THE INFLUENCE OF ASYMMETRICAL REGIMES ON THE FUNCTIONING RELIABILITY OF ELECTRO-ENERGETIC SYSTEMS

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Abstract: Graph sructure variations in the distribution networks and power increase in the generating nodes lead to the appearance of asymmetrical regimes which may be accompanied by additional phenomena including varions forms of short circuits (both monoplastic and triplastic). We can conclude that, as a result of these phenomena, the reliability of respective electrical equipement will change in its turn.
This article is concerned with the analysis of asymmetrical regimes influence on the functioining reability of electrical equipement.

Key-words: Asymmetrical regimes, electrical equipments, short circuit, reliability of electro-energetic systems.

1. INTRODUCTION

One of the key problems in developing process of power systems and especially in those of electrical energy distribution is the problem of unbalanced regimes which appear and the phenomena accompanying these regimes and their influence on the functioning of installed equipments. From the most common phenomena which could appear in three phase systems, which create the unbalanced regimes are short circuit which joins the normal functioning regimes.

RESOLVING OF THE PROBLEM

From all the installed equipments the most often are subjected to unbalanced phenomena and transitional regimes which appear in distributional systems are the switches. From this very reason the level of functioning reliability and the functioning way of distributional system are in direct dependence from the functioning way of switches, that the most often are installed at feeder beginning. At appearance of unbalanced regimes and the phenomena of short circuit the switches must trigger in a quick way (during 4 periods) the respective electric circuit , for keeping the functioning hardness of the respective system. From studied static materials can be found, that with increasing of short circuit current values in nodes of system power the most difficult functioning conditions of switches appear then, when the value of short circuit current constitutes the size which is determined through equation (1).

$$I_{s.c.} = \frac{2}{3} I_{s.c.\max} \qquad (1)$$

where: $I_{s.c.max}$ – the short circuit current at the beginning of network;

It was established that from all unbalanced regimes joined by transitional regimes , the most difficult at connection by switcher are those created depending on tension variation speed, (du/dt) and the electric current variation (di/dt) instead of unbalanced regimes appearance. The respective values variation in electric circuit nodes, and the switching off hardness of these regimes can be determined in an analytical way through the value of hardness coefficient, that is calculated according to this equation (2)

$$k_D = I_{scA} / I_n \qquad (2)$$

where: I_{scA} –is the expected short electric current in the electrical node.
In-is the nominal electric current switched off by the respective switcher.

In the analyzed process of transitional influence on three phase systems created by the unbalanced regimes one of the basic elements in the function reliability of electric equipments according to [2,3]. In determination process of short electric current influence and of unbalanced regimes on the functioning reliability of switchers goes from the assumption that the described in[2,3] conditions are fulfilled and in this case the frequency of switching off is the function of switched electric current values and it expressed by the equation (3).

$$\lambda(t) = f(I_{SC}^{(1)}; I_{nom}^{(3)}); \quad \lambda(t) = \frac{1}{t_p} \int_0^{t+t_p} \omega(x)dx \qquad (3)$$

If from this formula is established that the switching off frequency will be a determined value, then the function without rejection probability of respective equipments will be determined from the expression (4)

$$p(t) = e^{-\lambda t} \qquad (4)$$

The rejection probability of respective equipments in functioning process will be determined by following expression (5)

$$q(t) = 1 - p(t) = 1 - e^{-\lambda t} \qquad (5)$$

If it is known the rejection probability of respective equipments planned at the beginning of exploitation (q_1) and that real at the stage of doing the respective, consecutive repairs (q_2) for reestablished technical properties then it can be analytical determined the reliability reserve function of respective equipments according to expression (6)

$$\Delta q = q_2(t) - q_1(t) = e^{-\Delta\lambda t} \tag{6}$$

where: Δq – represents the possible value of function rejection increasing probability of respective equipments by the next consecutive repair.

$\Delta\lambda = (\lambda_2 - \lambda_1)$ – is the frequency switch off differences that is electric current values function switched off at the beginning of exploitation cycle [λ_1]and at the moment of doing the respective capital reparations [λ_2].

The operations number of respective equipments depending on frequency and probability of respective rejection occurrence can be analytic determined through the equation (7)

$$n = n_0 e^{-\Delta\lambda t} \tag{7}$$

Where: n_o-is the minimal operations number that are possible established for respective equipments till the next reviewing and capital reparation this comes from the switched of current values.

Thus the unbalanced processes the most often are joined by the emission of the warmth ,which has a negative influence on electric equipments function ,the appears the necessity of verifying the respective equipments and at thermal hardness. It comes from the real functioning conditions. In this case if the 7 formula inequality is fulfilled it can be established that the respective equipment will respect thermal hardness.

$$I^2_{\grave{O}.nom} \cdot \tau_{\grave{O}.nom} \geq \int_0^{\tau_{T.nom}} \hat{A} \tag{8}$$

Where: $I_{T.nom}$ - is the nominal value of the current with thermal hardness of equipments.

$\tau_{T.nom}$ - is the nominal thermal hardness time.

B - Is the integral of Jull with integral limits from 0.

Another index that characterizes the capacity and probability of respective equipments in respective node of electric system is the switched of capacity of electric parameters in different possible situations, as in normal functioning regime so in unbalanced regimes of accident. According to [4] the switched off capacity of respective equipments estimated from the nominal switched off current value. Id.nom and the nominal unbalance of switched of current in the moment (β_{nom}) of switched off, that may be determined according to expression (9):

$$\beta_{nom} = \frac{i_{a.\tau}}{I_{o.nom}\sqrt{2}} \tag{9}$$

Where: $i_{a\tau}$ - is the a periodic component value of electric current of short circuit in the moment of switching off the respective regime.

The functioning reliability of respective electric equipments (including switches)in this case is the function of electric current value of switching off and the variation speed of the transitional and restored tension in the respective moment, the probability of the functioning without rejection and the respective operations number that were done.

In analytical way the respective dependence can be presented according to expression (10).

$$R(t) = \frac{1}{n\sqrt{2\pi}} \int_0^t I^{(3)}_{\hat{E}\c{C}}(t) \int_0^t (\omega \cdot t + \gamma \cdot t)dt. \tag{10}$$

The reliability functioning dependence of the electric equipments as function of electric switched off current values and the done cycles number for respective equipments (including switch) installed in systems of different tension level, for different exploration periods (period 1980-2007) in various systems can be different, but for concrete analyzed system is presented in chart **1**

Chart 1

$I_{о\ ном}$ (кА)	20	30	40	50	63
$I_{кз}/I_{о.\ ном}$	0,16	0,25	0,50	0,75	1,0
N	30	25	20	12	10
R	0,996	0,998	0,999	0,993	0,991

From the numeric value analysis of functioning reliability presented in (chart 1) is explained that the reject frequency variation(intensity) of the electric equipments and the reject probability in time, can be presented in the respective graph by showed curves (1) and (2) from figure 1, which point out that the respective values correspond to the reestablished classic functions of the elements that enjoin the processes of restoration in time.

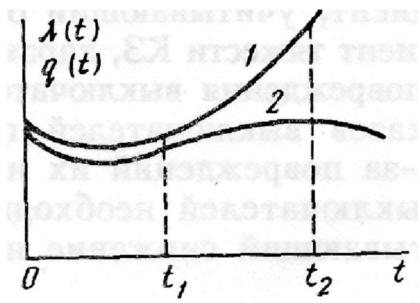

Fig. 1

The probability of functioning without rejection is a parameter that characterizes the electric equipment working reliability (including switches) that depends on the exploitation time can be analytical determined by the expression (11).

$$p(t) = e^{-\int_0^t \lambda(t)dt} \tag{11}$$

The electric equipments frequency rejection (including switches) q(t) is determined paying attention to the intensity working without rejection p(t) and analytical will be calculated according to (12):

$$q(t) = 1 - p(t) = 1 - e^{-\int_0^t \lambda(t)dt} \tag{12}$$

The analysis work process of electric equipments in three phase systems at occurrence of transitional systems can be established that approximately 25% from disconnection are spent in basis of the unbalanced regimes that appear in respective systems.

From this very conditions the equipments function reliability systems of distribution can be determined paying attention to the respective distribution phenomena and it will be determined according to the expression(13)

$$R(t) = K\frac{K_T}{n\sqrt{2\pi}}\int_0^t [w\tau + \gamma\lambda\tau] d\tau / (I_{SC} / I_{i.Nom}) \quad (13)$$

CONCLUSIONS

From all that was presented we established that transitional processes that accompany the unbalanced regimes of the respective electric equipments functioning that can be expressed through the functioning reliability of respective equipments.

In our thesis it is proposed a mathematical model and an algorithm that can modify the functioning reliability of electric equipments that depends on the unbalanced switched off current and of the variation reestablished tension speed at the bases of respective equipments.

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