ANALYSIS OF RELIABILITY INDICATORS OF SYSTEMS FOR THE DISTRIBUITION OF ELECTRICAL ENERGY

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Abstract:*Systems for the distribution of electricity are a component part of the electro energetic systems and the whole process of supply of electricity to consumers depends on their operation.*

At present the process of distribution of electricity is accompanied by many problems, of which the key problem is the reliability of electricity supply to all consumers, and we must pay a special attention to it.

The present work is devoted to problems of calculation and assessment of indicators of reliability of distribution systems and supply of electricity to consumers, both agricultural and industrial.

Key-words: *Electrical equipments, power energetic systems, reliability of distribution systems.*

1. Introduction

Systems for the distribution of electricity are a component part of the electric power systems and the entire process on the supply of electricity to all consumers depends on their mode of operation.

Operation of distribution systems is accompanied by many problems of which the most important is the reliability of these systems, which at present is the key issue for the development of electro-energetic.

To determine the level of reliability is an essential process, which can be both of foresight and of real calculation in the process of operation of respective systems. The process of analysis and calculation of reliability of distribution systems shall be carried out by means of reliability indicators. The determination of these indicators for the current systems, is quite a difficult matter, due to the fact that at the time these systems are very complicated [2,4,6].

To simplify the calculation mode, the indicators of reliability of these complicated systems can be determined on the basis of their decomposition into subsystems, but the determined indicators must reflect the stability of the quality of operation of the entire system. To determine the indicators of reliability it is required in relation to the studied system to designate all the requirements that these systems are to meet [1,3,5,7].

This article is devoted to the calculation of key indicators of reliability of systems for the distribution of electrical energy in the Moldova Republic resulting from the influence of random factors that have caused the occurrence of interruptions in electricity supply to all customers.

2. Material and method

Research on the evolution of indicators of reliability of distribution systems have been carried out during the last 5 years. The distribution systems have been analyzed and studied according to their geographical-territorial deviation from Central and South of our country.

Reliability indices of researched distribution systems have been determined, on the basis of variation of interruptions in different periods, and that have taken place according to the action of random factors of influence.

For the processing of statistical data computers have been used with computing programs "Microsoft Office Excel", "Matcad", "Statgrafixs". Because the process of assessing the reliability of distribution systems is quite difficult and includes a lot of operations in order to systematize the process of calculation the structural scheme and algorithm of reliability indicators were developed.

The values of the researched indicators have been determined in accordance with the following analytical expression for calculating [1,3,5]:

- average length of procedure:

$$\tau_m = \frac{\sum_{i=1}^{n}(NC_i \cdot T_i)}{NC_t} \quad (1)$$

- average chargeback rate:

$$\lambda_m = \frac{\sum_{i=1}^{n} NC_i}{NC_t} \quad (2)$$

- average chargeback restore:

$$\mu_m = \frac{\tau_m}{\lambda_m} = \frac{\frac{\sum_{i=1}^{n}(NC_i \cdot T_i)}{NC_t}}{\frac{\sum_{i=1}^{n} NC_i}{NC_t}} = \frac{\sum_{i=1}^{n}(NC_i \cdot T_i)}{\sum_{i=1}^{n} NC_i} \quad (3)$$

where:

NC, - the number of consumers that have been interrupted the supply of electricity during the *i* interruption;

T - time, the interruption *i* of the supply of electricity, *h*.;

NC - the number of served consumers during the year.

3. Results and discussion

As a result of the researches the values of flows of random interruptions that occurred in systems researched for five years have been obtained. The results are presented in table 1. Analyzing these values you can see that the number of unplanned interruptions is big enough. This is due to the action of the various factors which have a random character and have a particularly high influence over indicators of reliability in the supply of electricity to consumers. In Figure 1 is shown the example of the variation of random interruptions in the systems researched.

Table 1. The number of random interruptions that took place in the investigated systems

System	The number of random disconnections from different periods						
	2006	**2007**	**2008**	**2009**	**2010**	Mean	**%**
1	**1851**	**1260**	**1470**	**1359**	**1678**	**1524**	16,8
2	**2700**	**2540**	**2600**	**2360**	**3014**	**2643**	29,2
3	**1980**	**1570**	**2920**	**1865**	**2480**	**2163**	23,9
4	**1620**	**1490**	**1630**	**1262**	**1667**	**1534**	16,9
5	**1123**	**960**	**1140**	**1188**	**1556**	**1193**	
TOTAL SYSTEMS	**9274**	**7820**	**9760**	**8034**	**10395**	**9057**	**100**

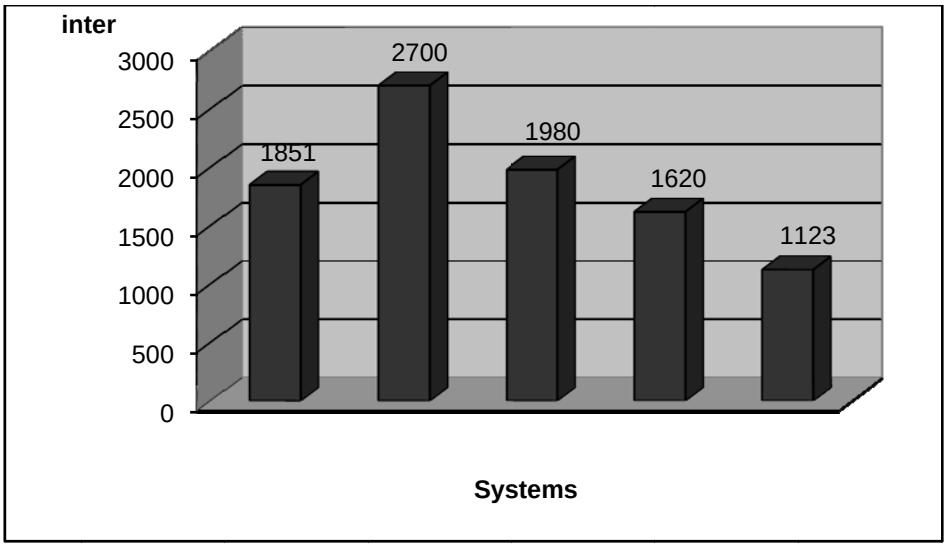

Fig. 1. The variation of random interruptions in the systems researched

As a result of analytical calculations the values of indicators of reliability were obtained for various periods (2006 - 2010): the average duration of the interruption τ_m, frequency of restoration λ, mean time of interruption T_{med} . As an example in table 3 are shown the respective indicators values determined.

Table 2.Indicators of reliability of researched systems

System	Indicator	Seasonal values				Annual
		Spring	Summer	Autumn	Winter	
1	τ	0,92	1,12	1,09	1,23	4,36
	λ	3,49	1,23	3,28	1,35	9,35
	μ	0,26	1,71	1,59	1,88	0,47
	Tmed	3,81	3,54	3,58	3,88	3,70
2	τ	5,88	6,97	5,52	7,64	26,01
	λ	5,76	4,48	5,41	4,92	20,56
	μ	1,02	4,66	2,36	5,11	1,26
	Tmed	5,95	6,29	5,59	6,89	6,18
3	τ	8,22	8,73	7,72	9,57	34,23
	λ	5,36	7,01	5,04	7,69	25,10
	μ	1,53	5,60	1,53	6,15	1,36
	Tmed	7,28	8,04	6,84	8,82	7,75
4	τ	4,40	4,64	4,13	5,09	18,26
	λ	4,48	3,47	4,20	3,81	15,96
	μ	0,98	2,92	0,98	3,21	1,14
	Tmed	4,01	6,95	3,77	7,62	5,58
5	τ	2,46	5,78	2,31	6,34	16,89
	λ	2,39	4,37	2,24	4,80	13,80
	μ	1,03	2,90	1,03	3,18	1,22
	Tmed	4,87	4,29	4,57	4,70	4,61
Total	τ	3,99	7,03	3,74	7,71	22,47
	λ	3,64	3,67	3,42	4,02	14,75
	μ	1,09	4,22	1,09	4,63	1,52
	Tmed	5,19	3,63	4,87	3,98	4,42

Based on the analysis of the results obtained it can be stated that the assessment of the reliability of the systems of power distribution can be achieved by means of indicators calculated, taking into consideration their variation over time, based on the influence of random factors. The obtained values of the indicators analyzed, fully corresponds to the actual level of reliability of distribution systems and allow you to define ways of increasing the safety of operation of these systems.

4. Conclusions

1. The level of reliability of energy distribution systems is characterized by means of reliability indicators. To assess the reliability of these systems it is sufficient to determine the four indicators: average duration of the interruption of the frequency of interruption τ_m, frequency of restoration λ, the average time of interruption T_{med}.

2. The determined indicators characterize fully the level of reliability of the researched distribution systems and the values obtained in this paper confirm that their variation in different periods is uneven for the Republic of Moldova, which is due to the action of the various factors which have a randomize influence.

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