity derived from short circuit breaker bars [1,2].

If the variation of electric short circuit current limit is $2 \prec di_{sc} / dt \prec 10, A / msc$, the probability and during the occurrence of arcing across the breaker is minimal and when this switch can disconnect any circuit.

If electric short circuit current variation is within, $15 \prec di_{sc} / dt \prec 30, A / msc$, then disconnect any type of air circuit breakers is defensible by any type of switch that is currently in operation, the system studied.

Depending on the expected values of the short circuit currents, moving to short circuit breaker, disconnect the short circuit is characterized by short circuit disconnection factor complicity. These factors characterize the influence of different parameters on the operation of circuit breakers now.

As parameters are:

a) the maximum expected short circuit currents of disconnection;

b) amplitude and current variance component a periodic short circuit;

c) first derivative amplitude initial period of transient recovery voltage circuit breakers to bars on both sides;

d) dynamic forces acting on breaker bars;

e) ambient temperature, arc length and other factors that may have direct influence.

The value of this factor depending on the values of short circuit current and maximum current disconnect to disconnect the circuit breaker is determined by the expression:

$$K_t = CLI_{SC}^{(3)}(t) \qquad (1)$$

where: C-is coefficient of proportionality, C = 0.375;
L - distance where the short circuit occurs to the bar;
$I_{SC}^{(3)}(t)$ -the value of three-phase short circuit current.
$I_{SC}^{(1)}$ -the current single-phase short circuit

The analysis results of, the network system reliability and system reliability of the equipment installed in the nodes depend on dynamic changes of sc currents. Reliability of the expected dependence of short circuit currents are shown in fig. 1

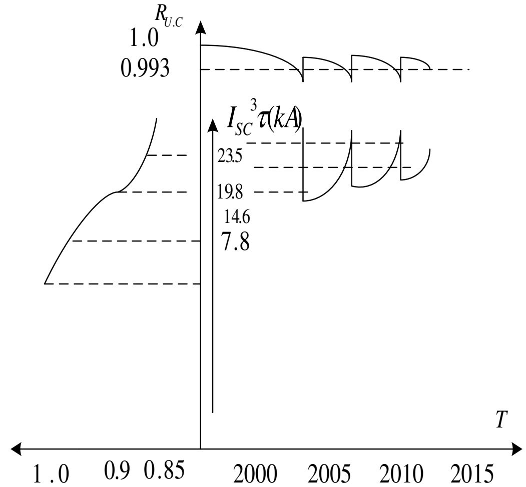

Fig.1 - The dependence on the reliability of random values of short circuit currents

One of the parameters that characterize the reliability of circuit breakers is the flow of refusal [ω (t)]. To assess flow refusal developed a mathematical model which enables to take into account the number of cycles and intensity of operation since last overhaul. In this case the frequency of operation without refusal λ(t) is determined as [3] depending on the values $I_{SC}^{(1)}(t)$; $I_{SC}^{(3)}(t)$.

If the frequency of operation λ_1 the commissioning of the equipment λ_2 and time of taking the overhaul are known then the limit of the operation in terms of reliability can be determined by the expression:

$$\Delta p(t) = e^{-\Delta\lambda(t)} \qquad (2)$$

where: $\Delta p(t)$ - is it possible to decrease the probability limit of operation until the next repair of equipment;

$\Delta\lambda = (\lambda_1 - \lambda_2)$ - the difference in probability at the beginning and end of the operation.

The number of complete cycles depending on the likelihood and frequency of operation is determined by the expression:

$$N(t) = N_0 e^{-\Delta\lambda(t)} \qquad (3)$$

where: No - is the number of cycles of operation of the circuit breaker that disconnects currents. value less than 10% of the maximum expected under STAS 687-89.

The breaker reliability R(t) the number of cycles until the next revisions to the repair or removal of N(t) by the currents of short circuit disconnect wait. The short circuit current I_{SC} was determined experimentally and presented in table 1.

Table 1.

$\frac{I_{SC}^{(1)}(t)}{I_{SCN}^{(3)}(t)}$	**0.08**	**0.16**	**0.25**	**0.50**	**0.75**	**1.00**
N(t)	**32**	**26**	**20**	**15**	**12**	**10**
R(t)	**0.9998**	**0.9997**	**0.9996**	**0.9996**	**0.9993**	**0.9991**

where: N (t) - is the number of cycles performed by switch disconnects;

R (t) - is reliability of operation of circuit breakers.

In considering the influence of short circuit currents on fiability necessary to take into account not only the expected values of short circuit currents, but also the thermo effect, they produce this year. The influence of thermal effect of the short circuit currents in this case is determined by thermal pulses,
which are proportional to the square values of short circuit currents and can be determined from the following expression:

$$W_k(t) \leq I^2(t)Z(t)dt \qquad (4)$$

where: $I^2(t)$ - is the effective value of short circuit disconnected.
From the above it is clear that reliability of operation of circuit breakers is a multifactor function determined by the currents of short circuit, transient change in voltage, short circuit factor aiding the disconnected [3,4].
In the analysis all relationships determined duration and frequency is received that has a probability distribution (p = 0.9997) and follow laws, corresponding Waybill distribution.
In this case this function can be determined from (5).

$$f(t) = \frac{\alpha(t)}{T} e^{\frac{(\alpha-1)t}{T}} \quad (\, t > 0 \,) \qquad (5)$$

where: T is the period of operation, t-the emergence of refusal set; $\alpha \succ 0$ - shape the distribution of refusals. The probability to refuse equipment operating in conditions that do not meet technical requirements (because that increases the probability of rejection) of all equipment can be determined from expression (6).

$$p_R(t) = (1 + a_b^0 K_A)K_t \cdot a_b \qquad (6)$$

where: a_b - is automatic recouping index (a_b= 1 if automatic recouping works without denial, a_b = 0 if automatic recouping missing.)

K_A - coefficient taking into account the automatic recouping cycles without success;

Kt - coefficient of complicity to disconnect the short circuit real;

a_b^0 - number of disconnects unsuccessful according to the values of short circuit currents.

Statistical analysis of materials (all refusals breakers) shows that about 25% of all refusals occur because of external insulation defects, therefore is necessary to introduce the correlation coefficient (kτ = 0.25), taking into account the decreasing reliability of due to external faults.

In this case taking into account all described it can be concluded that the indicators and the reliability of circuit breakers is based on random values of short circuit currents.

3. CONCLUSIONS

1. Comprehensive analysis of equipment reliability and electrical equipment installed in electricity distribution systems r EEA show that it depends on the expected values of short circuit currents, the transient recovery voltage and its variation in bars equipment and number of cycles performed. This feature bears a linear character.
2. Probability values of short circuit currents expected to meet technical requirements for electrical equipment reference. Otherwise it is necessary to develop additional measures to limit the short circuit current values of increase.
3. To determine the influence of short circuit current and voltage transient on indicators of reliability of equipment and machinery in distribution systems has developed a mathematical model that takes into account the dynamics of change of short circuit currents.

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