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STATISTICAL ANALYSIS OF ACCIDENT-RELATED POWER FAILURES, CAUSED BY ICE, SNOW AND FROST

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ABSTRACT
In the report is presented the statistical analysis of the power failures related to accidents, cause by ice, snow and frost when comparing the data from two settlements.

Key words: statistics, analysis, accident, parameters, reliability

INTRODUCTION

The subject of this report is based on the collected information regarding power failures related to accidents for settlements, which is collected and processed within the framework of scientific project on the topic of: "Analysis of the power failure occurrence in the power distributing networks" [1].

The classification of the power failures related to accidents in the current report is done according to the type of reason follows the identification of reasons, stated in the dispatcher bulletins. The stated reasons for an AERIAL CONDUCTOR 20 KV are: Lightning; Ice, snow and frost; Humidity and Contamination of the equipment; Wind and rain; Birds and animals' Third persons; Indeterminate reasons; Violations of objective nature. In this report will be examined only the power failures related to accidents, caused by ice, snow and frost.

INFORMATIVE PART

The given information presents the absolute number of accident-related power failures caused by ice, snow and frost for a given period of time and the failures' total duration for two settlements:

a/ Settlement A:

In **table 1** is shown the absolute number of accident-related power failures, caused by ice, snow and frost, for the period, which number is 3, and in **table 2** – their total duration, which is 4.45 hours. These failures constitute 1.7% from the total number of failures, caused by reasons which could be established, for the examined period of time and region.

Table 1. *Absolute number of accident-related power failures "N_{abc}", number*

PC	2001	2002	Total:
1	0	0	0
2	0	0	0
3	0	0	0
4	0	0	0
5	1	0	1
6	0	0	0
7	1	1	2
8	0	0	0
9	0	0	0
10	0	0	0
11	0	0	0
Total:	2	1	3

Table 2. *Total duration of the accident-related power failures "T", hours*

PC	2001	2002	Total:
1	0	0	0
2	0	0	0
3	0	0	0
4	0	0	0
5	3.25	0	3.25
6	0	0	0
7	0.10	1.10	1.20
8	0	0	0
9	0	0	0
10	0	0	0
11	0	0	0
Total:	3.35	1.10	4.45

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The given monthly distribution of the relative number of accidents caused by ice, snow and frost is expressed in %. The accident-related power failures from ice are during the winter months – January and December, as their number during January is the greatest – 66.7%

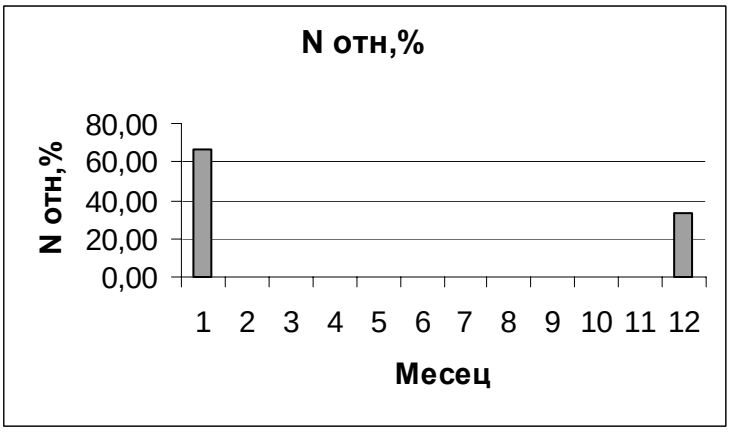

Figure 1. Distribution of the relative number of accident-related power failures caused by ice, frost and snow according to months, in %

The parameters for evaluation of the reliability of the examined power conductors are indicated for the defined period.

The parameter for the flow of refusals "w" is the highest for Power Conductor 7 -2.30/100km and the lowest for PC 5 – 0.88/100km. It is important to note, that only these two power conductors have received power failures, and the rest are zero.

The average time for repair of the power failures "t_{av}" is the highest for Power Conductor 5 – 3.25 hours/ number and the lowest for Power Conductor 7 – 0.60 hours/number. The remaining values are zero.
The examined two parameters "w" and "t_{av}" are united in the coefficient for damage occurrence or probability for accidental outage "q". The highest coefficient has PC (Power Conductor) 5 $0.33.1.10^{-3}$, and the lowest has PC 7 – $0.16.1.10^{-3}$ and the rest are zero.

Table 3. *Parameters for evaluation of the reliability of Aerial Power Conductors*

PC	ω, бр./100km	$\tau_{ср}$, час/бр.	q, 1.10^{-3}
1	0	0	0
2	0	0	0
3	0	0	0
4	0	0	0
5	0.88	3.25	0.33
6	0	0	0
7	2.30	0.60	0.16
8	0	0	0
9	0	0	0
10	0	0	0
11	0	0	0

b/ Settlement B
In **table 4** is shown the absolute number of accident-related power failures, caused by ice, snow and frost, for the period, which number is 4, and in **table 5** – their total duration, which is 5.31 hours. These failures constitute 3.57% from the total number of failures, caused by reasons which could be established, for the examined period of time and region.

Table 4. *Absolute number of accident-related power failures "N_{abc}", number*

PC	2001	2002	Total:
1	1	0	1
2	0	0	0
3	1	0	1
4	0	1	1
5	0	0	0
6	0	0	0
7	1	0	1
8	0	0	0
9	0	0	0
10	0	0	0
11	0	0	0
Total:	**3**	**1**	**4**

The given monthly distribution of the relative number of accidents caused by ice, snow and frost is expressed in %. The accident-related power failures from ice occur during the winter months – January, February and December, as their number during January is the greatest – 50%

Table 5. *Total duration of the accident-related power failures "T", hours*

PC	2001	2002	Total:
1	0.65	0	0.65
2	0	0	0
3	1.35	0	1.35
4	0	2.46	2.46
5	0	0	0
6	0	0	0
7	0.85	0	0.85
8	0	0	0
9	0	0	0
10	0	0	0
11	0	0	0
Total:	**2.85**	**2.46**	**5.31**

The parameters for evaluation of the reliability of the examined power conductors are indicated for the defined period.

The parameter for the flow of refusals "w" is the highest for Power Conductor 7 - 3.40/100km and the lowest for PC 1 – 1.20/100km. It is important to note, that power conductors 1, 3, 4 and 7 have received power failures, and the rest are zero.

The average time for repair of the power failures "t_{av}" is the highest for Power Conductor 4 – 2.46 hours/ number and the lowest for Power Conductor 1 – 0.65 hours/number.

The examined two parameters "w" and "t_{av}" are united in the coefficient for damage occurrence or probability for accidental outage "q". The highest coefficient has PC (Power Conductor) 4 - $0.43.1.10^{-3}$, and the lowest has PC 1 – $0.09.1.10^{-3}$.

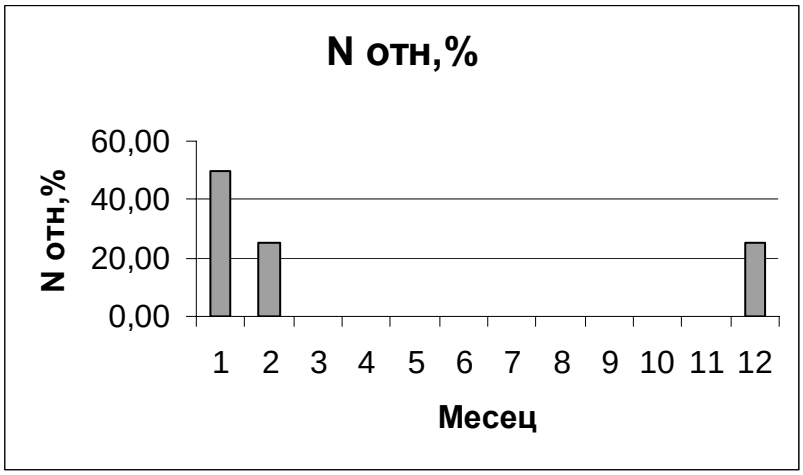

Figure 2. Distribution of the relative number of accident-related power failures caused by ice, frost and snow according to months, in %

Table 6. *Parameters for evaluation the reliability of Aerial Power Conductors*

PC	ω, бр./100km	$\tau_{ср}$, час/бр.	q, 1.10^{-3}
1	1.20	0.65	0.09
2	0	0	0
3	1.81	1.35	0.28
4	1.53	2.46	0.43
5	0	0	0
6	0	0	0
7	3.40	0.85	0.33
8	0	0	0
9	0	0	0
10	0	0	0
11	0	0	0

Comparing the results from the two settlement, we can report that ice, frost and snow cause in both of the settlement /settlement A – 3, settlement B -4/ an almost equal number of accident-related power failures /difference – 1/ with an almost equal duration. A great number of power failures are observed in Settlement B. Increased ice deposition is observed in both settlements during the winter – January and December /highest activity in the month of January/, as in settlement B such is observed as well during the month of February.

CONCLUSIONS

1. During the time of design of new power conductions, measures should be taken which take into consideration the climate region and the characteristics of the ice deposition.

2. It is necessary to observe strictly the requirements for installation during the pull up of the conductors and the construction of the poles' foundations.
3. At temperatures around – 5 Degrees Celsius and lower after snowing, inspections should be made and in case of ice deposition, immediate measures should be undertaken.
4. No lines with vertical distribution of the power conductors should be built. It should be known as well, that the thickness of the ice deposition depends on the diameter of the power conductor and the height of placement. It decreases with the increase in diameter and increases together with the conductor's height above the ground.
5. In cases where ice has been already deposited, it should be addressed by letting the ice melt on its own or using an isolation rod to break the ice.

REFERENCES

1. Analysis of the power failure occurrence in the power distribution networks, Report from a scientific project according to contract №08-1006/20.05.2008 of the Thracian University – Stara Zagora