Chancellor, R. D. & B.-U. Meyburg eds. 2004
Raptors Worldwide
WWGBP/MME

The BB Line - Evaluating the Role of Birds in Line Faults

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ABSTRACT

The Bernalillo to Blackwater 345kV Line experiences more faults than any other line in Public Service Company of New Mexico's system. The lattice steel configuration provides a ready home to nesting birds and it has commonly been assumed that nests were the cause of the faults. As a consequence, the company has systematically removed the nests. This paper evaluates possible causes of line faults—that faults result from nests; that the faults result from bird streamers; and that faults result from to rain and wind. Nesting data and line fault locations were analysed using a Geographical Information System. Data suggest that streamers are a likely cause for most faults. Although ravens are the most common species along the line, they do not appear responsible for line faults. Red-tailed and other hawks and possibly Great Blue Herons play a likely role. Wind and precipitation probably play a role but little correlation was found that nests cause line faults. Recommendations include field studies to identify roosting species and flash marks to corroborate study results. Bird guards are recommended, beginning in areas of frequent faulting. Continuing evaluation and retrofitting is suggested as the most prudent course of action to increase system reliability.

INTRODUCTION

Since it was constructed in 1985, Public Service Company of New Mexico (PNM)'s Bernalillo to Black Water (BB) 345 kV line has experienced more faults than any other transmission line in PNM's system. Approximately 216 miles in length, the BB Line runs from just north of Albuquerque to Clovis, New Mexico. Although it accounts for only 30 % of the total system length, it contributes on the order of 70% of the faults in the entire system. It is also the line with the most bird nests. The lattice steel guy delta and four post angle configurations provide ready homes for nesting raptors and ravens. Data suggest that, on average, birds construct over 800 nests every two years. It has commonly been assumed that nests result in faults, and nest removals have been undertaken four times in eight years. This fix is temporary and expensive. It was during the last nest removal project conducted in early spring of 2002 that PNM began to question its working assumption. A critical review of relevant literature and input from consultants suggested that bird streamers were responsible for faults observed on transmission lines in South Africa and South Florida.

This analysis was constructed to critically evaluate three hypotheses: that faults are related to nests; that faults are related to bird streamers; or that faults are related to weather patterns, not birds. Data sources include fault type, location, time of day and nest location by structure and position on structure. Nest locational data were collected by helicopter in 1999 and 2001 in conjunction with biological field studies. The present analysis focuses on 41 single-phase faults for which reliable locational data were available.

ASSESSING THE ROLE OF NESTS IN CAUSING FAULTS

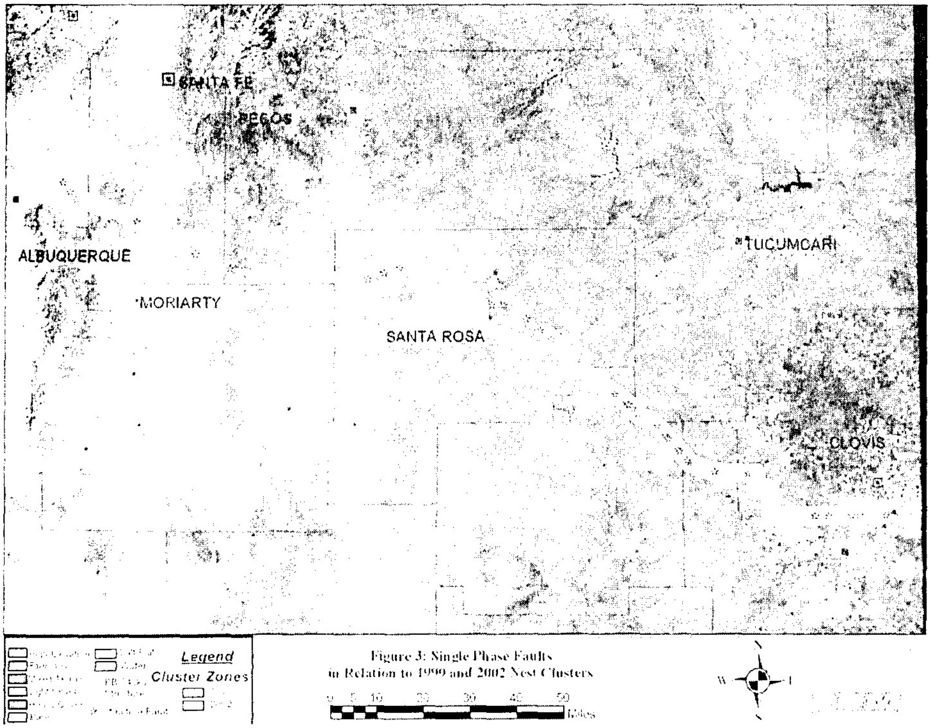
Nests probably do not cause faults but nesting materials can when materials, including sticks and wire, are introduced into the air gap between the structure and the conductor, resulting in a flashover. If nests do cause faults, the following expectations should be met:

- There should be a strong correlation between faults and nest locations.
- Faults should occur most frequently during the spring nest-building season when nest material would be brought into contact with the conductors.
- Faulting should occur more frequently on phases below the cross-arms where nest frequencies are the highest.
- Because nest building is a daytime activity, faults should occur during the daylight hours.
- Nest removal should result in a significant reduction in faults in the year following removal.

None of these expectations was met. Nest cluster zones were developed to measure the intensity and location of nesting activity along the line. A nest cluster was defined as the presence of ten nests within five structures either forward or backward from a single structure (Figure 1). Whereas the 1999 nest clusters include 53 % of the entire length of the line, 59 % of all the single-phase line faults occur within those clusters. In 2002, whereas 28 % of the line length occurred within nest clusters, 36 % of the faults fell within them. These figures indicate that there is only a slightly greater probability of a given fault occurring within a 1999 nest cluster than random chance would dictate.

If faults are related to nests, then most faults should occur during the nest-building season in the spring, when birds bring stick and wire materials up past the conductors on the way to the nest location. This expectation is not supported. Faults occur far more frequently in September than in any other month. Examination of faults by season indicates that faults throughout the summer (30.6%), fall (28.7%), and winter (24.4%) are evenly distributed with slightly fewer faults in the spring (16.3%).

Figure 1. Line-related faults in relation to 1999 and 2002 nest clusters



If nests are related to faults, they should occur most frequently on the phases closest to the most nests. Nest locations on the BB line structures are highly patterned and the pattern observed in 2002 is considered typical. During 2002, nests were most frequently positioned at the extreme ends of the cross-arms (54.5%) higher than and to the side of the lower two conductors. Less frequently, nests were positioned at the top corners of the structures higher than but to the side of the uppermost conductor (32.6%). In contrast, 51 % of the line faults occur on the upper centre phase. These results indicate that faults were less common on phases closest to the most nests.

If nest construction activities do cause faults, then faults should occur more frequently during daylight hours when birds are building nests. Examination of the figure indicates that faults occur much more frequently in the pre-dawn hours, and to a lesser degree in the late evening. Only two of the 41 faults have occurred during daylight hours.

Finally, if nest materials do cause faults, faults should decrease significantly in the year after nests are removed. Faults were significantly reduced from seven to two after nest removal in 1997. Closer examination of the faults indicates that five of the seven occurred during the autumn months near the eastern terminus. No decrease in the number of line faults was observed in the years after other removals. While other factors are certainly at work, nest removals do not appear to improve line reliability.

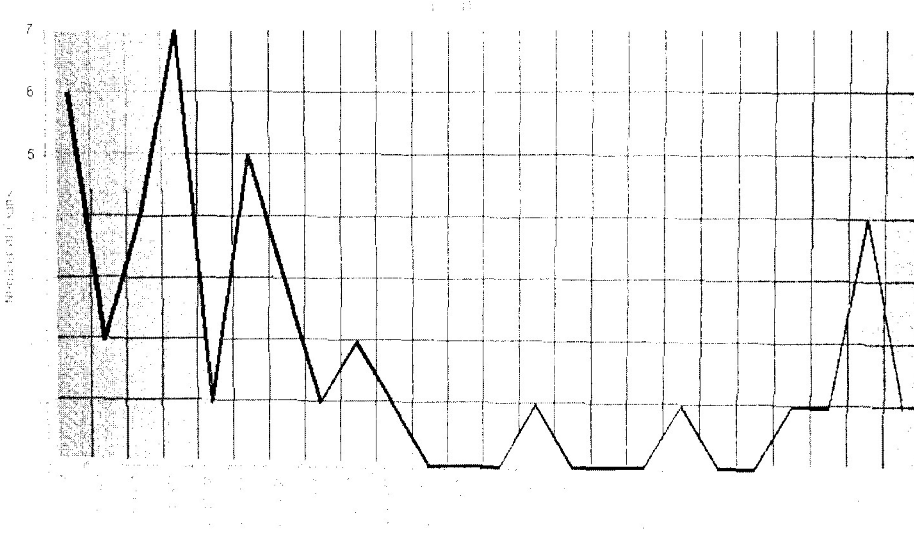
ASSESSING THE ROLE OF STREAMERS IN CAUSING FAULTS

Recent studies conducted by Burnham (1994), van Rooyen and Taylor (1999), and Vosloo and van Rooyen (2002) have demonstrated the importance of bird streamers in transmission faults. Expectations for streamer-related faults are as follows.

- Due to the rapid digestive system of birds, a late night peak from birds metabolizing their last meal, as well as an early morning peak when the birds awaken and begin the hunting day, is expected to lead to large streamer releases (Burnham 1994; van Rooyen & Taylor 1999). If streamers are a common cause of faults, we would expect a robust, bi-modal distribution of faults with peaks late at night and early in the morning.
- Whereas the cross-arms comprise the most favourable nesting location, the top of the structure, above the centre phase, is the highest and most favourable roosting location because it permits the best, unobstructed view of the surrounding countryside. For this reason, streamer-related faults should occur more commonly on the upper, centre phase.
- We might anticipate a positive correlation between habitat types supporting a favourable prey base and streamer-related faults.
- If streamers do cause faults, we might expect a positive correlation between fault time of year and seasonally available resources.

Examination of the fault frequency graphed against the time of day does reveal a robust bi-modal pattern with the highest number of faults occurring between 3 and 5 a.m. and a secondary peak between 9 and 12 p.m (Figure 2). Only two faults occurred between 10 a.m. and 5 p.m. The observed pattern strongly supports the role of streamers in transmission line faults.

Figure 2. Single phase faults by time of day



Because it provides the best view, another expectation is that the top of the structure would be used most frequently for roosting, even though nests more frequently occur in the cross-arms. This does indeed seem to be the case. Faults do indeed occur more frequently on the highest, centre phase (51.3%) in spite of the fact that nests are far more common in the arms.

Prey availability conditions the distributions of raptors. Just like the large birds themselves, their prey depends upon good sources of food and water. Lakes, ponds and streams comprise major water sources along the line. Irrigated farmland would provide a ready source of grain for rodents and small birds.

The proximity of food and water should result in a higher concentration of large birds. A slight tendency for faults to occur close to areas with favourable prey base characteristics is observable in the BB data. On average, structure fault locations occur 5 miles from water sources and 4.6 miles from farmland, while all structures average 5.4 miles from each of these sources.

Faults by season are depicted to evaluate the correlation between fault time of year and the seasonality of prey base resources. Faults occur most frequently in September, the same month in which crops are ripening. The graphic reveals strong patterning in the time of year in which faults are experienced. The few spring faults occur along the entire length of the line. The fault clusters around Santa Rosa near the centre of the line are heavily weighted to the summer months. Whereas some winter faults occur near the eastern end of the line, autumn faults are by far the most common.

Summer faults located around Santa Rosa near the centre of the line and the autumn faults near the eastern end of the line are not included in nest clusters defined for the study. The summer-related faults in the Santa Rosa Reservoir area raise questions about the Great Blue Herons known to occupy the area in the summer. These birds produce streamer-type faeces and their possible role in streamer-caused faults emerges as a research priority. The autumn faults near the east end of the line could be from migrating raptors feeding on rodents in agricultural fields as they pass through the area in the fall.

ASSESSING THE ROLE OF WEATHER IN CAUSING FAULTS

It is possible that birds have little to do with faults on the BB line. A competing hypothesis is that correlations with bird locations are not significant and that faults largely relate to meteorological variables. Was it possible that wind and weather account better for the observed patterns than do birds? To address that possibility, the co-occurrence of faults and wind conditions and moisture conditions were examined. The resulting correlation is not strong. Only one fault occurred on a day when wind speed exceeded 15 mph and six occurred on days when wind speed exceeded 10 mph. Over 82% of the faults occurred during dry conditions. The foregoing analysis suggests that wind and rain play some role in the faults observed but probably not a major one.

CONCLUSIONS AND RECOMMENDATIONS

The proceeding analyses have demonstrated a robust correlation between line faults and bird streamers. Expectations derived from the hypothesis that nests cause faults received little support, and whereas weather seems to play a role, it appears to be a minor one. There is some correspondence between nest locations and faults but indicators of the physical presence of birds are just as important to streamer-based arguments. Faults occur less frequently during the spring months, during nesting and nest construction, than during other months of the year. Faults rarely occur during the day when birds would be building nests, and occur more frequently on the upper centre phase whereas nests occur more frequently lower down in the cross-arms. Analysis of the efficacy of nest removal yielded ambiguous results.

There appears to be strong correlation between bird streamers and faults, even though streamer-related faults have not been directly observed. Faults occur far more frequently in the early morning hours at and just before dawn and late at night, and only extremely rarely during the day. Thus they assume the classic bi-modal distribution first reported by Burnham (1994) and further elaborated upon by van Rooyen and Taylor (1999), and Vosloo and van Rooyen (2001). Faults occur most frequently on the upper phase below favoured bird roosting locations. Faults occur more frequently in habitats that support more prey as defined by available water sources and agricultural fields.

The analysis suggests some avenues of further research. Although the patterns isolated are strongly suggestive, they have not been observed empirically. Biological field studies in fault clusters during specific seasons are strongly recommended to validate these results. If the biological studies further validate the study results presented here, targeted perch guarding in the identified fault clusters is recommended as the best strategy for increasing system reliability.

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