

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 6, June 2015

Reliability Index Evaluation of Electrical Distribution Systems

Victor Popescu¹, Anatol Racul², Bodarev Ghenadie³

Doctor, Associate Professor, Department of Rural Electrification and Automation, Moldova State Agrarian University,
Moldova¹

Doctor, Associate Professor, Department of Mathematics and Informatics, Moldova State Agrarian University,
Moldova²

Lecturer, Department of Engineering, Moldova State Agrarian University, Moldova²

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

KEYWORDS:Electrical distribution systems, Reliability indicators, Reliability of distribution systems.

I. 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 [2,4,9].

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 [2,5,6].

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.

II. MATERIALS AND METHODS

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, scheduled and exercises. Characteristics of electric energy distribution systems studied in this paper are presented in table 1.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 6, June 2015

TABLE 1
MAIN CHARACTERISTICS OF THE STUDIED DISTRIBUTION SYSTEMS

No. system	The number of supplied consumers, cons.	The summary length of the distribution networks 6-10 kV, km
System1	317690	2829,288
System2	162575	3857,236
System3	151933	3196,428
System4	100426	2159,293
System5	81385	2013,195
Total	814009	14055,440

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", "Statgrafix". 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[2,5].

III. RESULTS AND DISCUSSION

As a result of the researches the values of flows of random interruptions that occurred in systems researched for five periods(years) have been obtained. The results are presented in table 2.

TABLE 2
THE NUMBER OF RANDOM INTERRUPTIONS THAT TOOK PLACE IN THE INVESTIGATED SYSTEMS

No. system	The number of random disconnections from different periods				
	Period I, disconnections	Period II, disconnections	Period III, disconnections	Period IV, disconnections	Period VI, disconnections
System1	1851	1260	1470	1359	1678
System2	2700	2540	2600	2360	3014
System3	1980	1570	2920	1865	2480
System4	1620	1490	1630	1262	1667
System5	1123	960	1140	1188	1556
TOTAL	9274	7820	9760	8034	10395

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.

As a result of analytical calculations the values of indicators of reliability were obtained for various periods: 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.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 6, June 2015

TABLE 3
INDICATORS OF RELIABILITY OF RESEARCHED SYSTEMS

No. system	Indicator	Seasonal values				Annual
		Spring	Summer	Autumn	Winter	
1	τ , h	1,01	1,99	1,46	1,69	6,15
	λ , 1/h	0,53	1,76	1,73	1,52	5,54
	μ , h	1,91	1,13	0,84	1,11	1,11
	Tmed, h	5,16	6,13	4,76	5,67	5,43
2	τ , h	4,17	8,32	7,73	9,26	29,48
	λ , 1/h	3,21	6,12	3,95	5,12	18,40
	μ , h	1,30	1,36	1,96	1,81	1,60
	Tmed, h	2,89	2,76	3,56	3,23	3,11
3	τ , h	8,31	10,67	6,33	5,96	31,27
	λ , 1/h	4,53	3,45	4,68	5,11	17,77
	μ , h	1,83	3,09	1,35	1,17	1,76
	Tmed, h	6,84	5,98	7,26	2,49	5,64
4	τ , h	2,81	4,52	2,23	3,95	13,51
	λ , 1/h	1,64	3,86	2,86	3,72	12,08
	μ , h	1,71	1,17	0,78	1,06	1,12
	Tmed, h	3,24	2,93	2,65	2,22	2,76
5	τ , h	4,01	2,96	3,33	4,12	14,42
	λ , 1/h	2,42	3,45	2,65	4,36	12,88
	μ , h	1,66	0,86	1,26	0,94	1,12
	Tmed, h	5,40	3,68	3,84	4,86	4,45
Total	τ , h	3,25	6,24	4,03	4,21	17,73
	λ , 1/h	2,71	4,11	3,28	2,61	12,71
	μ , h	1,20	1,52	1,23	1,61	1,39
	Tmed, h	3,66	4,33	5,93	2,94	4,22

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

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 6, June 2015

actual level of reliability of distribution systems and allow you to define ways of increasing the safety of operation of these systems.

IV. CONCLUSIONS

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 these systems, which is due to the action of the various factors which have a randomize influence.

REFERENCES

- [1] Erhan, F, Popescu, V. "Characteristics of faults in systems for distribution of electricity", Bulletin AGIR, ISSN 1224-7928, No. 4, pp. 237-241, 2013.
- [2] Popescu, V, Popa, A, Bantaş, R. "Reliability analysis of systems for distribution of electricity", Acta Electrotehnica, ISSN 1841-3323, Vol. 54, No. 5, pp. 387-389, 2013.
- [3] Popescu, V. "The influence of asymmetrical regimes on functioning reability of electro - energetic systems", Journal of sustainable energy, ISSN 2067-5534, Vol. 2. No. 4, pp. 28-30, 2011.
- [4] Erhan, T. "Major factors, which influence on levels value of short circuit currents in electrical powersystems", Bulletin of the Politechnical Institute of Iassy, Romania, Tom XLVIII (LII) Fasc.5. pp.303-311, 2002.
- [5] Popescu, V, Burbulea, I, Racul, A. "Reliability analysis of power distribution systems", Jurnal of sustainable Energy, ISSN 2067-5534, Vol. 13, No.3, 2012.
- [6] Frind, G., Rich, J. IEEE, Trans, PAS, pp. 1675, 1974.
- [7] Erhan, T. "Analysis of single-ended mode and phenomenon that can occur in electrical circuits", Acta Electrotehnica, Vol. 54, No. 5, ISSN 1841-3323, pp. 190-193, 2013.
- [8] Ardeleanu, M. "Fault Localization in Cables and Accessories by Off-Line Methods" Annales of the University of Craiova, No. 13, 2007.
- [9] Secui D. "The Sensitivity of the Electrical Substationns Reliability Indices at the Variation of the Circuit - Breakers Sticking Probability" Annals of the Oradea University, Fascicle of Energy Enginiring, Vol.14, 2008.