INFLUENCE OF ASYMMETRICAL MODES ON INDEXES OF THE FUNCTIONAL RELIABILITY OF DISTRIBUTIVE SYSTEMS

ERHAN F.
State Agrarian University of Moldova
terhan@mail.ru

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.

Key words: Current of the short circuit, asymmetrical regimen, power electric distribution systems, reliability of electrotehnical equipment.

1. INTRODUCTION

Electroenergy and distributive systems are the artificial technical systems which dynamics of is development one of the highest in comparison with other technical systems [1]. Reliability of such systems carry probabilistic character and they are functions from the row of both certain and indefinite factors [2]. Among external factors influencing, the most considerable to reliability of the distributive systems indexes there are levels of currents of short circuit and their time-history.

It is necessary to mark that the levels of currents of short circuit in the distributive systems carry probabilistic character and depend on the row of factors both certain and indefinite and have a decision value at the choice of electrical equipment, count of development of electric networks and levels of tension.

A problem of optimization and co-ordination of the expected levels of currents of short circuit in the knots of the electroenergy systems is very actual.

Therefore determination of basic factors that have qualificatory influence on the values of levels of currents of short circuit and rates of their change in electric networks and knots will allow conducting their optimization and limitation of their height.

2. MATERIALS AND METHODS

Taking into account that speed of change of currents levels of short circuit in electric networks and knots of the electroenergy systems is carried probabilistic character, discretely change and the curve of change carries nonlinear character, then considerably development of calculation methods of the expected levels of currents of short circuit becomes important, taking into account the most essential factors, influencing on their value and speeds changes [1]. The modes of origin of short circuits can be most various, therefore at the development of mathematical models it is necessary to take into account those factors that is determined and mathematically can be described by corresponding equalizations 3]. Mathematically function, which describe the dependence of speed change of the expected levels of short circuit currents on basic certain factors can be presented by equalization (1).

$$di_{s.c.}/dt = f\cdot[(dU/dt)_g;(dU/dt)_l;(dS_{s.c.}/dt)_g;(dS_{s.c.}/dt)_l;dz/dt] \qquad (1)$$

where: $di_{s.c.}/dt$ - it is speed change of the expected levels of currents of short circuit in the set knot of the system :

$(dU_{RRT}/dt)_g$; - it is speed change repeatedly - the restored tension in the point of short circuit from the side of sources of feed :

$(dU_{RRT}/dt)_L$; - it is speed change repeatedly - the restored tension in the point short circuit from the side of loading :

$(dS_{s.c.}/dt)_g$ - it is speed change of power of short circuit in the point of short circuit from the side of sources of feed :

$(dS_{s.c.}/dt)_L$ - it is speed change of power of short circuit in the point of short circuit from the side of consumers:

(dZ/dt) - it is speed of change equivalent impedance is in the point of short circuit.

The process of short circuit is practically accompanied by the origin of voltaic arc, therefore speed of passing of process of short circuit and change of current of short circuit depend on speed change of the repeatedly-restored tension (U_{RRT}) in the point of short circuit [4].

The time variation of constituents the repeatedly-restored tension (U_{RRT}) depending on place where a short circuit took place it is brought around to a fig. (1).

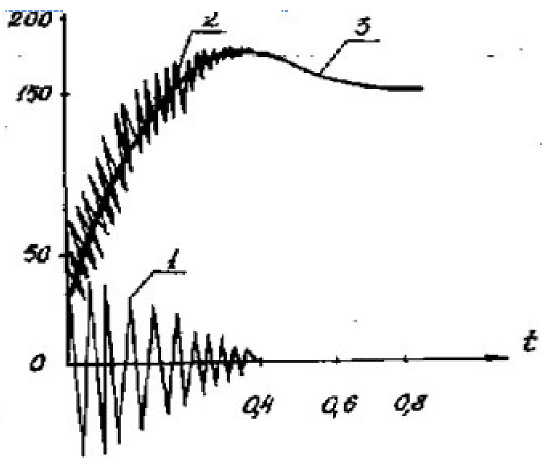

Fig.1. Complete (U_{RRT}) in the system of 110kV at short circuit on distance of 1.5км from the tires of trasformators stansin and switcher;

1- is a constituent (U_{RRT}) from the side of line;
3- is a constituent of repeatedly restored voltage (U_{RRT}) from the source; 2 – complete of repeatedly restored voltage (U_{RRT}) on a switcher;
4- is a curve of change of short circuit current .

A resulting value of repeatedly restored voltage (RRT) arising up here has two constituents: from the side of source of power supply $(dU_{RRT}/dt)_g$ and from the side of line on that a process ; $(dU_{RRT}/dt)_L$ is transitional.

These constituents are determined accordingly from next calculation expressions (2 and 3) taking into account reserved contour and their impedances:

$$(dU/dt)_L = z \cdot di_{s.c.}/dt \tag{2}$$

$$(dU/dt)_g = \frac{z}{n-1} di_{s.c.}/dt \tag{3}$$

where: **n** amount of the electricity transmission lines, added to the tires of source from where the point of short circuit can be power.

Z is an equivalent impedance of contour, where is a process of short circuit.

A resulting value U_{RRT} (t) taking into account speed of its change is determined from expression (4).

$$(dU_{RRT}/dt) = (dU_{RRT}/dt)_g + (dU_{RRT}/dt)_l = z\frac{n}{n-1} di_{s.c.}/dt \tag{4}$$

Ability of electrical equipment (in particular switch) to disconnect any type of short circuit is characterized by speed change of current on the contacts of the switcher of **$di_{s.c.}$ / dt.**

If $(0 \prec di_{s.c.}/dt \prec 10)$,A/мкs., the duration of burning of arc is minimum and a switch is able to disconnect any type of short circuit.

If $(25 \prec di_{s.c.}/dt \prec 30)$, A/мкs, that disconnecting of any type of short circuit. becomes problematic for any switches being presently in exploitation.

Depending on the size of the expected current of short circuit, its.

Place in relation to a switcher, the process of disconnecting of current of short circuit is characterized withe coefficient of weight of disconnecting, that is driven to the table (1).

Table 1. Dependence of reliability of wearing-out of switches (R) and the amount of cycles (N) to the their repair from the value of the disconnected current of short circuit Is.c.

Idc./Is.	0,08	0,16	0,25	0,50	0,75	1,0
N (t)	32	26	20	15	12	10
R (t)	0,996	0,998	0,999	0,999	0,993	0,991
R^1 (t)	25,0	50,0	100	100	14,3	11,1

where: **N(t)** is an amount of cycles of wearing-out of switches; **R (t)** - reliability of switches expected on a classic method; **R^1 (t)** - reliability of switches expected on an integral criterion.

The coefficient of weight characterizes the degree of influence of different factors to the process of wearing-out of switches and probability of their wearing-out in the moment of short circuit - such, as: value of current of short circuit, amplitude and speed change, initial velocity, (dU_{RRT}/dt) amplitude of the first peak of the transitional restored voltage of U_{RRT}, is dynamic efforts operating on the contacts of switcher, ambient temperature and other factors.

Research of dynamics of change of levels of short circuit currents shows in the electric networks of different level of voltage (6,10, 35, kV.), that dynamics of change of levels of currents of short circuit is a function from the row of factors driven to equalization (1).

It is revealed, that defining role on the values of the expected levels of short circuit currents, and the set power of generating knots and flow diagram of connection of elements have a dynamics of their change, have the power of generating knots of the system, from that depends and power of signup to the point of short circuit, from the side of consumers in case of origin of short circuit.

Pure resistance of explorers during a short circuit, and process of thermal slump of short circuit current depends from the value of these powers [4].

The height of the set power results in the height of peak short circuit currents, in the networks of different level of voltage in the investigated electroenergy systems taking into account the dynamics of development for 5 years: in networks by voltage of 10kV to 16%; in the networks of 35kV average to 20 %.

The dynamics of change of levels of short circuit currents, in the networks of different class of voltage of the electroenergy power systems different, because the transferrable stream of powers changes, therefore the electrical equipment is exposed to influence of short circuit currents, different form, size [5].

Thus transitional voltage of different sizes and different rate-of-change. for research of dynamics of change of levels of short circuit currents the distributive networks of the real electroenergy systems were investigational containing more than 1400 knots of different class of voltage in the process of their development with an interval of 5years.

the maximal values of the expected levels of mono phase and three-phase short circuit currents in the networks of different voltage (during winter maximums) and disconnecting ability of the set switches are given in the table 2.

Table 2. Change of level mono phase and three-phase currents of short circuit

Years	Amount of knots, N,un.	Mninimal value of levels of currents of short circuit (кА)		Maximal value of levels of currents of short circuit (кА)		Disconnecting ability of the set switches
		$I^{(3)}_{s.c.}$	$I^{(1)}_{s.c.}$	$I^{(3)}_{s.c.}$	$I^{(1)}_{s.c.}$	I dc.nom, (кА)
Unom = 10 кV						
1970	145	0.42	-	3.56	-	10 – 20
1975	178	0.50	-	4.24	-	
1980	246	0.61	-	5.12	-	
1985	312	0.73	-	6.19	-	
1990	392	0.90	-	7.43	-	
20155	405	1.13	-	6.32	-	
Unoм = 35 кV						
1970	105	0.51	-	4.96	3.6	6.6 - 16.5
1975	128	0.72	-	6.39	5.8	
1980	142	0.87	-	10.7	8.7	
1985	175	0.92	-	14.3	12.6	
1990	201	1.12	-	18.7	15.4	
2015	276	0.96	-	15.4	11.9	

The calculation values of the expected levels of short circuit currents are taking into account with presence in electroenergy power systems of points of sectionalizing of networks. Division of networks voltage 110 and 330 kV assists the decline of height of the expected levels of short circuit currents approximately on 25-40% in campaigned with a network in which a division did not come true.

From the table 2follows that levels of short circuit currents for the period of research of power electrical systems in networks with voltage 10, 35, kV accordingleg grow in 2,5; 3,1 time.

On key substations of power electrical systems the mono phase short circuit currents is 5-15% higher, than three phase short circuit currents, and on the tires of power-stations on 15-30%.

It leads to the sharp weighting of electrical equipment work (especially switches), because frequency mono phase short circuit in 20-30 times higher, than three phase.

Therefore requirements to the electrical equipment in the electroenergy systems become harder. In connection with that the rates of height of the expected levels of short circuit currents in the power electroenergy systems are high, there is a problem of concordance of parameters of electrical equipment with the existent and expected levels of short circuit currents and also problem that estimation and comparisons minimum of necessary expenses on the increase of interconnect ability of switches and other electrical equipment in case of setting of short circuit currents, with expenses necessary for realization of limitation of height of levels of short circuit currents.

There is characteristic for the investigated electroenergy system that knots with the maximal levels of short circuit currents are near-by powerful sources and with development electroenergy power systems their change is possible the network.

The results of calculations show that from the general amount of the electrical equipment set in knots investigated electroenergy systems about 15-18% is exposed to influence of maximal levels of short circuit currents, in rest of the power electroenergy systems the levels of short circuit currents considerably below.

Affecting electrical equipment and on cable networks the levels of currents of short circuit in time differentiate on amplitude, form of curve, duration and speed of their change, therefore in the real terms it is necessary to distinguish the most characteristic modes of operations of electrical equipment.

It ensues from the analysis of dynamics of change of levels of currents of short circuit, that both in distributive networks and in the networks of high tension of the electroenergy systems they have a tendency to the permanent height, although the dynamics of their height is more subzero on clear reasons.

The height of levels of currents of short circuit assists the change of terms of work of the set electrical equipment these terms become more heavy and in electroenergy systems there are a task of concordance or co-ordination of parameters of electrical equipment with the existent and expected levels of currents of short circuit in the networks of different level of tension and all these phenomena influence on functional reliability of electrical equipment of distributive networks.

For the decision of this task reliable information is needed about the parameters of the set electrical equipment and value of the expected levels of currents both three-phase and mono phase short circuit and also about basic factors influencing on their values. from the analysis of the got values and correlations presented on a fig. (1) follows. That between the levels of currents of mono phase and three-phase short circuit there is linear dependence that can be presented by dependence (5) concordantly [2] .

$$I_{s.c.}^{(1)} = \frac{3}{2+m} I_{s.c.}^{(3)} \tag{5}$$

The presented dependence (5) is just on condition that resistances direct and reverse sequences in the point of short circuit equal inter se. The maximal value of currents of mono phase short circuit can attain in ideal case in normal terms they change in limits according to equalization (6).

$$0,5I_{s.c.}^{(3)} \leq I_{s.c.}^{(1)} \leq 1,2I_{s.c.}^{(3)} \tag{6}$$

The equalization (5) shows that between the currents of three-phase and mono phase short circuit linear dependence can be set, and minimum and maximal values are described by expression (6).

3. CONCLUZION

It ensues from the conducted analysis that the dynamics of change of levels of currents of short circuit in electric networks depends on the value of transferrable power on the networks of this class of tensions, and the expected value of levels of currents $I_{S.C.}$ depend on next factors:
- are rate-of-change of the repeatedly restored tension in the point of short circuit from the side of sources of feed:
- are rate-of-change of the repeatedly restored tension in the point of short circuit from the side of loading:
- are sizes and rate-of-change of power of short circuit in the point of short circuit from the side of sources of feed:
-are sizes and rate-of-change of power of short circuit in the point of short circuit from the side of consumers:
- is a value of equivalent resistance in the point of short circuit.

BIBLIOGRAPHY

[1.] Erhan F., Neklepaev B. The currents of short circuit and reliability of grids. M., Energoatomizdat, 1988, 324p.
[2.] Neklepaev B. The coordination and optimization of levels of currents of short circuit in the electric systems ; M,. Energy, 1978,151p.
[3.] Disconnecting of currents in the networks of high tension // Edited K. Ragaller.,M., Energoizdat, 1981, 326 p.
[4.] Erhan F., Neklepaev B. Reliability of the power electroenergy systems depending on the levels of currents of short circuit, Moscow, Energoatom. 1987, 342p.
[5.] Erhan F., Melnic S. Research of influence of levels of currents of short circuit on reliability of knots of the electroenergy systems; International Symposium Poland, 1988; p. 80-87
[6.] Erhan F. Intercommunication between the levels of currents of short circuit . and reliability of electrical equipment;. News of VUZ of power engineering Minsk 1991, No 11, p. 13-17