RELIABILITY ANALYSIS OF POWER DISTRIBUTION SYSTEMS

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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

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 [1, 5].

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.

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 [2].

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. RESOLVING OF THE PROBLEM

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. Characteristics of electric energy distribution systems studied in this paper are presented in table 1.

Table 1 - Main characteristics of the studied distribution systems

System	Subsystem	The number of supplied consumers	The summary length of the distribution networks 6-10 kV, km
1	1.1	287114	2829,288
	1.2	30576	
2	2.1	28862	3857,236
	2.2	31490	
	2.3	41068	
	2.4	33938	
	2.5	27217	
3	3.1	25065	3196,428
	3.2	22765	
	3.3	45441	
	3.4	32802	
	3.5	25860	
4	4.1	29046	2159,293
	4.2	19485	
	4.3	33472	
	4.4	18423	
5	5.1	22889	2013,195
	5.2	25428	
	5.3	13114	
	5.4	19954	
Total	**20**	**814009**	**14055,440**

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To assess the development of the reliability indicators of electric energy distribution systems, during the investigated period, the outages that occurred in those schemes were analyzed and studied: random (R), scheduled (S) and exercises (E). These interruptions were recorded daily during the years 2006-2010.

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.

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 2. 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.

Table2 - The number of random interruptions that took place in the investigated systems

System	Subsystem	The number of random disconnections from different periods				
		2006	**2007**	**2008**	**2009**	**2010**
1	**1.1**	1102	907	1093	858	1112
	1.2	749	353	377	501	566
	TOTAL	**1851**	**1260**	**1470**	**1359**	**1678**
2	2.1	270	186	403	425	573
	2.2	651	614	567	524	644
	2.3	1040	1160	840	622	845
	2.4	529	458	530	403	567
	2.5	210	122	260	386	385
	TOTAL	**2700**	**2540**	**2600**	**2360**	**3014**
3	3.1	260	250	460	277	379
	3.2	412	235	309	237	320
	3.3	680	415	1011	596	650
	3.4	498	472	875	383	636
	3.5	130	198	265	372	495
	TOTAL	**1980**	**1570**	**2920**	**1865**	**2480**
4	4.1	330	580	340	286	481
	4.2	411	240	320	283	407
	4.3	520	468	650	485	546
	4.4	359	202	320	208	233
	TOTAL	**1620**	**1490**	**1630**	**1262**	**1667**
5	5.1	243	250	220	231	313
	5.2	259	165	270	245	360
	5.3	297	195	349	316	391
	5.4	324	350	301	396	492
	TOTAL	**1123**	**960**	**1140**	**1188**	**1556**
TOTAL SYSTEMS		**9274**	**7820**	**9760**	**8034**	**10395**

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.

The values of the researched indicators have been determined in accordance with the following analytical expression for calculating [3, 4].

As a result of analytical calculations the values of indicators of reliability were obtained for various periods (2006, 2007, 2008, 2009, 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 for the period of 2010.

Table 3 - Indicators of reliability of researched systems calculated for the period of 2010

System	Indicator	Seasonal values			
		Spring	**Summer**	**Autumn**	**Winter**
1	**τ, h**	1,01	1,99	1,46	1,69
	λ	0,53	1,76	1,73	1,52
	μ, h	1,91	1,13	0,84	1,11
	T_{med}, h	5,16	6,13	4,76	5,67
2	**τ, h**	4,17	8,32	7,73	9,26
	λ	3,21	6,12	3,95	5,12
	μ, h	1,30	1,36	1,96	1,81
	T_{med}, h	2,89	2,76	3,56	3,23
3	**τ, h**	8,31	10,67	6,33	5,96
	λ	4,53	3,45	4,68	5,11
	μ, h	1,83	3,09	1,35	1,17
	T_{med}, h	6,84	5,98	7,26	2,49
4	**τ, h**	2,81	4,52	2,23	3,95
	λ	1,64	3,86	2,86	3,72
	μ, h	1,71	1,17	0,78	1,06
	T_{med}, h	3,24	2,93	2,65	2,22
5	**τ, h**	4,01	2,96	3,33	4,12
	λ	2,42	3,45	2,65	4,36
	μ, h	1,66	0,86	1,26	0,94
	T_{med}, h	5,40	3,68	3,84	4,86
Total	**τ, h**	3,25	6,24	4,03	4,21
	λ	2,71	4,11	3,28	2,61
	μ, h	1,20	1,52	1,23	1,61
	T_{med}, h	3,66	4,33	5,93	2,94

The mode of variation in time of the calculated indicators of reliability is presented in Figure 1.

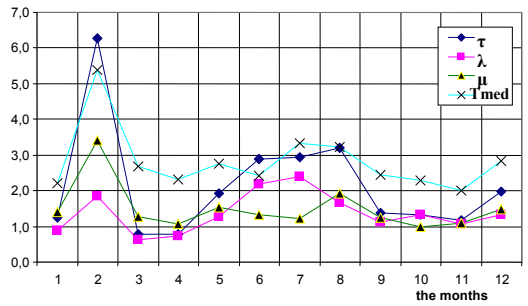

Fig.1 - Variation in time of calculated indicators of reliability

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.

3. CONCLUSION

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}.

Calculation of reliability indicators can be performed using an algorithm of simplified operations, which allows to determine the variation of these indicators, given the influence of random factors that have caused the occurrence of interruptions on various periods.

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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