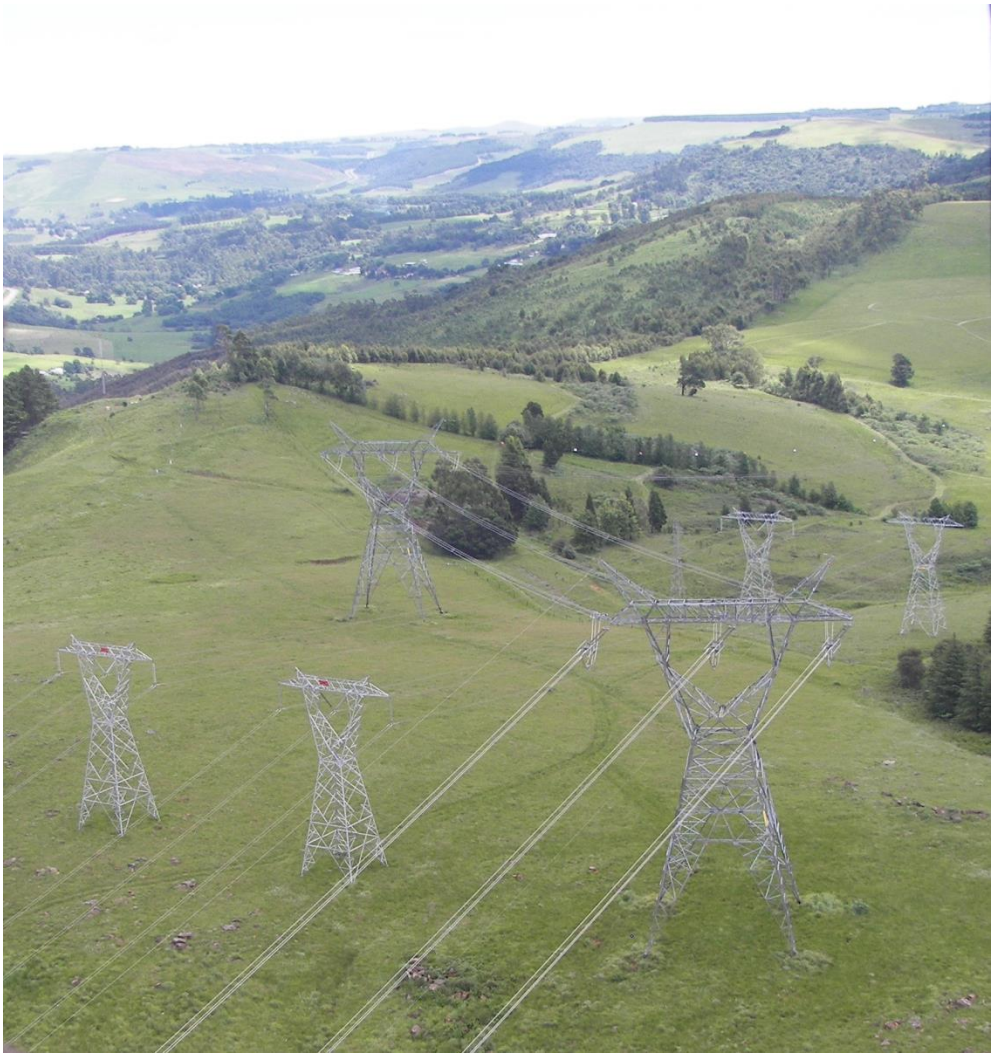
Eskom	Report	Technology

Title: **Everest-Perseus 1 275 kV Tower 389 Refurbishment**

Template Unique Identifier:	**240-68108455**
Project Unique Identifier:	**NA**
Document Unique Identifier:	**LES0606**
Area of Applicability:	**Engineering**
Documentation Type:	**Report**
Revision:	**1**
Total Pages:	**11**
Next Review Date:	**N/A**
Disclosure Classification:	**CONTROLLED DISCLOSURE**

Compiled by	Supported by	Authorised by
.....	.....	.....
GS Manqele	**Bharat Haridass**	**R. Vajeth**
Senior Technician	**Senior Consultant**	**Senior Manager - Lines Engineering Services Manager**
Date: 06/11/2020	Date: 06/11/2020	Date: 6 Nov 2020

Eskom	Everest-Perseus 1 275 kV – Tower 389 Refurbishment	Technology



Prepared by Line Engineering Services (LES)

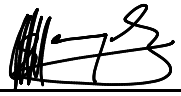
Doc No.: LES0606

Project No.: N/A

Revision: 1

December 2018

ESKOM ENGINEERING DESIGN TEAM

Name	Functional Responsibility	Date	Signature
Sizwe Manqele	Design leader	06/11/2020	

PEER REVIEW TEAM

Name	Functional Responsibility	Date	Signature
Bharat Haridass	Peer Review (LES Chief Engineers)	06/11/2020	

REVISION CONTROL

Revision Number	Date issued	Brief details of updates	Approved by
1	December 2018	First issue	R. Vajeth

Table of Contents

1 BACKGROUND

The Free State Grid approached LES to conduct an inspection of tower 389 on Everest-Perseus 275kV line which has deformed tower members and recommend remedial actions. LES conducted a ground inspection to establish the extent of the damage and to propose a solution to the problem. According to the grid personnel, the leg was deformed most probably by farming equipment as the farming activities are most active in the area. The tower damaged has since spread to the body of the tower with time.

	Everest-Perseus 1 275 kV
Construction year	1964
Phase conductor type	Bear
Phase conductor configuration	Twin
Earthwire	19/2.6 and 19/2.7 with Adlash
Tower Types	418 tower series
Affected Tower Type	418A Self Supporting Suspension
Line length (km)	147.2

Table 1.1: Basic Line information (TxSiS)

2 FINDINGS

A desktop study was conducted to confirm that the tower wind and weight spans are within limit. See the table below showing the As-built data and the original design parameters of the 418A tower.

	Design Parameters	**Eve-Per 1 275 kV**
Wind Span (m)	402	360
Weight Span (m)	457	390
Conductor Bundle	Twin Bear	Twin Bear
Earthwire	2 x 19/2.6	2 x 19/2.6+1 x Adlash

Table 1.2: Design data vs. As-built data

As seen on Table 1.2, the wind and weight spans are within the design parameters. This suggests that the tower damage was due to the application of an external load.

- The main member (beam) of the leg was found to have deformed due to the impact with the point of impact visible. The effectiveness of this member has been compromised by the deformation. Any further deformation of this tower member will result in tower collapse.

Figure 1: Deformed main member of the leg

- The truss and bracing members on both the longitudinal and transverse faces were found to have deformed as well with zero effectiveness. The load on this leg is entirely supported by the deformed main leg with the rest of the members wobbling.

Figure 2: Deformed truss and bracing members

- The body was also found to have deformed tower members. The buckled tower members were clearly visible from ground level.

Figure 3: Deformed tower member on the body

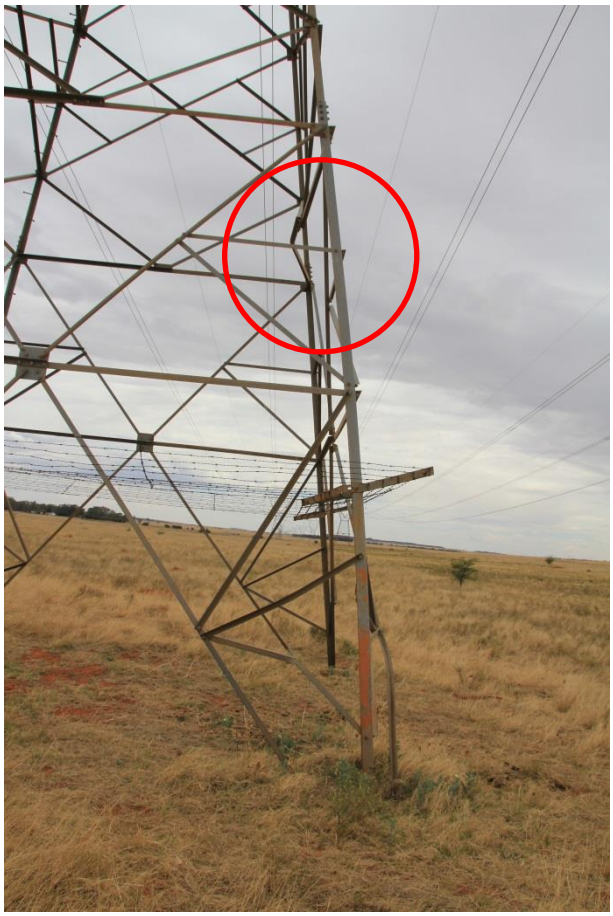


Figure 4: Buckled tower members on the body and leg

3 PROPOSED SOLUTIONS

The following three options are considered below

I. Installation of a new tower (10m-20m away from the damaged tower)
II. Replacement of bent members only
III. Add bracings to the affected tower members

3.1 Installation of a new tower (10m-20m away from the damaged tower)

This method requires a new tower to be constructed at a distance of about 10m to 20m of the existing tower. A new tower similar to the existing 418A with the same height as the original tower will be required.

ADAVANTAGES

- New tower (Uncompromised tower strength)
- Short line outage would be required

DISADVANTAGES

- Costly i.e. new steel, new foundations, dismantling costs, new conductor
- Requires a lot of time: - casting of new foundations, assembly and erection, dismantling of the damaged tower, conductor stringing.

3.2 Replacement of bent members only

This method involves the replacement of the damaged tower members and the reinforcement the affected stubs. A crane would be required to support the tower during the replacement procedure.

Tower type	Weight (Tons)	Conductor (Tons)	Earthwire (Tons)	Total Weight (Tons)
418A	8 (Approx.)	2x1220x3x0.720/1000 =5.3	2x361x0.72/1000=0.52	13.82

The maximum weight as seen on the table above is 13.82 tons. To account for the construction and wind loads a factor of about 2.5 is applied. A minimum of 35 ton crane is required to temporarily support the structure during refurbishment.

Figure 5: Tower rigging (For illustration purposes only)

ADVANTAGES

- Short duration for an outage (Line can be off ARC).
- Cost minimal when compared to method 2.1 i.e. only few steel members are required, low labour costs and a saving on conductor and foundation costs.

DISADVANTAGES

- Requires an experienced contractor.
- High risk activity since the line will be live.

The table below summarizes the differences between the three options based on risk during construction, outage required and construction costs.

Option	Risks	Outage Required	Costs (Rands)
1	Standard line construction risks	4-5 days to take down existing conductor, erect tower to full height and to string a new conductor	+/- 1.5million
2	Standard line construction risks	2-3 days outage required (off Arc)	R300 000

Table 4: Risks and mitigation

3.3 Method Statement

The contractor is to supply a detailed method statement on all activities for the refurbishment of the bent members and reinforcing of the stub.

Baseline Method statement

1. Attach the tower to the crane (min 38 ton) using adequately rated and tested slings. Ensure that is symmetrically supported by the crane in both longitudinal and transverse directions. Enough tension can now be applied to the slings enough to just support the tower
2. Excavate around the tower leg to expose the foundation cap and to ensure enough space to carry out work.
3. Remove the bent main leg member and replace with a new member. This may be cut and drilled on site in the absence of manufacturing drawings.
4. The truss and bracing members can now be replaced as well.
5. The bent members on the body can now be replaced. All these activities should be carried out with the crane supporting the tower. The crane should be released once all the members are fitted in place.
6. Where there are no lengths of the members given, the contractor is required to measure the required length on site. The stub must be reinforced first followed by the main leg member, crossing diagonals and ultimately the redundant bracings.
7. All nuts must be punched and painted with a calcium based paint to prevent corrosion.
8. The tower members must be galvanised to a minimum of 85µm (SANS121:2000)
9. All tower members to be fabricated using S355JR grade of steel
10. Bolts for the lattice structure shall be metric to SABS 136-1991 grade 6.8 with length as per SABS135-1991. All steel members within 5m from the ground level in lattice structure shall be fitted with anti-theft fasteners in at least one hole per side of the member. The anti-theft fasteners will be of minimum 8.8 grade strength bolts and shall involve metal deformation during installation.
11. After the members have been replaced, the concrete cap will be casted with the top surface chamfered at an angle to prevent water collection.

12. Ensure suitable back filling material after completion of the foundation construction. The material shall be mechanically compacted to a minimum of 90% of the dry density of the undisturbed material.

3.4 Risk and mitigations

The following high level risks were identified with recommended mitigations. It is important to note that the contractor still needs to identify and analyse the risks specific to each activity.

Risks	Mitigations
Tower damage/twist when relieving the compression on the loads	Conduct operations under still air conditions and properly support the tower by means of a mobile crane.
Disturbing the tower foundation	A proper method statement must be submitted to LES for approval on the method of how the contractor intends to carry out the tasks
Member cut and drilling of holes	The drawings of the tower are old and hard to read. The contractor will have to cut and drill members on site
Electrocution	An outage will be required to carry out the stub reinforcement procedure.

3.5 Discussion and recommendations

All two possible solutions are viable, however solution 1 should be ruled out completely due to cost implication. Although greater risks with option 2 than 1, proper measures will be put in place to control the risk associated with the various activities entailed by these options. Option 2 is favoured due to cost implications.

3.6 Conclusion

A conclusive bill of material needs to be drawn up on site to identify all affected tower members and associated weights. The contractor is to submit a detailed method statement for approval by Eskom LES before conducting any work. The contractor will conduct a detailed risk analysis, management and mitigation for the associated activities. All replacement members can be cut and drilled on site in the absence of drawings.