Eskom	VOLUME 2 – Detailed Design Watershed 132kV Line diversions Project ID: – CTXQ0827	NED NWOU-AC Rev 0

INDEX

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1. Design Considerations

The design for the Watershed 132kV lines to be deviated is based on but not limited to normative statutory standards as well as Eskom Distribution standards. The design further prescribes to mandatory environmental standards as advised by such legislative frameworks.

1.1. Phase Conductor

The tensioning and stringing of the overhead conductor has been designed according to the wind load, maximum permissible tension and sag conditions. The conductors shall be strung, tensioned and handled in accordance with the following Eskom Standard: DST-34-1207 and SANS10280, where it is stated that the tension in the conductor shall be limited to 70% of UTS. The phase conductor to be used is Kingbird which shall be templated at 70°C and tensioned at a C-value not exceeding 1800, the closing spans shall be tensioned at a C-value not exceeding 425.

1.1.1. Mechanical Properties

Table V2.1: Mechanical properties

Description	Kingbird
Stranding and wire diameter	18/1/4.78
Overall diameter (mm)	23.88
Unit Weight (N/m)	10.08
Ultimate Tensile Stress (UTS) (kN)	71.32

1.1.2. Electrical Properties

Table V2. 2: Electrical Properties

Conductor	Thermal Limit	Current Rating (70° C)	
		Rate A	Rate B
Kingbird	Current (A): single	855	1088

1.2. Shield wire/OPGW Requirements

The shield wire to be used on this line shall be an OPGW for Watershed-Sephaku line and single phase Wolf conductor for the other lines. The planning fault levels for Watershed substation are as tabulated below:

Table V2.3: Substation Fault Levels

	Watershed(132kV)	
	Existing	New
1Φ	9.75 kA	8.65kA
3Φ	6.51	12.97

1.2.2.Mechanical Properties

The properties of the Wolf shield wire to be used are as follows:

Table V2. 4: Mechanical properties

Description	Wolf	16kA OPGW
Overall diameter (mm)	18.13	17.7
Unit Weight (kg/km)	730	663
Ultimate Tensile Stress (UTS) (kN)	69.2	60

The OPGW will be procured through the new Eskom national contract. The contractor responsible for OPGW installation will supply and install OPGW and all relevant hardware which shall conform to SANS specification and criteria. Proof of SANS certification shall be submitted to Eskom prior to OPGW installation. Over and above the OPGW requirements listed below, the contractor shall ensure that the OPGW fits the criteria set by the North West Operating Unit. The specification of the OPGW to be used will meet the set electrical and mechanical standards and specification for 16kA as discussed in the Eskom national contract. The detailed OPGW design and further instructions in this regard shall be done by NED, Control Plant.

The detailed Shielding design and further instructions in this regard shall be done by NED, Control Plant.

1.3. Burn-Off Times

The highest expected HV fault level at the Watershed Substation is the HV three phase of 12.97 kA on the 132kV bus bar. This fault level is used to calculate the burn off time for the Kingbird phase conductor, The Wolf and equivalent OPGW conductor.

Table V2. 5: Burn Off Times – Water shed, Single Kingbird

Type of fault	HV Fault Current (kA)	Burn Off Time (s)
Single phase fault	8.65	11.14
Three phase fault	12.97	4.95

Table V2. 6: Burn Off Times – Water shed, Single Wolf

Type of fault	HV Fault Current (kA)	Burn Off Time (s)
Single phase fault	8.65	5.051
Three phase fault	12.97	2.246

Table V2. 7Burn Off Times – Water shed, Single OPGW equivalent

Type of fault	HV Fault Current (kA)	Burn Off Time (s)
Single phase fault	8.65	0.52
Three phase fault	12.97	0.63

2. Line Earthing

In accordance with Eskom's Standard: Earthing of Transmission Line Towers, TRMASAAJ7 and Distribution Standard, Part 6, Section 6: Earthing of Transmission Line Towers SCSASABF9, the footing resistance of the first five structures from the substation on 66kV to 132kV lines shall be less than 20Ω. Should the footing resistance of the structures within 1km of the substation be less than 10Ω , then shield conductor jumper leads shall be fitted on strain structures only.

At terminal towers connected to a low profile substation, no shield wire is strung between substation terminal steelwork and the terminal structure. The Shield wire on the terminal structure shall be bonded to the steel structure. The three bases of 3-pole steel structure shall be connected together by means of 50x3mm copper strap, each with an 18mm diameter hole at the end, which is buried 600mm below ground level. The leg of the terminal tower shall be bonded to the main substation earth mat using a 50x3mm copper strap.

3. Structural Design

The structures to be used for the construction of the Kingbird 132kV lines from Watershed to Zeerust, Sephaku, Klerksdorp North, Makokskraal substation are as follows:

3.1. Structure Selection

Terminal structures

The 132kV Kingbird lines will be terminated with strain self-support at Watershed substation.

Intermediate structures

Where the line is relatively straight, the **Intermediate Structures D-DT-7617,** 3pole steel monopole structures will be used due to crossings.

Strain structures

Where the line deviates from 0°, a combination of **Strain Planted 3pole** stayed steel structures and self support monopole strain structures will be used for the different deviation angles ($2° < \theta < 90°$).

Please note:

The line has been simulated based on the latest criteria file which is in accordance with SANS 10280.

Monopoles steel structures are to be constructed in accordance with Eskom Distribution Specification: DSP-34-1683.
The contractor will be required to erect all structures. The types and quantities shall be as indicated in the staking table. The contractor shall adhere to the method statement of the pole manufacturer regarding jacking of structure member sections together. The contractor shall jack the sections together with the force specified by the pole manufacturer.

The orientation of stays/foundations is categorized as follows:

- **Intermediates** –inversely inline – i.e. foundation width must be inline thereby leaving foundation length to be transverse.

- **Angle Strains** – stays are to be positioned in the line deviation angle bisector to counter the resultant tension

- **Terminal Structures** – length of foundation must be Inline (longitudinal) to power line such that they counter the resultant tension of the line.

3.2 Abridged line data (Data according to PLS CADD)

Table V2.8 Line data

WATERSHED 132KV LINES DIVERSION - STAKING TABLE								
Structure Number	Ahead Span (m)	Line Angle (deg)	Structure Name	Structure Description	Struct. Height (m)	Embedded Length (m)	Crossing ahead	Crossing Label (Y/N)
	62.682	0	**WAT-ZEE 132kV-12m beam.106**	132kV S/S Gantry, 14.326m Columns & 12.129m Beam	14.326	0	None	N
1WAT/ZEE1	111.637	-90.2526	strsce9018kw110	132KV 90 deg 18m monopole self-support	18	0	None	N
1WAT/ZEE2	25.633	-47.1279	strsce4518kw110	132KV 45 deg 18m monopole self-support	18	0	None	N
1WAT/ZEE3	180.83	-42.654	strsce4518kw110	132KV 45 deg 18m monopole self-support	18	0	None	N
1WAT/ZEE4	169.266	0	7617a-k1-5w-r2.154	D7617 - 132kV 3-Pole Intermediate (0°)	18	2	88kV lines	Y
1WAT/ZEE5	154.183	-89.4609	7618d-k1-90-r2.134_tic	D7618 - 132kV Stayed 3-Pole Strain (5°-90°)	15.6	2.4	400kV lines	Y
1WAT/ZEE6	199.697	0	7617a-k1-5w-r2.134	D7617 - 132kV 3-Pole Intermediate (0°)	15.6	2.4	400kV lines and 11kV	Y
1WAT/ZEE7	160.926	-55.2376	7618c-k1-90-r2.134	D7618c - 132kV Stayed 3-Pole Strain (30°-60°)	15.6	2.4	132kV lines	Y
1WAT/ZEE8	105.722	53.5223	7618d-k1-90-r2.174_tic	D7618 - 132kV Stayed 3-Pole Strain (5°-90°)	19.6	2.4	None	N
	27.141	0	**WAT-TLH 132kV-12m beam.106**	132kV S/S Gantry, 14.326m Columns & 12.129m Beam	14.326	0		N
1WAT/TLH1	65.391	0	strsce0218kw110	132KV 02 deg 18m monopole self-support	18	0	None	N
1WAT/TLH2	171.325	-90.2468	strsce9018kw110	132KV 90 deg 18m monopole self-support	18	0	None	N
1WAT/TLH3	68.195	-47.2141	strsce4518kst110	132KV 45 deg 18m monopole self-support	18	0	None	N
1WAT/TLH4	31.487	-42.8959	strsce4518kw110	132KV 45 deg 18m monopole self-support	18	0	None	N
	27.927	0	**WAT-KLN 132kV-12m beam.106**	132kV S/S Gantry, 14.326m Columns & 12.129m Beam	14.326	0		
1WAT/KLN1	54.014	23.6119	strsce4518kw110	132KV 45 deg 18m monopole self-support	18	0	None	N
	30.111	0	**WAT-SEP 132kV-12m beam.106**	132kV S/S Gantry, 14.326m Columns & 12.129m Beam	14.326	0		
1WAT/SEP1	78.179	35.0743	7618c-k1-90-r2.134	D7618c - 132kV Stayed 3-Pole Strain (30°-60°)	15.6	0	88kV lines	Y

3.3. Hardware & Assemblies

Assemblies must comply with the code of practice for overhead lines for conductors prevailing in South Africa, SANS 10280. In all other cases standard hardware based on Distribution Standards will be used. According to SANS 10280, the strain assembly should have a strength value of at least the breaking point of the conductor or ground wire. Kindly refer to drawings in the assembly section of this document for illustrations of the strain, closing span and suspension assemblies.

Joints

All joints shall be done in accordance with the Eskom Standard: DST-34-1207 section 4.7.

Insulators

- Insulator options are to be determined as per the Distribution Standard Specification and the information provided in the buyer's guide.
- Horizontal Post and long rod insulators have been specified for this project. All insulators shall have a creepage distance of 31mm/kV.
- The minimum cantilever load for post insulators shall be 5.3kN
- Long rod insulators have been specified for all strains. These shall comply with IEC 60120 and shall be supplied complete with ball and socket end fittings. The minimum failing load shall be 120kN.
- Insulators are to be handled strictly in accordance to SCSAGAAR0 such that no damage is sustained on the insulator as this may cause failure at a later stage.

Basic Insulation Level (BIL)

The rated insulation withstand levels for lightning and switching impulse for 132kV is 550kV (peak) and the rated short time power frequency withstand is 230kV (rms). These are specified in the Eskom Distribution Specification DSP-34-2202 and are also in accordance with standard values in SANS 60273.

Jumpers

Jumpers shall be made to provide the minimum amount of clearance from the earthed hardware and steel work. Their positioning shall comply with the clearance stated under the specified displacements.

Vibration Dampers

Damping devices are installed to reduce Aeolian Vibration that may damage the conductor and associated hardware. These vibrations are most commonly caused by wind. It is advised that lines built in known high wind density areas or close to large masses of water should be fitted with vibration dampers. Multi frequency Vibration Dampers have been specified for this line, these should be fitted on all spans in accordance with the Eskom Specification: DSP-34-1204.

Position of dampers:

To determine the number of multi frequency vibration dampers required:

Table V2. 9: – Number of dampers required

1	2	3	4
Span (m)	**Number of dampers per span per conductor**	**Arrangement of dampers per conductor**	**Damper placement**
0 to 369	2	1 damper at each end	0.7 x L from ends
370 to 550	4	2 dampers at each end	0.6 x L from 1st dampers
551 to 730	6	3 dampers at each end	0.9 x L from 2nd dampers
731 to 1000	8	4 dampers at each end	1.2 x L from 3rd dampers*
1001 to 1250	10	5 dampers at each end	1.5 x L from 4th dampers*
1251 to 1500	12	6 dampers at each end	1.8 x L from 5th dampers*

**: These are all assumptions*

Position of dampers on the span:

The following equation shall be used to determine the position of installation of the damper onto the span:

$$F_C = \frac{0.185 * V}{D} \quad \text{in Hz} \quad (1)$$

$$L = \frac{1}{2 * F_C} * \sqrt{\frac{H}{W}} \quad \text{in m} \quad (2)$$

$$L = \frac{2.703}{V} * D * \sqrt{\frac{H}{W}} \quad \text{in m} \quad (3)$$

$$C = \frac{H}{W} \quad (4)$$

Where,
- F_c is the critical frequency (frequency giving rise to shortest loop length)
- L is the loop length, (m)
- V is the wind speed perpendicular to the conductor, (m/s)
- D is the conductor diameter, (m)
- H is the conductor tension, (N)
- W is the conductor mass per unit length, (kg/m)

The position of the damper is measured from the point of contact between the dead end or suspension hardware and the conductor. A damper is placed on each end of the span at a distance of 70% of the loop length, i.e. 0.7xL.

For **phases** strung with **Kingbird conductor**

Table V2. 10: Kingbird Conductor Data

Conductor Type	Kingbird
Diameter, mm	23.90
Wind Velocity, m/s	4
Mass per unit length, kg/km	1038
Tension UTS, N	71320

Where no wind speed data is available, 4m/s may be used to calculate the loop length and critical frequency. For this project the default of 4m/s was used for calculating the loop length.

Table V2. 11: Damper positions for Kingbird conductor

Diameter (mm)	**Wind Velocity** (m/s)	**Mass** (kg/km)	**Tension (20% of UTS)** (N)	**Critical Frequency** (Hz)	**Loop Length** (m)	**Damper from end fittings**
23.90	4	1038	14264	30.96	1.89	1.32

Table V2.12 Number of multi-frequency vibration dampers needed for kingbird conductor per phase and per span according to profile

Structure Number	Ahead Span (m)	Line Angle (deg)	Structure Name	Structure Description	Conductors per phase	Number of dampers per phase for span	Total number of dampers per span
	62.682	0	**WAT-ZEE 132kV-12m beam.106**	132kV S/S Gantry, 14.326m Columns & 12.129m Beam	Single	0	0
1WAT/ZEE1	111.637	-90.2526	strsce9018kw110	132KV 90 deg 18m monopole self-support	Single	2	6
1WAT/ZEE2	25.633	-47.1279	strsce4518kw110	132KV 45 deg 18m monopole self-support	Single	2	6
1WAT/ZEE3	180.83	-42.654	strsce4518kw110	132KV 45 deg 18m monopole self-support	Single	2	6
1WAT/ZEE4	169.266	0	7617a-k1-5w-r2.154	D7617 - 132kV 3-Pole Intermediate (0°)	Single	2	6
1WAT/ZEE5	154.183	-89.4609	7618d-k1-90-r2.134_tic	D7618 - 132kV Stayed 3-Pole Strain (5°-90°)	Single	2	6
1WAT/ZEE6	199.697	0	7617a-k1-5w-r2.134	D7617 - 132kV 3-Pole Intermediate (0°)	Single	2	6
1WAT/ZEE7	160.926	-55.2376	7618c-k1-90-r2.134	D7618c - 132kV Stayed 3-Pole Strain (30°-60°)	Single	2	6
1WAT/ZEE8	105.722	53.5223	7618d-k1-90-r2.174_tic	D7618 - 132kV Stayed 3-Pole Strain (5°-90°)	Single	2	6
	27.141	0	**WAT-TLH 132kV-12m beam.106**	132kV S/S Gantry, 14.326m Columns & 12.129m Beam	Single	0	0
1WAT/TLH1	65.391	0	strsce0218kw110	132KV 02 deg 18m monopole self-support	Single	2	6
1WAT/TLH2	171.325	-90.2468	strsce9018kw110	132KV 90 deg 18m monopole self-support	Single	2	6
1WAT/TLH3	68.195	-47.2141	strsce4518kst110	132KV 45 deg 18m monopole self-support	Single	2	6
1WAT/TLH4	31.487	-42.8959	strsce4518kw110	132KV 45 deg 18m monopole self-support	Single	2	6
	27.927	0	**WAT-KLN 132kV-12m beam.106**	132kV S/S Gantry, 14.326m Columns & 12.129m Beam	Single	0	0
1WAT/KLN1	54.014	23.6119	strsce4518kw110	132KV 45 deg 18m monopole self-support	Single	2	6
	30.111	0	**WAT-SEP 132kV-12m beam.106**	132kV S/S Gantry, 14.326m Columns & 12.129m Beam	Single	0	0
1WAT/SEP1	78.179	35.0743	7618c-k1-90-r2.134	D7618c - 132kV Stayed 3-Pole Strain (30°-60°)	Single	2	6

Vibration dampers on the shield wire

Table V2. 13: Table V2.11 – 12kA OPGW Data

Conductor Type	16.1kA OPGW
Diameter, m	0.017
Wind Velocity, m/s	0.5 to 7 (Average 4m/s)
Mass per unit length, kg/m	663
Tension UTS, N	60000
Conductor tension (20% UTS)	12000

$F_C = 43.53Hz$ and $L = 0.049m$

Table V2. 14: Damper positions

Span (m)	**Number of dampers per span per conductor**	**Arrangement of dampers per conductor**	**Damper placement**
115 to 250	2	1 damper at each end	100mm from hardware
251 to 500	4	2 dampers at each end	100mm from 1st dampers
501 to 750	6	3 dampers at each end	100mm from 2nd dampers
751 to 1000	8	4 dampers at each end	100mm from 3rd dampers*
1001 to 1250	10	5 dampers at each end	100mm from 4th dampers*
1251 to 1500	12	6 dampers at each end	100mm from 5th dampers*

Table V2.15 Number of multi-frequency vibration dampers needed for wolf conductor (shield wire) per phase and per span according to profile

Structure Number	Ahead Span (m)	Line Angle (deg)	Structure Name	Structure Description	Conductors per phase	Number of dampers per phase for span	Total number of dampers per span
	62.682	0	**WAT-ZEE 132kV-12m beam.106**	132kV S/S Gantry, 14.326m Columns & 12.129m Beam	Single	0	0
1WAT/ZEE1	111.637	-90.2526	strsce9018kw110	132KV 90 deg 18m monopole self-support	Single	2	2
1WAT/ZEE2	25.633	-47.1279	strsce4518kw110	132KV 45 deg 18m monopole self-support	Single	2	2
1WAT/ZEE3	180.83	-42.654	strsce4518kw110	132KV 45 deg 18m monopole self-support	Single	2	2
1WAT/ZEE4	169.266	0	7617a-k1-5w-r2.154	D7617 - 132kV 3-Pole Intermediate (0°)	Single	2	2
1WAT/ZEE5	154.183	-89.4609	7618d-k1-90-r2.134_tic	D7618 - 132kV Stayed 3-Pole Strain (5°-90°)	Single	2	2
1WAT/ZEE6	199.697	0	7617a-k1-5w-r2.134	D7617 - 132kV 3-Pole Intermediate (0°)	Single	2	2
1WAT/ZEE7	160.926	-55.2376	7618c-k1-90-r2.134	D7618c - 132kV Stayed 3-Pole Strain (30°-60°)	Single	2	2
1WAT/ZEE8	105.722	53.5223	7618d-k1-90-r2.174_tic	D7618 - 132kV Stayed 3-Pole Strain (5°-90°)	Single	2	2
	27.141	0	**WAT-TLH 132kV-12m beam.106**	132kV S/S Gantry, 14.326m Columns & 12.129m Beam	Single	0	0
1WAT/TLH1	65.391	0	strsce0218kw110	132KV 02 deg 18m monopole self-support	Single	2	2
1WAT/TLH2	171.325	-90.2468	strsce9018kw110	132KV 90 deg 18m monopole self-support	Single	2	2
1WAT/TLH3	68.195	-47.2141	strsce4518kst110	132KV 45 deg 18m monopole self-support	Single	2	2
1WAT/TLH4	31.487	-42.8959	strsce4518kw110	132KV 45 deg 18m monopole self-support	Single	2	2
	27.927	0	**WAT-KLN 132kV-12m beam.106**	132kV S/S Gantry, 14.326m Columns & 12.129m Beam	Single	0	0
1WAT/KLN1	54.014	23.6119	strsce4518kw110	132KV 45 deg 18m monopole self-support	Single	2	2
	30.111	0	**WAT-SEP 132kV-12m beam.106**	132kV S/S Gantry, 14.326m Columns & 12.129m Beam	Single	0	0
1WAT/SEP1	78.179	35.0743	7618c-k1-90-r2.134	D7618c - 132kV Stayed 3-Pole Strain (30°-60°)	Single	2	2

4. Civil Design

4.1. Foundation Selection

It should be noted that a detailed geo-technical survey was not conducted for this line. An estimation, as a base for the design of the soil conditions was made as (i.e. 80% Type3 and 20% Type Rock). The foundation nominations will be done by the contractor during construction; these should be signed off by a professionally registered civil engineer to be appointed by the contractor. In the event that a certain Eskom standard foundation is not found adequate for the apparent site conditions, it remains the responsibility of the contractor to recommend the appropriate one. The foundation schedule is attached as an annexure to this document.

5. Construction Notes

All precautionary measures must be exercised to ensure safety during the construction phase. The authorised person shall be on site during construction to ensure safety measures are adhered to at all times. The line is to be built in accordance with TRMSCAAC1 Transmission Line Towers and Line Construction as well as Construction Regulations and OHS Act 85 of 1993, in which the responsibilities of the designer and those of the contractor are discussed. The SHE spec has also been included as part of this report, and outlines possible risks and mitigation actions that are to be taken on site. It will cover all road crossings, river crossings, sensitive environmental areas, which are some of the issues on this line.

The contractor shall be responsible for but not limited to:

Establish and maintain the necessary Site Offices and facilities.

- Communicate with all landowners along the line route advising them of work done and the contractors' presence.
- Drill or excavate all foundations for the new structures and reinstate on completion of foundation installation.
- Pending Procurement's contract strategy the following shall be determined to be supplied at the new engineering contracts meeting:
    - All foundation materials and transport of such materials to site.
    - Supply and install formwork as required/specified by the Geotech.
    - Supply, layout, assemble and erect all structures as specified.
- String, join, make off, regulate, clamp in and install jumpers on all phase and shield wire conductors. Install vibration dampers as per specification.
- Complete all quality documentation and mark up any changes to drawings.
- Clear and de-establish the total site.

- Liaise with property owners to obtain Clearance Certificates on completion of the contract.

- Provide the employer with completed contract documentation, including ‘As Built’ drawings.

- Construction may not commence unless the contractor has a valid statutory approval from the municipality and adheres to all approval conditions.

5.1. Construction notes on Structure Erection:

Ensure that precautionary measures are exercised to avoid structures from falling onto any live 11kV/22kV/132kV lines.

5.2. Construction notes on Stringing

The crossings of the 132kV lines and other MV lines are some of the areas where the contractor should have a systematic approach/method statement in order to minimise outages and to mitigate the associated risks; details will be covered in the Implementation Plan which will be finalised once the contractor has been appointed and once the necessary outages have been approved. Where major roads are crossed, the traffic department must be contacted by the contractor to ensure traffic control during this time.

5.3. Construction notes on Foundations

It must be emphasized that the foundations should be selected to take the maximum load on specified orientation; for strain structures, stay foundations must be positioned in the line’s deviation angle bisector according to the stay layout.

5.4. Construction notes on Earthing/Shielding

All structures (including intermediates) will be earthed, should any railways or underground pipes exist within 800m of the line; the shield-wire shall be insulated from the structures. The strain plate to be used shall be designed for 120kN.

6. Access Roads

Access roads are to be managed as per Section 4.4 of the TRMSCAAC1 standard.

It must not be an expectation of the Contractor that the route of the power line is directly and continuously accessible by vehicle from tower to tower. It will be necessary to divert away from the line route to access further tower positions via the existing road and path networks. It is preferred that the Contractor uses the existing roads and paths as far as is practicable and his equipment allows. The existing tracks shall be jointly inspected prior to their use and their condition recorded and mutually agreed upon by the Contractor and the owner.

Where there are no existing roads or paths, it is preferred that the access be established by vehicles passing over the same track on natural ground. Should there be any compelling need to create any access road; such need shall be raised in conjunction with the client’s Project Engineer as well as the

client's Environmental Control Officer, prior to a decision being made. No new roads shall be constructed without Eskom's prior written instruction.

Road widths shall be restricted to 4m in extent unless a specific need for a greater width arises, in which event Eskom's prior approval is required. In the event of any access roads passing through bush areas that require clearing, such bush and/or tree stumps are to be cut to ground level. The de-stumping of trees will not be accepted. If any bush clearing is necessary, the environmental officer for the project shall be contacted before any bush clearing is done.

Servitude gates are only to be installed when required as per Section 4.5 (b) of TRMSCAAC1 standard. On completion of the project, the contractor shall obtain written acceptance from the Project Manager that the working area has been cleared and left to his satisfaction.

7. Testing and Commissioning

The information below should be read in conjunction with point 25 "Commissioning and Operational Acceptance" in Section VII: General Condition of the tender document.

Definitions

- Commissioning procedures: The documented method whereby the Contractor shall ensure that the installation is constructed in accordance with the requirements of the applicable manufacturers' specifications, employer's specification, design regulations and codes of practice.

- Performance tests: The physical testing in the manufacturing works or on site of the equipment or systems as needed to demonstrate the ability to reach the performance levels specified or required.

- Acceptance tests: The physical testing and inspection on site of the system or sub-system to show that it is supplied installed and operates generally in accordance with the specifications, design and regulations.

Commissioning

The Contractor shall supply, as part of the Enquiry Documentation and for approval before implementation, the commissioning procedures to be used on the project. The commissioning procedure will cover in detail all the major items of equipment sub-systems of the works. The procedures must allow for the recording in writing and the signing off by a qualified person in terms of applicable regulations for any inspections or tests made in accordance with the procedures. The records and signed document will form part of the as-built records.

Performance Tests

Where required in terms of the commissioning procedure, specification or an instruction, a supplier or Contractor shall carry out on site or at the manufacturer's premises, performance tests on selected equipment or portions of the works. Type test certificates in accordance with appropriate standard specifications will be accepted as performance tests unless otherwise specified.

On-site performance tests will always be carried out on the following:

- Voltage with-stand tests of all overhead line systems.
- Earth continuity and resistance.
- Polarity and phase rotation of three phase circuits.
- Rigidity of all fastenings.
- Concrete cube strength tests

The results of all tests shall be recorded in writing by the Contractor. Only a representative sample of performance tests on site will be witnessed.

Acceptance Tests

Acceptance tests will be carried out in terms of the commissioning procedure. On completion of acceptance tests, a test certificate shall be signed by the Contractor and taking-over authority to the effect that the tests specified on the certificate have been completed successfully.

Responsibility of Contractor

The Contractor shall provide not less than seven days' notice in writing of all performance and acceptance tests so that they may be witnessed if considered necessary. Notwithstanding the attendance at or failure to attend performance or acceptance tests by any witness, the Contractor is responsible for the correctness of the installation in terms of the manufacturers' requirements, the design and specification and applicable regulations and for the preparation of a written record of the tests and test results.

8. Salient Points of the Line Design

Table V2. 16: Salient points of the line design

Conductor	Single Kingbird conductor, templated at 70 degrees
Maximum Fault level	1ϕ 9.75kA, 3ϕ 12.97kA
Shield wire	Wolf shield wire and OPGW for water shed sephako
Earthing	Footing resistance values shall be obtained as per Eskom Earthing standards. All terminal structures shall be bonded to the substation's earth mat as specified in the Eskom standard SCSASABF9.
Length	Watershed-Sephaku 132kV = 110m Watershed-Klerksdorp North 132kV = 85m Watershed-Makokskraal 132kV = 310m Watershed-Zeerust 132kV = 1.1km.
Insulators	Long-rod and post insulators used on this line shall have a Creepage of 31mm/kV
Structures	Steel monopole (self-support 7645 pole top config, D-DT-7617, D-DT-7618)
Foundations	Soil and foundation nomination shall be approved by a registered civil engineer (the ones attached in this document are only assumed)

9. Legal Requirements

Clearances

The line profiles for the 132kV line will satisfy the clearances given in the Occupational Health and Safety Act, Act No. 85 of 1983 (OHSA) detailed in the following table. Refer to the Construction Handbook for the minimum vertical clearances of power lines at maximum sag and swing.

Table V2. 17: Minimum Safety Clearances

Description	Clearances (m)
Safety Clearance:	
Phase to Ground	1.45
Phase to Phase	1.65
Vertical Clearances:	
Outside townships	6.3
Inside townships	6.3
Roads in townships or proclaimed roads outside townships	7.5
To buildings, poles and structures not forming part of the power line	3.4
Other power lines	2.0
Telephone lines – Angle of crossing from right angle	30º
Telkom – Telephone lines	2.0
Spoornet – non-electrified railways (Single Power Line)	10.4
Spoornet – electrified railways (Multiple Crossing)	12.4

10. Environmental Considerations

Land rehabilitation must be done to cover all damages done on the ground surface due to construction work. All damage done to paving must be rehabilitated. The SHE spec and EMP which will form part of this document will cover mitigation actions to be taken should the following environmental issues arise: oil spillage, damage or removal of any plants or trees, fires etc

11. References used in the Design

TRMSCAAC1: Transmission Line Towers and Line Construction standard

OHS Act: Occupational, Health and Safety Act and regulations (Act No.85 of 1993)

DST-34-1207: Eskom Standard on Sub-transmission lines Section 2: Conductors

DSP34-510: Eskom Distribution Specification – Part 6: Outdoor Post and Long rod insulators or new and refurbished power lines for 66kV and 132kV

DSP-34-2202: Eskom Specification: Outdoor Ceramic Post insulators for Systems with nominal voltages up to 765kV

SCSASABF9: Eskom Distribution Standard: Sub-transmission lines, Section 6: Earthing of sub-transmission line structures

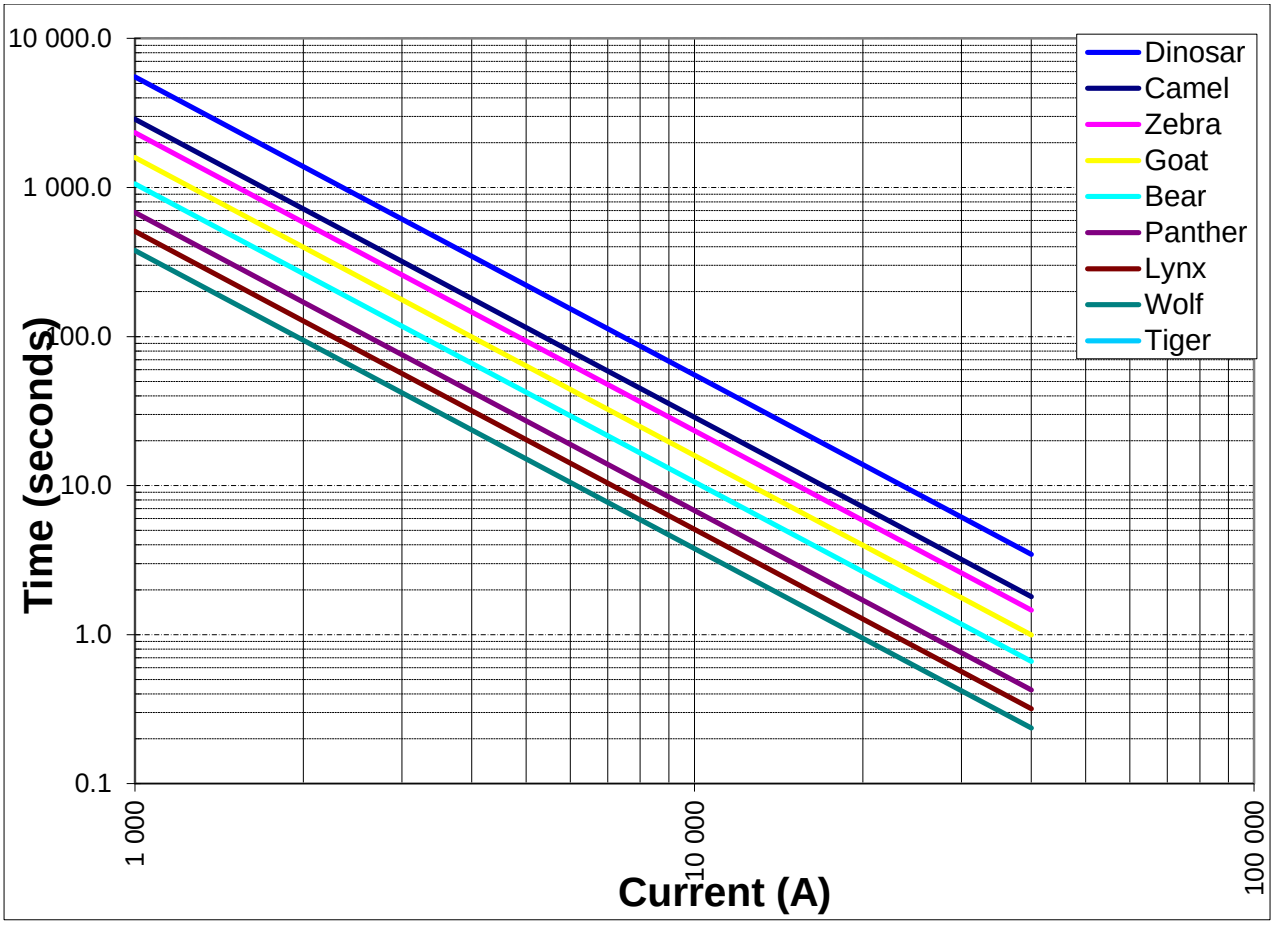
DISASABL1: Eskom Distribution Standard: Sub-transmission lines, Section 3: Insulators

DSP-34-1204: Eskom Standard: Sub-transmission lines Section 4: Vibration Dampers

SCSASABK8: Eskom Distribution Standard Part 6: High Voltage lines, section 5: soil compaction for stay and pole foundations

ANNEXURE A

CONDUCTOR BURNOFF TIMES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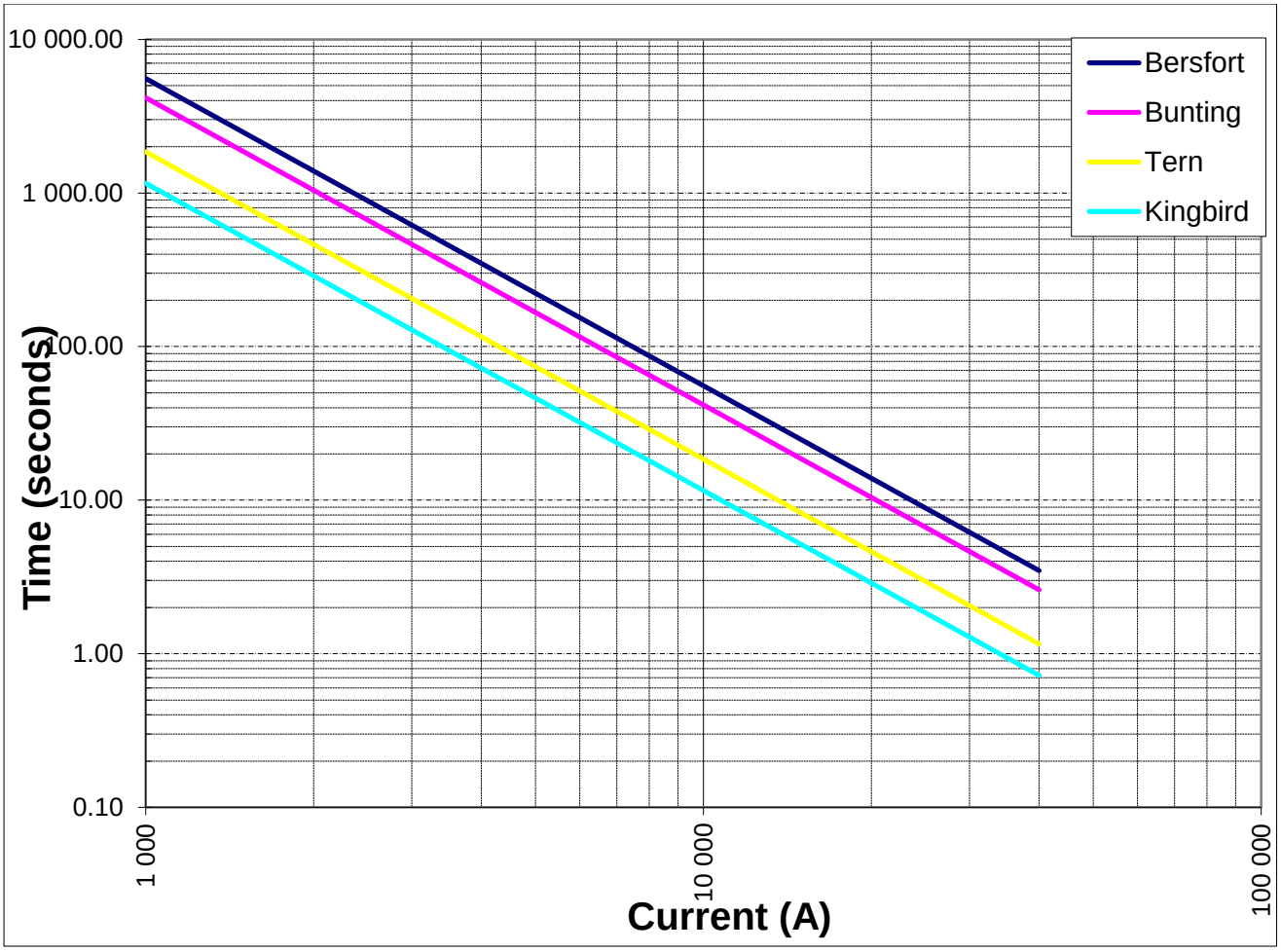
Goat
Bear
Panther
Lynx
Wolf
Tiger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Current (A)
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Bunting
Tern
Kingbird