

Evaluating the Risk existing Powerlines pose to large Raptors by utilising Risk Assessment Methodology: the Molopo Case Study

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ABSTRACT

Eskom is the largest electrical utility in the Republic of South Africa. Prior to 1991, Eskom powerlines were designed and built without awareness of electrocution risk to birds, especially large raptors. In the late 1980's, Eskom launched an electrification project (the Molopo Project) along the border between South Africa and Botswana. Because of the absence of a policy dictating the use of a bird friendly design, a bird unfriendly line was constructed. This prompted various conservationists and non-Governmental organisations to approach Eskom with a request that the line be modified to make it bird friendly. In response to these requests a risk assessment was undertaken and recommendations made to Eskom's management on how to deal with the issue. The following factors were taken into account as part of a comprehensive risk assessment:

- topography and vegetation;
- land use;
- raptor populations;
- powerline design;
- environmental performance of the powerline;
- interested and affected parties; and
- cost of mitigating measures.

Management accepted the recommendations and 6830 structures will be pro-actively fitted with raptor protectors, an insulating device used to prevent birds from being electrocuted. This paper provides an overview of the risk assessment methodology, results and recommendations.

INTRODUCTION

During the late 1980's the previous South African Government launched various programmes to encourage farmers along the border between South Africa and Botswana to inhabit their farms on a permanent basis. Part of this programme was the supply of electricity to farms along the corridor to

the border. Eskom launched an electrification project referred to as the Molopo Project which was subsidised by the Government and completed during 1990.

At the time of the design of the powerline, Eskom had a policy of constructing powerlines in the most cost effective method within electrical parameters. Some of these designs were not always compatible with wildlife, and large raptors were particularly at risk of being electrocuted (Hobbs & Ledger 1986a; Hobbs & Ledger 1986b; Hobbs *et al.* 1990; Ledger & Annegarn 1981; Ledger 1984; Ledger 1992; Ledger *et al.*, 1992; Van Rooyen *et al.*, 1998). Subsequent to the completion of the project, Eskom adopted a policy during 1991 that all future powerline designs would be compatible with birds - or so-called "bird friendly designs".

Concern was expressed at various forums by conservationists and non-Governmental organisations, regarding the potential hazard the powerlines (approximately 680 km of the Molopo Project¹) pose to large raptors. To address the various concerns, as well as some allegations, it was proposed to Eskom management that as part of the Eskom/EWT² partnership, a risk assessment be undertaken to provide them with information enabling them to make informed decisions on how to deal with the issue. The risk assessment was based on risk management³ methodology, focusing on identifying the biological risk of electrocutions, negative perception of interested and affected parties, cost implications to Eskom's business, and pro-active actions to either terminate, treat, tolerate or transfer these risks. Eskom management accepted the recommendations of the risk assessment and a programme has commenced by fitting raptor protectors⁴ to an estimated 6830 structures, over the next five years.

METHODS

An investigation team consisting of the authors conducted the risk assessment. The fundamental principles of risk management were used to assess the risk the powerlines pose to large raptors, and the risk of raptor electrocutions to Eskom's business. According to Valsamakis *et al.*, (1992) risk management can be defined as "*a managerial function aimed at protecting the organisation, its people, assets, and profits, against the consequences (adverse) of pure risk, more particularly aimed at reducing the severity and variability of losses*".

Risk implies the presence of uncertainty (uncertainty prevails because outcomes of situations are not known in advance) which is the foundation of any discussion of risk in a risk management context. The degree of uncertainty surrounding an event determines the extent of risk⁵. Risk can be defined as "*the presence of uncertainty, where there may be uncertainty as to the occurrence of the event producing a loss⁶, and uncertainty as regards the outcome of the event*" (Valsamakis *et al.*, 1992). Outcome in itself can assume various forms, however, for this study the concern was primarily about the environmental outcomes of risk, as well as the risk to Eskom's business.

¹ The powerlines assessed during the study were erected in the North West Province's districts of Tosca, Bray, Terra Firma, Pomfret and Vorstershoop as part of the Molopo Project.

² Eskom and the Endangered Wildlife Trust (EWT), an environmental non-government organisation focusing on promoting the region's biodiversity, entered into a partnership at the end of 1995 to address the problem of wildlife interactions and electricity structures, in a systematic manner on a national basis.

³ The concept of risk management is extensively marketed by insurance brokers, who, by nature of their business, have a strong leaning towards insurance. However, risk management is becoming more pro-active, holistic and systematic. In this way, risk management becomes an integral part of general management (Valsamakis *et al.*, 1992).

⁴ The RP3 Raptor Protector is an insulating device intended to permanently cover up energised conductors at support structures for the purpose of preventing accidental contact with the conductor by birds, as they perch in close proximity to the conductors. The device consists of one moulded alkaline product approximately 2 metres in length, and is fitted over the insulator.

⁵ In the context of the risk assessment the term "event" is considered to be the electrocution of a raptor. The extent of risk (biological) is determined by the conservation status of the species.

⁶ Loss is considered to be financial loss due to supply interruptions (loss of income), damage to equipment as a result of an electrocution, third party claims due to veld fires as a result of a flashover during electrocution, and loss of biodiversity due to raptor mortalities.

The present understanding of risk management as a process (Valsamakis *et al.*, 1992), adopted for the study, comprised four distinct stages:

- risk identification,
- risk evaluation,
- risk control directed at loss elimination, or more usually loss (or risk) reduction,
- risk financing *via* transfer.

Any risk management programme must be put in motion by the process of risk identification, for obviously a risk cannot be managed if it is not identified. Risk identification is considered to be the single most important step in the risk management programme, and should not be entertained in a spurious fashion, but in as systematic a manner as possible (Valsamakis *et al.*, 1992). The obvious and most commonly used method to identify the risks is to conduct a physical inspection. The main advantage of this method is that the terrain and network are seen firsthand and, importantly, such a visit brings one into contact with those people on whom reliance is placed for much of the information concerning risks and hazards⁷. Some of the drawbacks, however, are that it is time consuming, and the effectiveness of any inspection is directly related to the competence and expertise of the individual(s) carrying out the survey (Valsamakis *et al.*, 1992).

In the current case study, the following factors were considered and evaluated to determine the risks:

- Topography and vegetation: riverbed or otherwise; trees, shrubs or grassland; nesting substrates.
- Land-use: type of farming and intensity; human population density.
- Raptor populations: species diversity; active breeding in the area; and conservation status of species.
- Powerline design: distance between conductors; distance between grounded hardware (i.e. earthwires) and energised conductors.
- Environmental performance of the powerlines: perusing line performance reports determining whether reason for outage was birds.
- Interested and affected parties: meetings with local Eskom staff, landowners, and a local conservationist to obtain their perspectives on the perceived problem.
- Cost of mitigation measures: financial and resource implications in connection with the implementation of mitigation measures.

It should be noted that it is unlikely that any particular method or technique of identification will be sufficient to identify all the risk exposures, and address all the problems associated with such risks. It is more appropriate to consider a combination of methods (*viz.* fault-tree analysis, hazard indices, audits, research etc.) in order to ensure risk identification is as complete and encompassing as possible. The process of identification is greatly assisted and enhanced by consultation with as many interested and affected parties as possible. Finally, risk identification entails a certain degree of imagination. Whilst past routines used in risk identification do provide some system and rigour to the activity, there should be no limit imposed on any lateral approach to identification (Valsamakis *et al.*, 1992).

RESULTS AND DISCUSSION

Topography and Vegetation

The route of the powerline along the Molopo Riverbed is characterised by large camelthorn trees *Acacia erioloba* which are used by raptors for nesting substrates (Steven Dell, Conservation Officer - Molopo Nature Reserve, pers. comm.). The presence of the exposed powerline within this breeding territory, especially to juvenile raptors, was considered to be a real and potential risk and threat to raptor populations.

⁷ Hazard relates to the environment surrounding the cause of loss (Valsamakis *et al.*, 1992).

The sections of the route away from the riverbed are characterised by grassland, scattered trees, shrubs and fallow agricultural lands. Raptors use power poles as perches from which to establish territorial boundaries, hunt, rest, feed and sun themselves (APLIC, 1996). The presence of fallow lands attracts large numbers of foraging Helmeted Guineafowl *Numida meleagris*. Electricity poles are often used as hunting perches which attract raptors. Despite the presence of trees, electricity poles are evidently used a lot by the raptors⁸, probably because the pylons offer an unrestricted view and are often on average significantly higher than the surrounding trees. In view of this, the electricity poles were regarded as both a real and potential risk to raptors.

Land Use

Land use consists mostly of extensive cattle and game farming, with very large farms, or even blocks of farms managed as a single unit. Such units are anything from 5,000 to as big as 50,000 hectares. Given the low intensity of the farming operations, the impact on the vegetation is minimal. This area is one of the very few places in South Africa where a large predator like the cheetah is still regularly encountered on commercial farmland (Steven Dell, Conservation Officer - Molopo Nature Reserve, pers. comm.). A local landowner in the area consulted during the investigation was very aware and positive about the large raptors in the area.

The good rains that the region experienced prior to the inspection resulted in dense ground cover which makes it very difficult to locate carcasses of electrocuted raptors below structures. The vastness of the area as well as the limited human activities make it unlikely that carcasses will be found in the event of an incident. Furthermore, the possibility that scavengers such as jackal will scavenge and remove carcasses in the event of an incident may be one of the reasons why no incidents have been reported to date. These factors contributed to one of the conclusions of the assessment, namely that the lack of past reports of raptor electrocutions may not be a true reflection of actual raptor mortality rates.

Raptor Populations

The Molopo area was found to be rich in raptor populations, both in species numbers and species diversity. It is one of the few areas in South Africa where raptors and vultures, such as the Martial Eagle *Polemaetus bellicosus*, Bateleur *Terathopius ecaudatus*, Tawny Eagle *Aquila rapax*, African Whitebacked Vulture *Gyps africanus* and Lappetfaced Vulture *Torgos tracheliotus*, are found and even breed in large numbers outside proclaimed game reserves and national parks. In the course of 1997, the vulture restaurant at the Molopo Nature Reserve attracted up to 196 African Whitebacked Vultures and 15 Lappetfaced Vultures at a time.

In the past three years, the following active raptor nests were recorded in the study area (Table 1).

Table 1. Active raptor nests in the period 1995-1997 (Steven Dell, Conservation Officer - Molopo Nature Reserve, pers. comm.).

Nests	Species	Conservation status: South African Red Data book-Birds (Brooke, 1984)
2	Martial Eagle	Vulnerable
6	Bateleur	Vulnerable
1	Tawny Eagle	Not endangered
2	Brown Snake Eagle	Not endangered
8	Wahlberg's Eagle	Not endangered
7	Giant Eagle Owl	Not endangered
200	Whitebacked Vulture	Not endangered

⁸ In the course of three days, the investigation team personally recorded four Martial Eagles *Polemaetus bellicosus*, all of which perched on electricity poles. An adult Bateleur *Terathopius ecaudatus*, a large unidentified raptor and two immature Martial Eagles, on electricity poles, were observed in the course of one morning's drive from Bray to Vostershooop (approximately 150 km) along the banks of the Molopo river. The investigation team also encountered scores of Pale Chanting Goshawks *Melierax canorus*.

Martial Eagles, Bateleurs and Lappetfaced Vultures are regarded as vulnerable in the South Africa Red Data book - Birds (Brooke, 1984). Even though the Tawny Eagle is not included in the Red Data book, its numbers outside protected areas have declined disastrously in the past 15 years, and do not show any signs of recovery. It should also be added that the South African Red Data book - Birds is almost 13 years old and in dire need of updating. The recent Atlas of Southern African Birds (Harrison *et al.* 1997) confirms the decline of the Tawny Eagle and Bateleur to a fraction of their previous distribution in South Africa, and clearly shows that humans are responsible for these distribution patterns. The Atlas also confirms that healthy populations of all the birds mentioned in Table 1 still occur in adjacent Botswana. It may well be that there is a natural influx of large raptors from Botswana into the region, re-populating areas where farmers exterminated large raptors in the recent past (before education and awareness programmes were launched, aimed at changing farmers' attitudes to raptors). Conservationists were of the opinion that the persecution by farmers have to a great extent been eliminated as the major cause of decline, and that the exposed poles were considered to be a risk to the high and growing raptor population of the area.

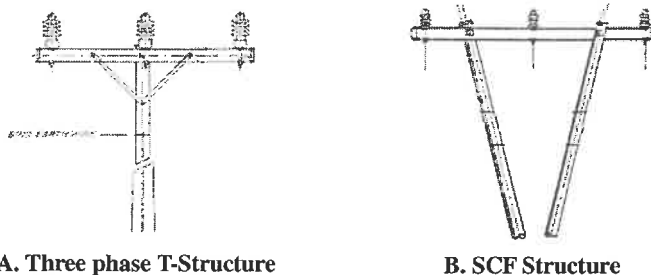
Powerline Design

Electrocutions of raptors are directly related to powerline design and spacing between elements that can comprise a phase-to-phase or phase-to-ground contact (APLIC, 1996). According to APLIC (1996) two design factors make a line hazardous to raptors: (1) phase conductors separated by less than the wingspread of the bird that is landing, perching or taking off; (2) a distance between grounded hardware and an energised conductor that is less than the wingspread or the distance from the tip of the bill to tip of the tail.

The majority of the reticulation poles in the study area are three phase T-structures with raised pin insulators (Figure 1a). The cross-arms are 2.5m in length, with the earthwire terminated below the attachment point of the bracing strap to the pole. The design of these poles constitutes a threat to the large raptors and vultures with a wingspan of more than 1.7m. Martial Eagles, Tawny Eagles and Brown Snake Eagles and all of the vulture species are particularly vulnerable in this respect, due to their large size and wingspan and habit of using electricity poles as hunting or roosting perches.

The main 22kV line from Tosca to Vesel substation is built for some distance on a wooden SCF type structure (Figure 1b). This three-phase structure has an earthwire running all the way to the top of the supporting pole(s) extending to approximately 100mm above the pole top. This leaves a gap of only about 450mm between the earthwire and the outer conductor which creates a very dangerous situation as even small raptors risk electrocution when perching within this space. During the course of the inspection, an adult Martial Eagle perched on one of the structures. These structures are also significantly higher than the surrounding vegetation, and are therefore ideal perches for large raptors.

Figure 1. Wooden SCF Structure



Based on the above parameters, the assessment found that the design of the powerlines poses a real and potential risk of electrocution to raptors.

Environmental Performance of the Powerlines

To assess the environmental performance of the powerlines, the Network Availability and Performance Indicator (NAPI) system reports⁹ for the powerlines in the study area from the period January 1995 - August 1997, were analysed to determine possible trends. The only other system to indicate whether incidents occurred, was the internal reporting of electrocution incidents. However, no incidents were reported through this system.

The NAPI reports of the study area for the period January 1995 - August 1997 recorded no incidents where birds were the reason for the outage. There were however 25 incidents without positive identification of what caused the interruption (reason unknown). However, if incidents did occur between two phases, the bird would not have caused a permanent fault and hence not required a line patrol. The number of outages without positive identification of what caused the interruption (reason unknown), could possibly be linked to birds; however, this could not be verified. The NAPI report system did therefore not contribute materially to the knowledge about the situation.

Interested and Affected Parties

Meetings were held with the local Eskom staff, as well as the conservation officer at the Molopo Nature Reserve, to obtain their views. One landowner was also consulted. From these meetings the following information was obtained:

- Eskom at that stage had already pro-actively fitted approximately 1800 structures with raptor protectors, but the process was time consuming;
- Local Eskom staff were of the opinion that due to their limited manpower and budget capacity the request for an acceleration of the process from conservationists was unrealistic;
- Conservationists from the Raptor Conservation Group¹⁰ and provincial Nature Conservation bodies launched various programmes¹¹ amongst the farmers to actively promote the conservation of raptors on their properties. They were of the opinion that the powerlines posed a significant threat to large raptors, but they would be satisfied if a systematic programme was instituted to fit raptor protectors to the powerlines.

Cost of Mitigation Measures

The total cost to fit raptor protectors to the powerlines in the study area was calculated at R683, 191,24 (US\$ 110, 192), and the implementation period approximately 6 years and 10 months.

CONCLUSION

The investigation team found no conclusive evidence of any bird mortalities as a result of electrocution or collisions with the powerlines. Although no formal reports of wildlife incidents were reported to Eskom since the time the powerlines were built, various factors such as high raptor populations, low human population density, vegetation cover, scavenger activities and infrequent Eskom patrols, suggest that the number of incidents reported may not present a true reflection of the environmental performance of the powerline.

The investigation team concluded that the parameters discussed during the risk assessment indicated that the reticulation network in the Molopo area constituted a real and potential threat to the growing population of large raptors in the area. It furthermore concluded that the general awareness of the local landowners and the potentially negative consequences for Eskom's image which might result in the event of Eskom failing to take any action, should be evaluated by Eskom management when making a decision on this matter.

⁹ NAPI is an electronic fault recording system used by some of the divisions within Eskom's Distribution Group.

¹⁰ The Raptor Conservation Group is a working group of the Endangered Wildlife Trust, a non-Governmental Organisation focusing on the conservation of biodiversity in southern Africa.

¹¹ Programmes were launched to educate farmers about the dangers that poisoning, drowning in farm reservoirs, as well as direct prosecution pose to the local raptor populations. Since these programmes were launched, the number of sightings of large raptors as well as nests recorded have risen sharply.

Having identified the risks and evaluated their possible impacts, the stage was reached where it had to be treated through design and implementation of a physical risk management programme. According to Valsamakis *et al.*, (1992) risk control entails “any activity which is aimed at preventing losses that may arise from all pure risks facing an organisation; even those which are relatively unpredictable and which pose a threat to the organisation’s existence”. It can also be defined as “a method of countering risk and includes all activities conducted for the purpose of”:

- eliminating or reducing the factors that may cause loss to a person or organisation, and
- minimising the actual loss that occurs when preventative methods have not been fully effective.

The approach adopted to risk control was through an engineering approach and perspective to control the physical aspects of the risk situation. Attention was thus directed at physical factors such as design and protective devices and the following recommendations as part of the risk assessment were forwarded to Eskom management:

- That a formal communication programme be launched to inform all interested and affected parties on Eskom’s decision and, if recommendations were accepted, the progress of the project, and that the project be marketed as a success story.
- That the earthwire on the mainline SCF structure from Tosca to Vesel substation be terminated to a distance below the cross-arm as specified by the Eskom Design Section.
- That all the powerlines of the Molopo Project be fitted with RP3 Raptor Protectors according to a fixed schedule.
- That a systematic programme be compiled with set targets and management information (Key Performance Indicators) to track project progress.
- That a formal audit programme be compiled to ensure compliance with set targets.
- That intensive market research be conducted and incentives developed for suppliers to design a Raptor Protector, which can be fitted with a link-stick without having to interrupt the electricity supply.

Eskom management accepted all the recommendations and at the time of this paper the project was in progress.

Effective management of risks is often sacrificed in the quest for progress and usually only leaps to the forefront when a major incident occurs. A systematic approach to the management of risks is necessary. Emphasis should not be placed on short-term cost to benefit relationships, but on maximising or achieving risk-return trade-off efficiency in the long term.

By using risk management methodology and systematically evaluating the biological and business risks, the risk existing or prospective powerlines pose to raptors can be determined and pro-active measures taken to either terminate, treat, tolerate or transfer these risks. It should also be noted that risk management must be viewed as an ongoing process, and not as a single event.

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