

CURRENT RESEARCH INTO THE REDUCTION OF THE NUMBER OF TRANSMISSION LINE FAULTS ON THE ESKOM MTS

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ABSTRACT

Line faults are a major cause of concern particularly to those electricity customers that have continuous process plants. Whilst Eskom is striving to be the world's cheapest supplier of electricity, quality of supply is an important consideration for an investor that proposes to invest in industries that rely on good quality electricity. Line faults are caused by a number of mechanisms such as fires, pollution etc. To this end, a research programme entitled "Transmission line performance enhancement research" was initiated to find practical ways to reduce line faults, particularly in the unknown and lightning categories (largest percentage faults). This paper gives an overview of the methodologies followed to achieve this.

1. INTRODUCTION

Transmission line faults (both transient and permanent) are a major cause of concern, particularly to those electricity customers who make use of continuous process plants. Whilst Eskom is striving to be one of the world's cheapest suppliers of electricity, quality of supply is also a complementary and important consideration; this is especially true for an investor who proposes to invest in industries that rely on good quality electricity, notably the minimisation or elimination of severe voltage dip events.

An analysis of the Eskom Main Transmission System (MTS) line faults by Britten [1] (Figure 1) for the period 1993-1999 concluded that about 35-38% of line faults could be attributed to "unknown" causes and about 30% to lightning. (The two largest segments with the highest percentage faults are the "unknown" and lightning categories.) To this end, a research programme entitled "Transmission line performance enhancement research" was initiated to find practical ways to reduce line faults in the "unknown" and lightning categories.

This paper gives an overview of the methodology followed to achieve this.

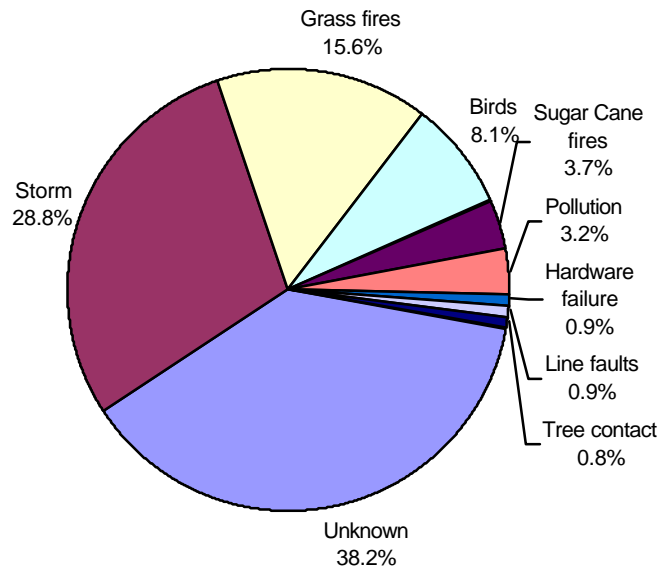


Figure 1
Summary of Transmission Line faults for the period 1993-1999

2. APPROACH

In the case of known faults such as lightning, the aim of the research work is to understand causes so that the correct mitigation can be applied. In cases where the cause is unknown (some 35% of line faults) mitigation cannot be easily applied. The main objective in this case is to determine the causes of the unknown faults and apply the most appropriate and cost effective mitigation. In terms of the unknown category there are two areas of interest, namely, flashovers caused by the postulated light pollution and light wetting mechanism, and flashovers caused by bird streamers. Another major area soon to be included in this research is lightning, and will focus on reducing the high number of lightning flashovers currently experienced on the MTS.

3. "UNKNOWN" CATEGORY

Since 1995 various initiatives have been undertaken by Transmission to reduce the high incidents of "unknown" faults on individual lines. However, the continuing widespread occurrence of such faults led to speculation that several underlying causes may be present. Studies summarised by Britten [1] showed that virtually all "unknown" line faults occur on glass cap and pin insulators between the hours of 20H00 to 06H00. Based on this, two separate research initiatives were undertaken, both focusing on reducing the number of faults in the "unknown" category. After some initial research it was speculated that there were two contributing mechanisms; one of these is the bird streamer mechanism, the other being flashovers across lightly polluted and lightly wetted glass cap and pin insulators.

Following some initial research by Taylor [2] on the mechanism of bird streamers, a national bird guard project was initiated by Vosloo [3] to provide a solution to bird related line faults. An amount of R37 million has been made available by Transmission over a two-year period (2000-2001) to address this problem. (This problem has been estimated to cost the South African economy in the region of R25 million annually.)

Although a number of solutions are available to address the bird streamer problem, the best option still needs to be established. Further knowledge also needs to be gained on the dynamics of streamers to enable more confident discrimination between bird induced and other line faults to be made. An example of a bird guarded 400kV line is shown in Figure 2.

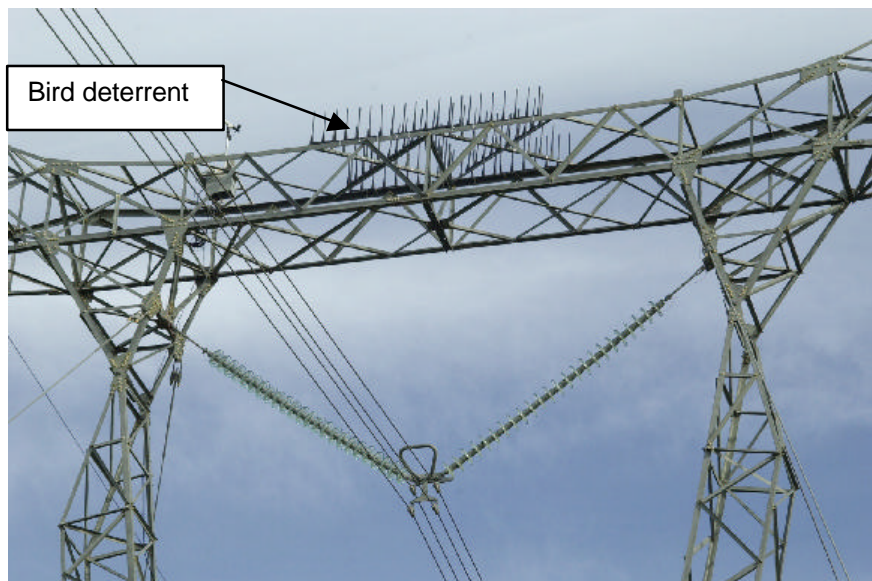


Figure 2
A Bird Guarded 400kV Tower

The aims of this project are therefore:

- Define the evaluation criteria for bird deterrent devices.
- Evaluate bird deterrent devices according to above criteria. This includes field-testing.
- Investigate and document the physical mechanism of bird streamer flashovers under controlled natural conditions. Identifying line faults caused by bird streamers still relies on initial research conducted in the United States on bird species different from those found in South Africa.
- Monitoring the interaction between birds and bird deterrent devices.

The other area of research in the unknown category is the light wetting, light pollution flashover mechanism. The hypothesis here is that critical light wetting of light to medium severity pollution on glass insulators in high humidity conditions can cause high transient currents, which in turn could lead to flashovers [1,2]. As a means of investigating this, a dual approach has been followed: the first was to study the leakage currents and environmental conditions of in-service glass insulators on the

Grassridge-Poseidon 400 kV line, a line that is prone to such faults. The second was to use this data as the basis in setting up laboratory tests to try to simulate the mechanism.

Field results have indicated the following:

- The overall pollution level of the line can be classified as light in terms of IEC 815.
- There are frequent periods of high humidity.
- The pollution distribution on the insulator discs is non-uniform.

During periods of high humidity unusual corona glow is observed on the top surface of many of the insulator discs. This has been observed to occur from the live end to the earth of a string (Figure3).

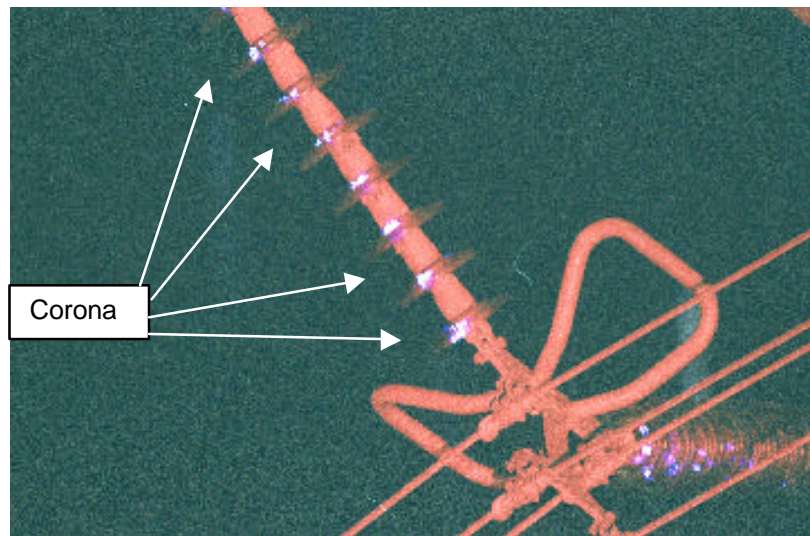


Figure 3

Unusual Corona Activity photographed on the Grassridge-Poseidon 400kV Line

On the other hand, laboratory component of this work has shown that a wetted, light pollution layer can create sparking on an insulator surface, and in cases where the disc is dry, a flashover across that disc. Figure 4 shows a single disc flashover under laboratory conditions.

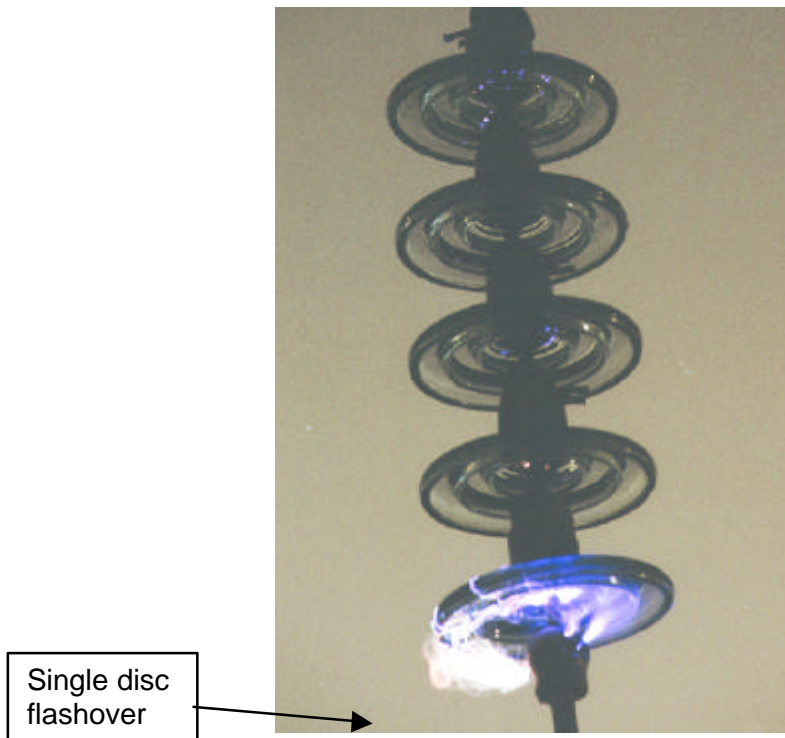


Figure 4

An example of single disc flashover.

Although this work has given encouraging results, a flashover across an entire string has not yet been demonstrated. In order to reduce the effect of sparking, recommendations have been made that larger insulator discs (disc having a higher flashover voltage) be added to existing strings. This has been proposed and implemented on parts of the Grassridge-Poseidon 400 kV line. Future research in this area will focus on single disc flashover as the initiating mechanism.

4. LIGHTNING RESEARCH

This work is the latest addition to the research programme. The aim will be to provide an accurate assessment of transmission line performance regarding lightning, as well as some practical steps to improve its immunity against lightning outages; this will include the feasibility and findings of "Operation Lightning" being led by Transmission.

To achieve these objectives, the transmission line performance will be correlated with the following: geographic region, average predicted ground flash density, LPATS records, tower types, tower footing resistance measurements, the use of line surge arrestors and the performance of station surge arrestors. The above research will also evaluate the costs of the various mitigation options.

5. CONCLUSIONS

The main achievements to date are

- A strong, well-directed research programme – aimed at reducing light pollution, bird and lightning initiated transmission line faults - has been described and explained.
- Promising progress has been made with the simulation and demonstration of the light pollution mechanism; practical mitigation also appears possible.
- The phased installation of mechanical bird guards on several lines has already helped to reduce the number of unexplained line faults, especially at night.
- The lightning research work has only started, but it is anticipated that this will add to the overall reduction of line faults.

6. ACKNOWLEDGEMENTS

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7. REFERENCES

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