FERRUM – GARONA

275kV LINE DEVIATION

PRELIMINARY TEMPLATING REPORT

Prepared by Line Engineering Services (LES)

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Revision Control

Revision Number	Date issued	Brief details of updates	Approved by
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1 EXECUTIVE SUMMARY

This report details the templating of a 15km line deviation of the Ferrum – Garona 27kV line at the request of Kumba Iron Ore to cater for the expansion of their Sishen pit to the west of their current mining operations. The original Ferrum Garona 275kV line had been looped into Lewensaar and the section we are dealing with is between Ferrum and Lewensaar, original towers between 37 and 70.

The relocation of the 275kV line will be moved to a position adjacent to a relocated rail line and along the western boundary of the Kumba properties. The future Ferrum – Niewehoop 400kV transmission line will run parallel to the route followed by the 275km. The separation distance between the two lines is approximately 50m from the centre of the 400kV line servitude to centre of the 275kV line servitude.

The existing 275kV line was built in 1977 using the 423 and 427 series of towers. The current conductor on the line is twin (2 x) bear with 2 x 19/2.65mm steel earthwire.

The deviation will make use of the 434 tower series. However, the conductor and earthwire will remain the same as the existing: twin (2 x) bear conductor and 2 x 19/2.65mm steel earthwire. There is one major crossing in this preliminary profile and that is crossing of the electrified Transnet Railway line.

This report is based on a preliminary profile of the 275kV line. A line walk down and final design report will follow to identify and detail any hazards or risks that may be encountered during the construction of this deviation.

2 TOWER SPOTTING

The 15km line deviation starts from the existing bend at tower 37 on the current line to tower 70 as shown in Figure 1.

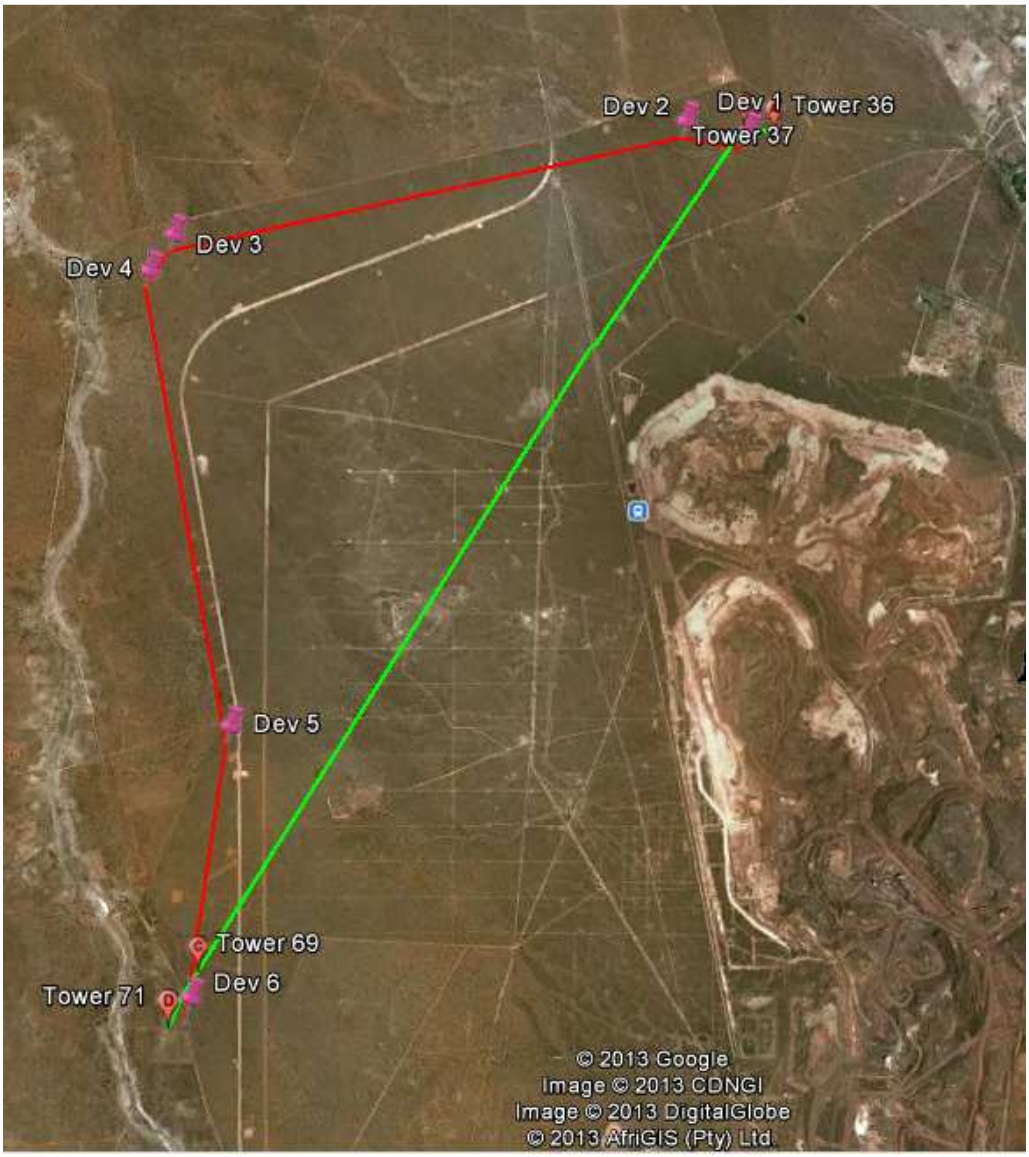


Figure 1 Proposed Ferrum - Garona 275kV line deviation (shown in red) and existing line (shown in green)

The terrain is fairly flat through most of the line route with some vegetation along the line route. The existing line uses the 423 series of towers at the bend points and the 427 suspension towers. These

are horizontal (flat) configuration self-supporting towers. The towers support a conductor bundle of twin Bear with two 19/2.65mm steel earthwires.

The relocation of the 275kV line will be moved to a position adjacent to a relocated rail line and along the western boundary of the Kumba properties. The future Ferrum – Niewehoop 400kV transmission line will run parallel to the route followed by the 275km. The separation distance between the two lines is approximately 50m from the centre of the 400kV line servitude to centre of the 275kV line servitude. The design of the 400kV line will need to take this line separation during the tower spotting studies.

Other infrastructure was also relocated at the mine to cater for the expansion of the pit, these include a pipeline and a railway line. These will be considered during earthing studies in the final design report.

The standard required ground clearance for a 275kV line is 7.4m (SANS 10280-1:2013).

3 FEATURE CODE LIST AND CLEARANCES

Table 3.1: Electrical clearances for conductors

Feature Description	Required Vertical Clearance 275kV (m)
11kV power line	3.5
22kV power line	3.5
Public Roads, non-electrified railways, (excluding farm tracks)	9
33kV power line	3.5
Communication lines & power lines	3.5
Buildings, structures not part of power lines (including Transnet owned structures)	5.3
Vegetation canopy	6.3
66kV power line	3.5
Railways (statutory clearance requirements)	9
Transnet owned single supply	12.2
Transnet owned multiple supply and single supply line crossings, level crossing	13.7
Transnet owned railways – conductor	4.6
Transnet owned railways – structures	5.2
Transnet footbridges	6.9
88kV power line	3.5

WATER COURSE/RIVER – EDGE	7.8
Navigable WATER	20.75
132kV power line	3.5
Ground	7.8
220kV power line	3.5
275kV power line	3.5
400kV power line	4.2
PIPELINE	7.8
FENCE	5.3
Telephone lines	3.5
533kV DC line	4.7
765 kV power line	6.5

4 LINE PHASING

All towers used on this line have a flat (horizontal) configuration and no phase swapping takes place within this section of the line deviation.

5 TRANSPOSITIONS

There is no transposition planned on this section of the line deviation.

6 LINE CROSSINGS

There is only one major crossing on the line route the deviation follows: an electrified Transnet Railway line.

Table 6.1: Required Clearances for Transnet Crossings

Clearance Point	Required Clearance (m)
Railways (statutory clearance requirements)	9
Transnet owned railways – conductor	4.5
Transnet owned railways – structures	5.2

The criteria used for crossing the Railway line must ensure that the 275kV line clearances are maintained at the templated temperature (50°C).

7 STAKING TABLE

Structure Number	Station (m)	X Easting (m)	Y Northing (m)	Centerline Z Elevation (m)	TIN Z Elevation (m)	Ahead Span (m)	Line Angle (deg)	Transverse Axis Azimuth (deg)	Structure Name	Structure Description	Struct. Height (m)
1	0	-2119.7	-3061863.52	1171.95	1171.95	306	0	9.7564	434c 2kin.182	0-18deg Angle Strain 434c 275kV	22.3
2	306	-2421.274	-3061811.665	1170.168	1170.169	304.408	0	9.7564	434a.195	light suspension tower type 434a	24.53
3	610.408	-2721.28	-3061760.08	1169.106	1169.106	322.873	-22.2942	358.6094	434d 2kin.162	15-45deg Strain 434d 275kV	21.1
4	933.281	-3036.453	-3061830.17	1168.679	1168.679	375.676	0	347.4623	434a.195	light suspension tower type 434a	24.53
5	1308.957	-3403.171	-3061911.723	1167.816	1167.816	356.676	0	347.4623	434a.200	light suspension tower type 434a	25.03
6	1665.633	-3751.341	-3061989.151	1166.48	1166.48	352.088	0	347.4623	434a.190	light suspension tower type 434a	24.03
7	2017.721	-4095.033	-3062065.583	1166.176	1166.176	287.7	0	347.4623	434a.190	light suspension tower type 434a	24.03
8	2305.421	-4375.872	-3062128.037	1164.954	1164.954	377.972	0	347.4623	434b 2kin.202	Self Supporting Suspension 434b 275kV	28.33
9	2683.393	-4744.831	-3062210.088	1163.226	1163.226	358.961	0	347.4623	434a.021	light suspension tower type 434a	26.03
10	3042.354	-5095.232	-3062288.012	1162.205	1162.205	356.672	0	347.4623	434a.190	light suspension tower type 434a	24.03
11	3399.026	-5443.399	-3062365.44	1160.734	1160.734	363.935	0	347.4623	434a.190	light suspension tower type 434a	24.03
12	3762.961	-5798.655	-3062444.443	1158.722	1158.722	343.828	0	347.4623	434a.190	light suspension tower type 434a	24.03
13	4106.789	-6134.284	-3062519.082	1157.031	1157.031	349.654	0	347.4623	434a.190	light suspension tower type 434a	24.03
14	4456.444	-6475.6	-3062594.986	1155.286	1155.286	361.198	0	347.4623	434a.200	light suspension tower type 434a	25.03
15	4817.641	-6828.184	-3062673.396	1153.792	1153.792	337.976	0	347.4623	434a.180	light suspension tower type 434a	23.03
16	5155.617	-7158.1	-3062746.764	1152.07	1152.07	333.774	0	347.4623	434a.180	light suspension tower type 434a	23.03
17	5489.391	-7483.916	-3062819.221	1149.229	1149.229	307.229	0	347.4623	434a.180	light suspension tower type 434a	23.03
18	5796.62	-7783.818	-3062885.915	1147.869	1147.869	341.818	0	347.4623	434a.190	light suspension tower type 434a	24.03
19	6138.438	-8117.484	-3062960.117	1145.049	1145.049	344.083	0	347.4623	434a.190	light suspension tower type 434a	24.03
20	6482.521	-8453.362	-3063034.812	1144.389	1144.389	327.979	0	347.4623	434a.190	light suspension tower type 434a	24.03
21	6810.5	-8773.52	-3063106.01	1142.929	1142.929	232.886	-37.4129	328.7558	434d 2kin.162	15-45deg Strain 434d 275kV	21.1
22	7043.386	-8923.37	-3063284.282	1139.814	1139.814	216.382	0	310.0494	434a.180	light suspension tower type 434a	23.03

23	7259.768	-9062.6	-3063449.92	1135.98	1135.98	280.232	-50.8381	284.6303	434d 2kin.162	15-45deg Strain 434d 275kV	21.1
24	7540	-9010.144	-3063725.199	1138.646	1138.646	341.017	0	259.2113	434a.180	light suspension tower type 434a	23.03
25	7881.017	-8946.31	-3064060.188	1139.743	1139.743	323.721	0	259.2113	434a.180	light suspension tower type 434a	23.03
26	8204.738	-8885.713	-3064378.187	1136.167	1136.167	357.882	0	259.2113	434b 2kin.182	Self Supporting Suspension 434a 275kV	26.33
27	8562.62	-8818.722	-3064729.743	1135.738	1135.738	365.544	0	259.2113	434a.195	light suspension tower type 434a	24.53
28	8928.164	-8750.296	-3065088.826	1138.358	1138.358	320.819	0	259.2113	434a.195	light suspension tower type 434a	24.53
29	9248.983	-8690.243	-3065403.975	1137.559	1137.559	341.01	0	259.2113	434a.190	light suspension tower type 434a	24.03
30	9589.993	-8626.41	-3065738.957	1142.892	1142.892	339.203	0	259.2113	434a.180	light suspension tower type 434a	23.03
31	9929.196	-8562.915	-3066072.164	1144.521	1144.521	359.315	0	259.2113	434a.190	light suspension tower type 434a	24.03
32	10288.51	-8495.656	-3066425.128	1147.612	1147.612	347.679	0	259.2113	434a.190	light suspension tower type 434a	24.03
33	10636.19	-8430.574	-3066766.661	1148.184	1148.184	351.038	0	259.2113	434a.190	light suspension tower type 434a	24.03
34	10987.23	-8364.864	-3067111.494	1148.982	1148.982	346.18	0	259.2113	434a.190	light suspension tower type 434a	24.03
35	11333.41	-8300.064	-3067451.555	1146.826	1146.826	347.999	0	259.2113	434a.190	light suspension tower type 434a	24.03
36	11681.41	-8234.922	-3067793.403	1148.75	1148.75	345.133	0	259.2113	434a.185	light suspension tower type 434a	23.53
37	12026.54	-8170.318	-3068132.436	1148.925	1148.925	318.921	0	259.2113	434a.190	light suspension tower type 434a	24.03
38	12345.46	-8110.619	-3068445.719	1150.875	1150.875	306.427	0	259.2113	434a.190	light suspension tower type 434a	24.03
39	12651.89	-8053.26	-3068746.73	1154.322	1154.322	314.894	20.1406	269.2816	434d 2kin.162	15-45deg Strain 434d 275kV	21.1
40	12966.78	-8104.43	-3069057.439	1155.576	1155.576	306.218	0	279.3519	434a.185	light suspension tower type 434a	23.53
41	13273	-8154.189	-3069359.587	1155.438	1155.438	363	0	279.3519	434a.190	light suspension tower type 434a	24.03
42	13636	-8213.176	-3069717.762	1156.877	1156.877	368	0	279.3519	434b 2kin.202	Self Supporting Suspension 434b 275kV	28.33
43	14004	-8272.975	-3070080.871	1157.604	1157.604	357.813	0	279.3519	434a.190	light suspension tower type 434a	24.03
44	14361.81	-8331.119	-3070433.928	1157.074	1157.074	336.187	0	279.3519	434a.200	light suspension tower type 434a	25.03
45	14698	-8385.748	-3070765.647	1155.709	1155.709	352.31	0	279.3519	434a.190	light suspension tower type 434a	24.03
46	15050.31	-8442.998	-3071113.274	1158.863	1158.863	358.797	0	279.3519	434a.195	light suspension tower type 434a	24.53
47	15409.11	-8501.302	-3071467.303	1159.661	1159.661	283.4	0	279.3519	434a.190	light suspension tower type 434a	24.03
48	15692.51	-8547.354	-3071746.936	1160.292	1160.292	0	0	279.3519	434c.182	0-15 deg angle strain tower type 434c	22.3

8 PRELIMINARY BOQ

Line:		**Ferrum - Garona 275kV line deviation**	
Lines quantities:		**Total**	**16.17 km**
Total No of towers:		**48**	
Suspension			
	434A	39	
	434B	3	
Total:		**42**	
Strain			
	434C	2	
	434D	4	
Total:		**6**	
Suspension Assemblies:		450	mm
I-susp assy		84	(120kN) I Susp Assy 4xxxxx 120kN 450mm CP/OP
V-susp assy		42	(120kN) V SUSP ASSY 4xxxxx 120kN 450mm
Strain Assemblies:		450	mm
Str assy		36	(120kN) STR ASSY 4xxxxx 120kN 450mm
Insulators:			
Composite 31mm/kV		204	(120kN)
Conductor:			
Conductor (km)		97.02	(2 x Bear)
Earth wire 1 (km)		16.17	(1x 19/2.7)
Earth wire 2 (km)		16.17	(1x 19/2.7)
Earthwire Assemblies: **NB: (OPGW quantities exluded)**			
Non ins EW susp assy		68	(19/2.7)
Ins EW susp assy		16	(19/2.7) 30-120kN_ESUS1-001
Non ins EW str assy		6	(19/2.7)
Ins EW str assy		6	(19/2.7) 30-120kN_ESTR1-001

9 TOWER OFF-SET POSITIONS

No tower offsets are required on this line.

10 TOWER ORIENTATION

All towers will be orientated about their bisectors. There are no special considerations regarding tower orientations required for this line.

11 GENERAL DISCUSSIONS

A line walk down will be carried out on the deviation to verify all the tower positions. All obstacles that could violate clearances or make the construction of this line difficult are noted and catered for in the final design.

From the preliminary profile, there is evidence showing that extensive vegetation clearing will required, especially at the Garona end of the deviation. This will be verified after the line walk down as this could have an impact on the EIA.

There is a pipeline in close proximity to the line, the exact positions will need to be confirmed so the necessary earthing design requirements are met.

12 CONSTRUCTABILITY

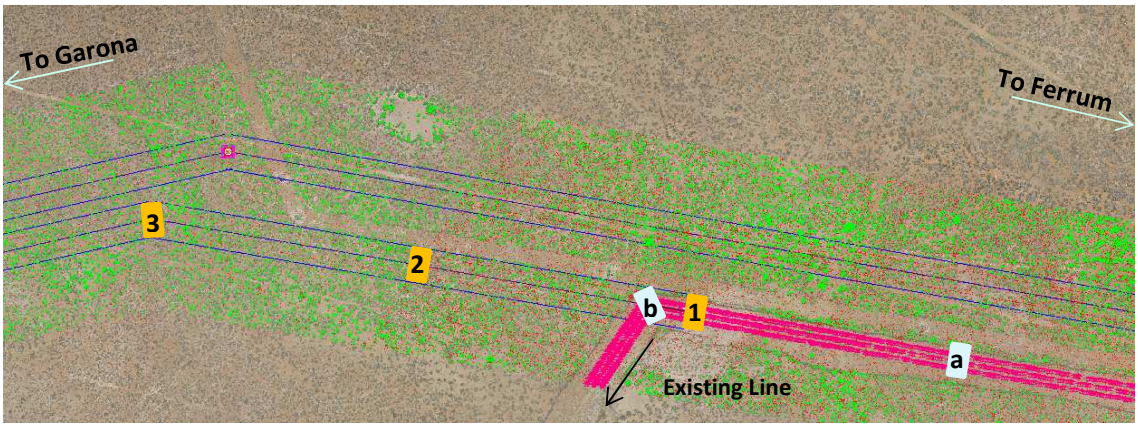
IDENTIFICATION OF ENGINEERING RISK

In terms of accessibility to towers, there is an existing access road since the new line runs parallel to the existing line for the entire line length. The terrain is fairly flat and easily accessible however, the area is very sandy and precautions will have to be taken when driving and working on the sandy surfaces.

At the Ferrum end of the deviation:

In order to make the tie-ins to the existing lines easier to construct, new strain towers (1, 2 and 3 in the Figure below) have been spotted such that the deviation extends until it is under the existing 275kV line. Outages will be required to complete the construction of the tower labelled 1 under the existing 275kV line. Construction of the legs and sections of the body of **tower 1** will take place before hand and on the day of the outage, the following work will need to be carried out:

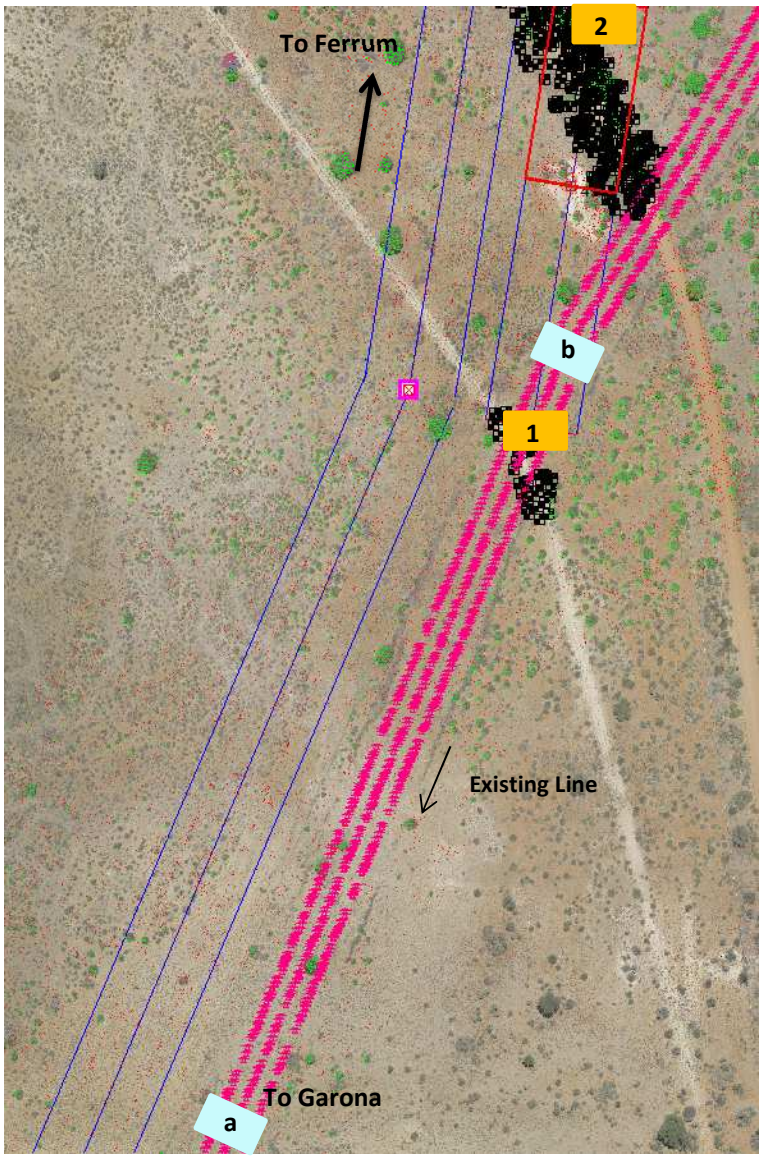
1. Back stay conductor from **tower a** towards **tower b** under outage conditions.
2. Drop conductor at **tower b** on both sides.
3. Complete tower erection for **tower 1**, while dismantling **tower b**.
4. Cut existing conductor to attach to **tower 1**, make off, regulate and tension existing conductor to the new **tower 1**.
5. Make off, regulate and complete stringing of new **tower 1** to the rest of deviation (**tower 2**).
6. Make off jumpers and complete deviation.



At the Garona end of the deviation:

Similarly, to ease the construction of the line, the new **towers 1** and **2** in the Figure below will be strain towers. During an outage, the following work will be carried out:

1. Back stay conductor from **tower a** towards **tower b** under outage conditions.
2. Drop conductor at **tower b** on both sides.
3. Complete tower erection for **tower 1**, while dismantling **tower b**.
4. Cut existing conductor from **tower b** to attach to **tower 1**, make off, regulate and tension existing conductor to the new **tower 1**.
5. Make off, regulate and complete stringing of new **tower 1** to the rest of deviation (**tower 2**).



13 CONCLUSION

The basic design parameters of the line are as follows:

- Design voltage: 275kV
- Twin (2x) Bear conductor
- 19/2.7 earthwire used
- Conductor templating at 50°C
- Composite insulators used with specific creepage of 31mm/kV
- Tower series used: 434A -E

Specific conditions about the line:

- Construction of the tie-in towers will have to be done under outage conditions.
- Line walk down will be required to ensure that most obstacles have been catered for.
- The clearing of vegetation under the line will need careful consideration as it may affect the EIA submissions.
- There is one major line crossing: Transnet railway crossing.
- Pipeline route will need to be confirm with the mine to verify earthing design.

14 APPENDIX A: TOWER TYPE DRAWINGS