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Title: **SCOPE OF WORKS ALPHA BETA 1 765KV TOWER 672 GUY ANCHOR FAILURE**

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Revision Control

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0.1	March 2022	Draft
1	April 2022	First issue

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1. APPLICABILITY

This document shall apply to Alpha Beta Line 1 765kV tower 672.

2. NORMATIVE/INFORMATIVE REFERENCES

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs.

2.1 NORMATIVE

[1] 240-47172520 - TRMSCAAC6, The Standard for The Construction of Overhead Powerlines

[2] 240-60725816, Standard for High Voltage Live Working

[3] 240-105015449, Live line risk assessment and fall protection plan

2.2 INFORMATIVE

[4] 240-114967625: “Operating Regulations for High Voltage Systems (ORHVS)”

3. DEFINITIONS AND ABBREVIATIONS

3.1 DEFINITIONS

Term	Definition
Construction work	The erection, maintenance, alteration, renovation, repair, demolition or dismantling of or addition to a building or any similar structure.
Contractor	Contractor is a person/company responsible to sufficiently and safely conduct the construction work accordingly to applicable standards and legislature, ensuring alignment to technical specifications.

3.2 ABBREVIATIONS

Term	Definition
LES	Lines Engineering Services

NGL	Natural Ground Level
SOW	Scope of Work
PPE	Personal Protective Equipment
OHS Act	Occupational Health and Safety Act
ORHVS	Operating Regulations for High Voltage Systems
UTS	Ultimate tensile strength

4. HEALTH AND SAFETY

The Contractor :

i. submits Safe Working Procedures (SWP) for all activities

ii. ensures that all personnel are familiar with the Employers Health and Safety induction, and PPE requirements before commencement of the Works.

iii. ensures that all activities do not contravene with environmental compliances

iv. allows for sufficient prevention/mitigation measures of all risks identified on site prior and during the activities.

v. Emergency procedures – e.g.: Emergency preparedness and injury relevant emergency safety procedures etc.

vi. ensures all assembly areas highlighted during emergencies.

vii. designates areas for smoking, eating and ablution.

viii. takes particular note that all work will be conducted under live-line conditions, and ensures all work is done safely. Earthing of plant and equipment, adhering to clearances need to be highlighted in the SWP and method statement. An authorised person as per the ORHVS needs to be present.

ix. outlines sufficient Covid – 19 safety regulations

x. allocates sufficient lay down areas and access routes, that are clearly identified and made secure.

														
Overall	Pants	Top	Dust coat	Apron	Hard hat	Gum boots	Safety shoes	Safety Glasses	Face shield	Dust mask	Respirator	Ear protection	Safety (harness)	Gloves
X					**X**		**X**			**X**		**X**	**X**	**X**

5. INTRODUCTION

The Alpha Beta 1 765 kV line runs from Alpha substation close to Thuthukani and runs to Beta substation close to Dealesville parallel to Alpha Beta 2 765 kV. Figure 1 below shows the Alpha Beta 1 765kV servitude area. Figure 2 below shows the surrounding area of tower 672 (the tower with the failed guy anchor). During a fly over inspection of the Alpha Beta 1 765kV powerline conducted on 22 February 2022, the Free State Grid had noticed an eye link (guy anchor) had pulled out of the ground. From the images received by the grid it was found that the failure was due to corrosion of the eye link. The Grid has temporarily stabilised the guy wire. The Guy wires are crucial in stabilising the 701B towers coupled with the correct tension. The line was built using the 701-tower series.

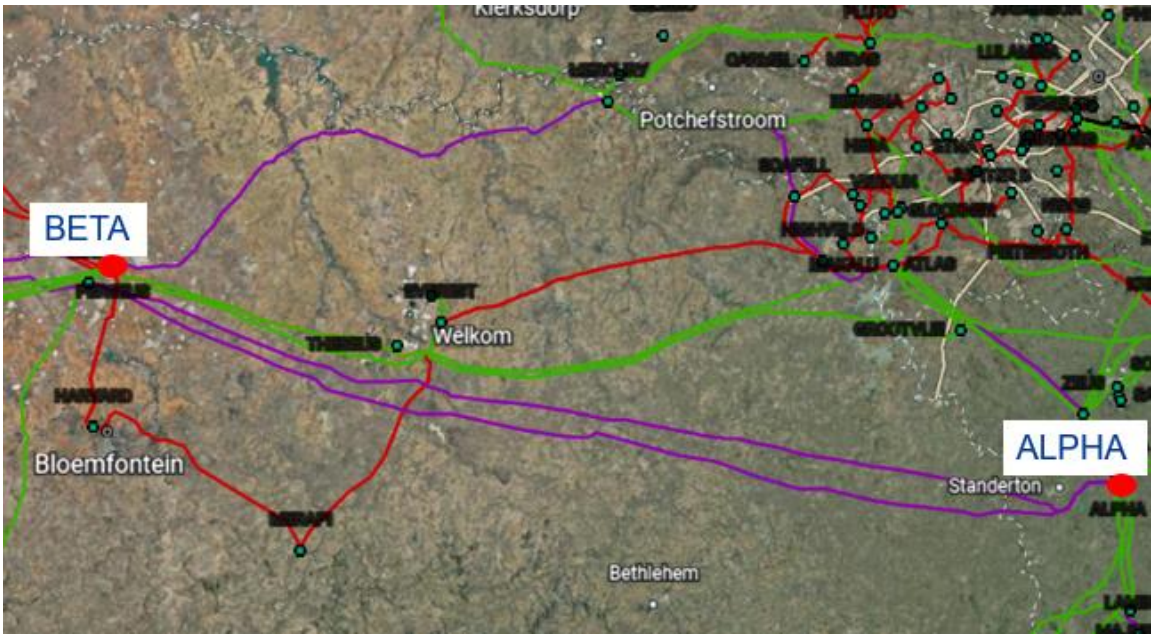

Figure 1 :Alpha Beta 1 765kV Line route

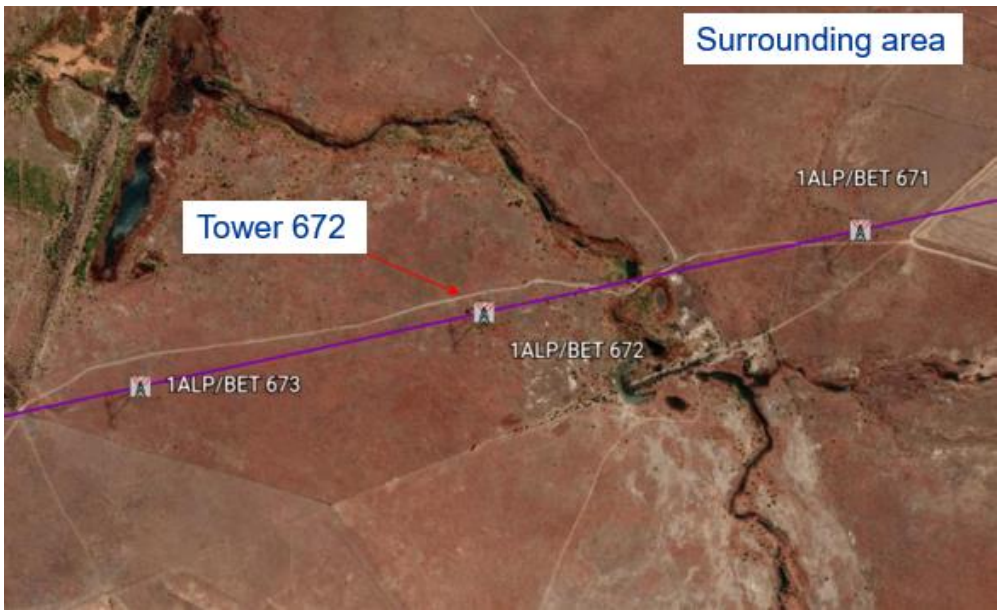

Figure 2 : Tower is located in a small area called Masilonyana

A site inspection was conducted by Lines engineering services (LES) on the 7 March 2022 to inspect the guy anchor shown in Figure 3 on the Alpha Beta 1 765kV line. The purpose of the site visit was the following:

- Inspecting the remaining guy anchor stays above ground
- Inspect the existing hardware and guy wires.

Due to the remaining anchors being in a similar ground condition the assumption is that the existing anchors are also compromised.

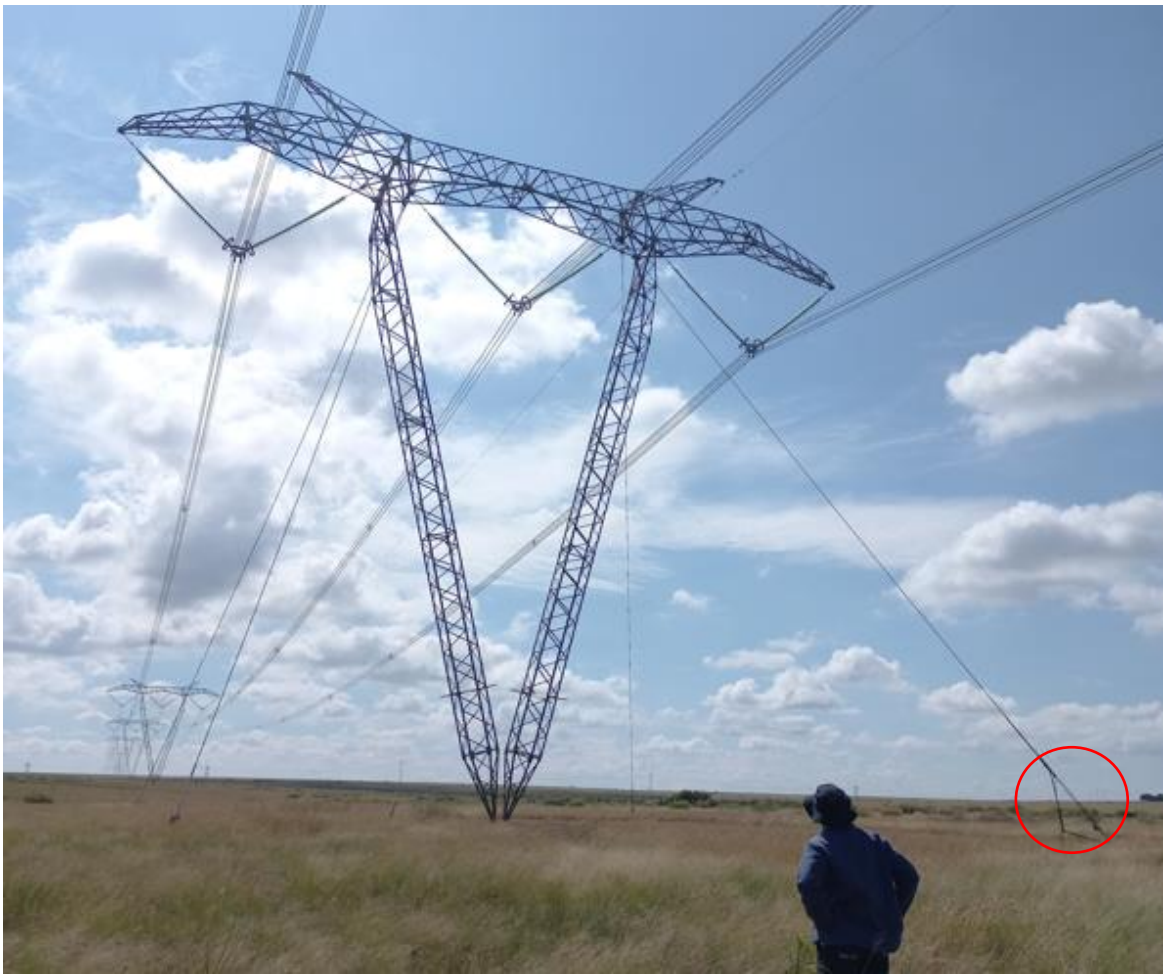

Figure 3: Tower 672 (701B) failed guy anchor

Preliminary inspection findings:

The inspection included the failed guy anchor and the remaining guy anchors, as well as the surrounding area. The remaining anchors could only be visually inspected above ground. This section outlines the findings for Tower 672:

- Figure 4 below shows the failure of the eye link which occurred between the eye link and foundation connection point. The first 1 m of the link connected to the U-bolt assembly showed very little evidence of corrosion but going further down the link the rate of corrosion increased significantly.
- From the preliminary inspection and discussion with subject matter expert's (LES) the following conclusions were made:
    - It appears the corrosion at the point of failure had occurred and was present for some time before pulling out.
    - After pulling out no evidence of shearing was noticed.
- Figure 5 below shows the failed eye link and figure 6 below shows the failure zone on the foundation.
- High-level geotechnical parameters:
    - Figure 7 below shows the Sausage test conducted on in-situ soils on the surface at natural moisture content(i.e. no water added). The soils retained the sausage shape when compressed without crumbling and breaking.
    - Indication of cohesive fine-grained material.
- Figures 8,9 and 10 below show ponding of water around the guy anchors and center mast foundations

Figure 4:Failed guy anchor

Figure 5: Corroded eye link

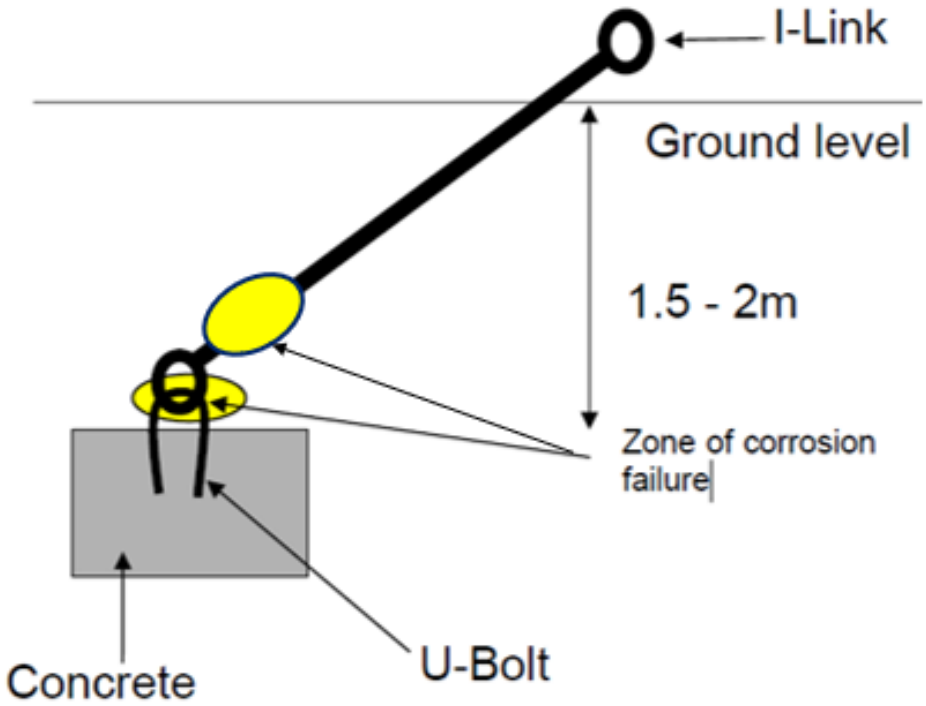

Figure 6: schematic illustration of failure zone

Figure 7:Sausage test

Figure 8:Existing guy anchor

Figure 9: Ponding of water by existing guy anchor links

Figure 10: Ponding of water around the centre mast of tower 67

Figure 11 below shows the temporary backstay of the failed anchor. The approximate position of the temporary anchor is shown in figure 12 below.

Figure 11: Temporary backstay

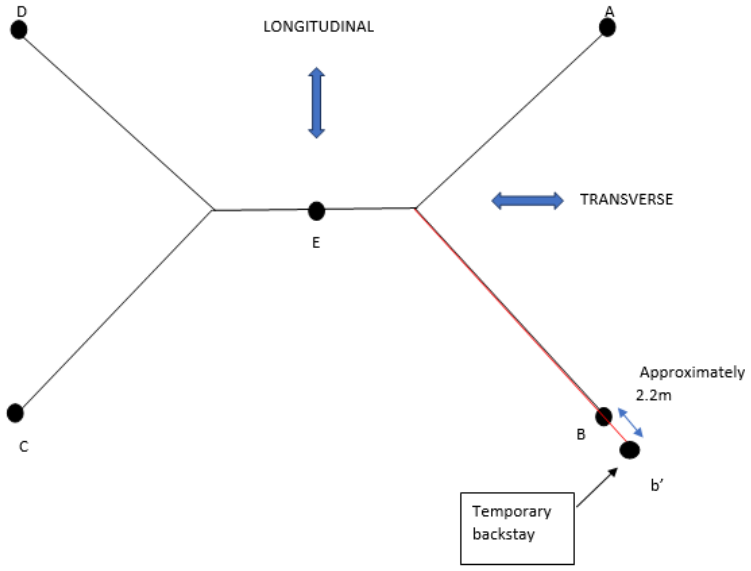

Figure12: Approximate location of the temporary backstay

6. SCOPE OF WORK

6.1 ALPHA BETA LINE 1 LINE DETAILS

The Alpha Beta 1 765 kV powerline has 958 towers. The powerline runs from Alpha substation to Beta substation. Table 2.1 below shows the line specific details

TABLE 2.1: SUMMARY OF LINE DETAILS

Line details	
Line name	Alpha Beta 1
Line length	435.97km
Voltage	765kV
Structure types	701 Tower Series
Conductor	Zebra
Ground wire	19/2.65

TABLE 2.2: SPAN DATA

Tower Prefix	From Tower	To Tower	Type	No. Cond.	Earth Wire	Earth Wire2	Contr. No.	Contractor	Length	Chainage	Temp.	Constr. Year
1ALP/BET	671	672	ZEBRA	6	19/2.65	19/2.65	11752	POWERLINES	459.0m	304.768km	70C	1986
1ALP/BET	672	673	ZEBRA	6	19/2.65	19/2.65	11752	POWERLINES	415.0m	305.183km	70C	1986
1ALP/BET	673	674	ZEBRA	6	19/2.65	19/2.65	11752	POWERLINES	302.0m	305.485km	70C	1986

TABLE 2.3: TOWER DATA

Twr Pref No	Bend?	Type	S_Type	Cond Att.	Tube	Sheet	Deg. Lat	Deg. Long	Height Above MSL
1ALP/BET 671	N	701	B31.5	30.50	456	26	-28.341683S	26.966097E	1434.6
1ALP/BET 672	N	701	B30	29.00	456	26	-28.343490S	26.961874E	1428.4
1ALP/BET 673	N	701	B30	29.00	456	26	-28.345125S	26.958054E	1430.5

6.2 PROJECT SCOPE OF WORK FOR TOWER 672

The following will highlight the high-level scope of work:

- Visual inspection of all guy ropes, and guy assemblies of tower 672.

- Securing of all four guy anchors, installation of new foundations for all guys and transferring of old guys to new foundations.
- Removal of old foundation guy links.
- Re-shaping of ground around the centre mast and guy anchors to prevent water from ponding.

6.2.1 Replacement of foundation

A new guy anchor foundation will need to be installed for all four anchors. Figure 13 below shows the new anchor position(A',B',C',D') in respect to the existing foundation position(A,B,C,D).

Access

- Tower 672 can be accessed from the main road, but during rainy conditions these roads will become difficulty to drive on. Any work to be done on the roads must be designed by the contractor's temporary work engineer, which will then be sent for acceptance from LES.

Foundation Design and soil nominations

- The new foundations is to be designed (by a professionally registered (ECSA) engineer) and constructed by the Contractor as per the TRMSCAAC 6 (Ref 2.1 Normative section [1]).
- The design should be approved by Eskom LES before construction commences.
- Care must be taken when installing the new foundation to ensure that it does not clash with the existing foundation.
- The Contractor will need to confirm the soil type prior to the execution of works to ensure that the correct foundation can be design and constructed.
- After the installation and transfer of hardware to new guy anchor foundations, the removal of existing foundation links to concrete interface is required, backfill and make good the area. Dispose demolished material and steel at the nearest approved landfill site.
- A comprehensive safe working procedure will need to be developed by the Contractor detailing exactly how the work will be carried out. A detailed risk matrix including the mitigation measures must be included in the safe working procedure.
- All designs and safe working procedures are to be reviewed by LES prior to commencement of works.
- All construction work is to be done in accordance to TRMSCAAC6 (Ref 2.1 Normative section [1])..
- Annexure A below has an outline drawing of the tower and Annexure B shows the concept drawing with the guy anchor force (which is not to be used for construction).

Concrete mix design

- Mix design shall be done by the Contractor and submitted to LES for acceptance. The concrete mix design shall comply with TRMSCAAC6 (Ref 2.1 Normative section [1]) requirements.

Position of new foundation

The construction of the new foundation shall be as per TRMSCAAC6 (Ref 2.1 Normative section [1]). All embedded steel (i.e., Link plates and stubs) below ground line shall be galvanised and encased in concrete.

- All steel link plates extending below the ground level, shall be encased in concrete (minimum grade 25MPa/13 mm coarse aggregate) with a watershed top surface using a 300 mm diameter minimum HPDE (High.Density.Poly.Ethylene) pipe as permanent formwork.
- The vertical distance between the highest point of the foundation and the ground surface shall be a minimum of 250 mm and a maximum of 650 mm.
- All link plates must be painted with a bitumastic/zinc rich paint/UV resistant 500mm below ground level and 500mm above ground level (subject to approval by Employer).

The new position should be determined such that the same stay rope can be used. The new location (highlighted using the red line) is at a point rotated approximately 5 m (Maximum rotation distance to not exceed 5.5 meters, any changes need to be discussed with LES) towards the transverse direction of the line as shown in Figure 13 below. The contractor will be required to use a professional surveyor to peg the correct position and alignment of the new anchors.

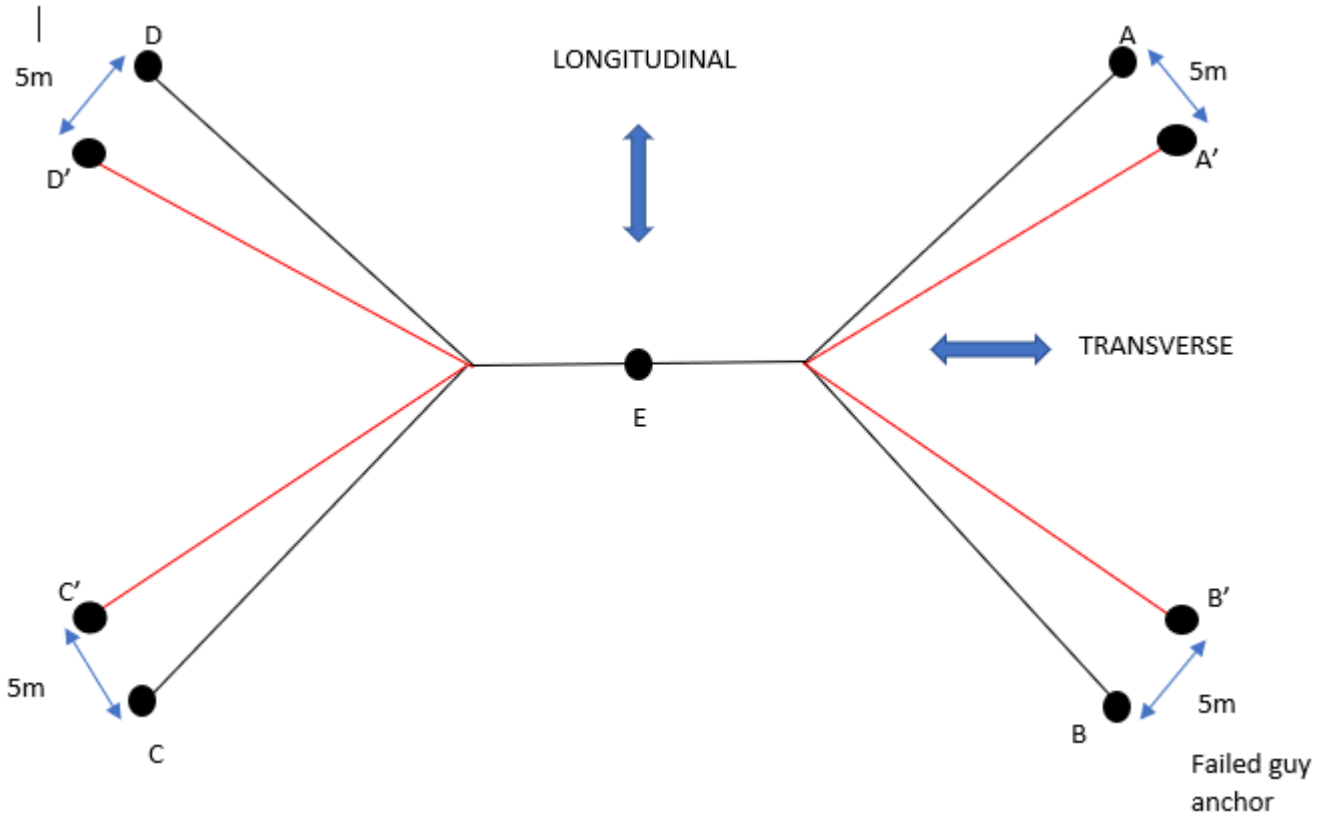

Figure 13: Proposed new guy anchor position

Connecting of the guy rope to the new foundation

- Backstaying of the existing guy anchors prior to the execution of each foundation. Contractor to advise on the preferred method of backstaying.
- All the hardware, existing guy wire, attachment points to be inspected prior to construction.
- The process of transfer of the old stay to the new one will only commence once the concrete tests pass, and the transfer will be done one leg at a time.
- Connection of the guy rope to the new foundation should be done prior to dismantling the temporary solution/ backstay connection.
- UTS of guy wire – 850kN
- During tensioning care must be taken to ensure its done safely and correctly (Latest version - TRMSCAAC6, 5.4.3 Erection of guyed towers).
- A comprehensive safe working procedure will need to be developed by the contractor detailing exactly how the work will be carried out. A detailed risk matrix including the mitigation measures must be included in the safe working procedure.
- All designs and safe working procedures to be reviewed by LES prior to any work being done.
- All construction work to be done in accordance to TRMSCAAC6 (Ref 2.1 Normative section [1])..

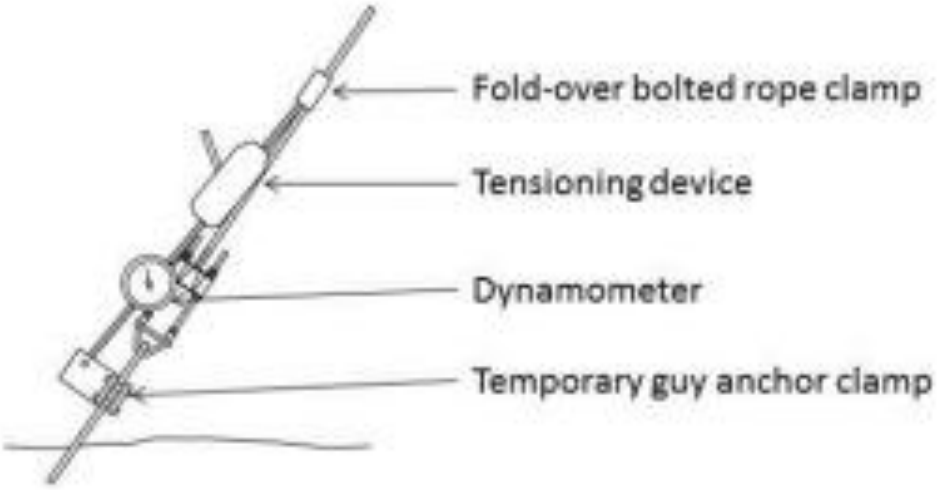

Figure 14: Checking correct tension in the guy wire

7. SAFETY AND RISKS

All operations done to repair this tower will require a corresponding safe working procedure. These safe working procedures must highlight all the risks involved in every operation and suitable mitigation measure to minimize and remove such risks. Safe working procedures must be developed for all the activities surrounding and including the following operations:

- Back staying of existing guy anchors.
- Installation of the new foundations (including all activities associated with the foundation installation eg: shoring of excavation).
- Installation of the guy wire (Including details of adjustment of the tension in the guy wire as per TRMSCAAC6 (Ref 2.1 Normative section [1]).).

The following risk can be found on site and must be mitigated in the safe working procedure:

- Uneven ground conditions
- Working under a live line.
- Deep excavations
- Transferring of loads from old to new foundations

8. EARTHING

All work will be done under live conditions. All work must comply with the Annex C in the latest version of TRMSCAAC6 (Ref 2.1 Normative section [1]).It is the responsibility of the Contractor to ensure that all the machinery and equipment being used are correctly earthed at all times. An Authorised ORHVS person is present on site on a full time basis. It will be necessary to use equipotential plates in some instances.

9. MATERIAL MANAGEMENT AND TEMPORARY WORKS

Access needs to be clearly marked and identified prior to the works being conducted. The work will be carried out on uneven terrain, the Contractor must ensure all machinery are correctly positioned for the work to be carried out. Prior to commencement of work the Contractor must visit the site to identify access routes and machinery limitations. Any bush or trees need to be identified prior to commencement of the works.

The Contractor identifies and clears area/s for laydown of materials and equipment (as required) to ensure the secure and correct management of plant, materials and equipment. The Contractor allows for ablution facilities for personnel (portable). The Contractor makes provision for potable water for all staff as required.

The Contractor ensures excavation sidewall safety to allow personnel to work inside the excavations. Where large plant is employed, the Contractor ensures the use of points person/s to ensure no injury or loss of life is caused by equipment and machinery.

10. CONCLUSION

The new guy anchor foundations will be located approximately 5m (Maximum rotation distance to not exceed 5.5 meters, any changes need to be discussed with LES) away. The new foundation will be constructed at the same radius distance as the original foundation.

In addition to this the foundation should be swung around in the direction that takes the guywire toward the transvers face of the tower, away from the conductor. Please note the activities will require work in

close proximity to live lines and warrants an Authorized Person in terms of the OSH (Occupational health and safety) Act. The objective of the site visit conducted was to determine the scope of work for tower 672 (Alpha Beta 1 765kV Line). The failed guy anchor will need to be replaced with a new foundation in addition with the remaining guy anchors. The remaining anchors will require replacement to prevent failure at a later stage.

11. ANNEXURE A – TOWER OUTLINE DRAWING

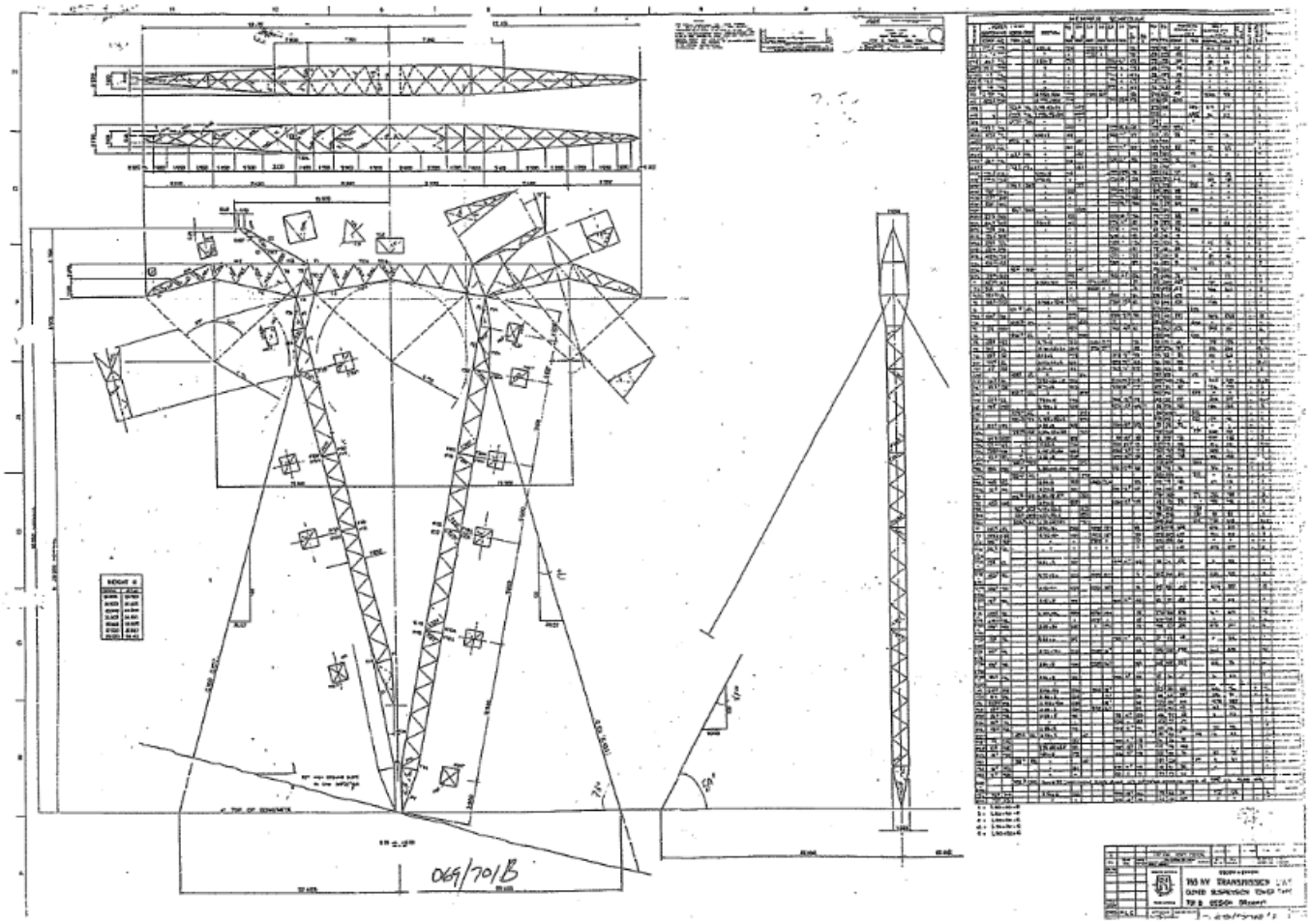

Figure 15:701B – Tower outline drawing

12. ANNEXURE B -FOUNDATION INFORMATION

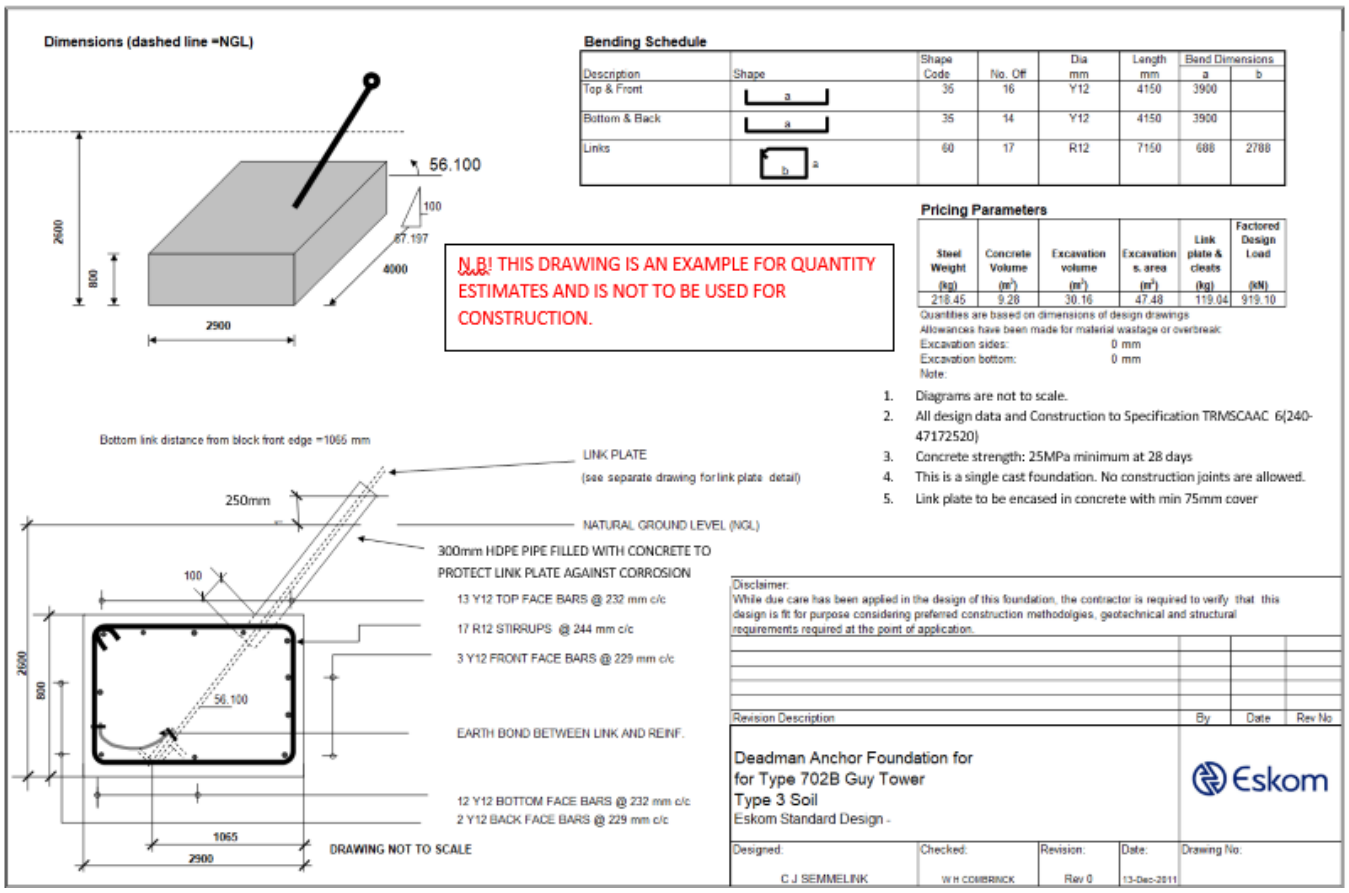

Figure 16: Foundation concept drawing