

	Report	Transmission
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Title: **EVEREST - MAKALU 275KV
TOWER 237 – PERMANENT
SOLUTION-SCOPE OF WORK**

Unique Identifier: **240-47411023**

Alternative Reference Number: **LES1335**

Area of Applicability: **Engineering**

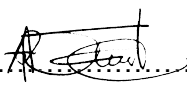
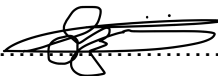

Documentation Type: **Report**

Revision: **3**

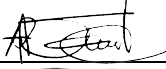


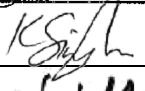

Total Pages: **18**

Next Review Date: **N/A**

Disclosure Classification: **CONTROLLED
DISCLOSURE**

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Date: 01/10/2021	Date: 04/10/2021	Date: 06/10/2021

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1. INTRODUCTION

On the 13th of December 2020, the Everest - Makalu 275 kV line tripped and locked out. A team was dispatched on the same day to patrol the line and the patrol was called off at midnight without locating the fault for safety reasons. The patrol was resumed on the next day (14th December 2020). Tower 237 was found to have totally collapsed and conductors were on the ground. Lines Engineering Services was notified and a site visit for failure assessment was arranged. Following the Line Engineering Services site visit a failure investigation report was produce by Line Engineering Services with three options.

Following the site visit conducted by LES, the site findings revealed the following:

- Tower 237 had buckled on the main legs and totally collapsed on the side with two phases (this is a delta configuration tower, KV/10 two phases on one side and one phase on the other side)
- There was minor damage on the conductors, due to the configuration of the tower which prevented the conductor from making contact with the structure.
- Minor damage was noted on the earth wire. Multiple damage areas were noted on the ADSS cable, and the cable is currently not functional.
- Damage on the earth peak of tower 238 was noted.



Figure 1.1: Tower 237 - Collapsed



Figure 1.2: Tower 238 – Damaged Earthpeak

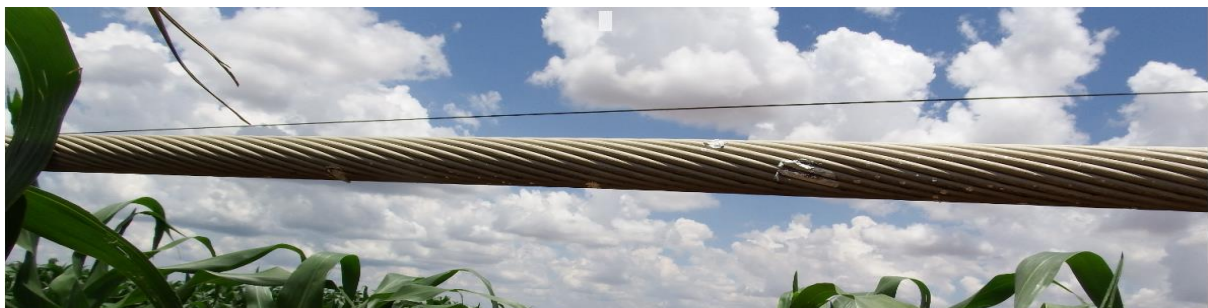


Figure 1.3: Minor conductor damage between T236 and T237

Two temporary ERS (KEMA) towers were installed to recover the line at the shortest possible time. The line is back to operation as of 24 December 2020.

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Figure 1.4: Two KEMA (ERS) towers installed

1.1 APPLICABILITY

This document shall apply for this project only.

1.2 NORMATIVE/INFORMATIVE REFERENCES

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

1.3 NORMATIVE

- [1] 240-105015449, Live line risk assessment and fall protection plan
- [2] 240-47172520 - TRMSCAAC6, The Standard for The Construction of Overhead Powerlines
- [3] 240-147502360 - Everest - Makalu 275kV Line T237 Staking Table Rev B (LES1330)
- [4] 240-95118949 - BOM - Everest Makalu 275kV Permanent Solution (LES1337)

1.4 INFORMATIVE

- [5] 32-846, Eskom Operating Regulations for High Voltage System (ORHVS)

2. DEFINITIONS AND ABBREVIATIONS

2.1 DEFINITIONS

Term	Definition
Construction work	The erection, maintenance, alteration, renovation, repair, demolition or

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	dismantling of or addition to a building or any similar structure
	The installation, erection, dismantling or maintenance of a fixed plant where such work includes the risk of a person falling
	The construction, maintenance, demolition or dismantling of any bridge, dam, canal, road, railway, runway, sewer or water reticulation system or any similar civil engineering structure
Contractor	An employer who performs construction work and includes principal contractors

3. ABBREVIATIONS

Term	Definition
LES	Lines Engineering Services
SOW	Scope of Work
PPE	Personal Protective Equipment
OHS Act	Occupational Health and Safety Act

4. HEALTH AND SAFETY

- Safe Working Procedures
- Personal Protective Equipment (PPE) as marked below.
- Prevention/mitigation measures
- Emergency procedures
- Covid – 19 safety regulations
- Access

														
O/all	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

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5. SCOPE OF WORK

5.1 EVEREST - MAKALU LINE DETAILS

The Everest – Makalu 275 kV line was constructed from 1956 to 1978. The line is 183.34 km long and is located in the Free State between Welkom (Everest Substation) and Sasolburg (Makalu Substation). The line was designed using KV/10 (A, B, C, D, and Z) tower series. The towers being utilized on the line is the KV/10 series (376 towers) and 430 series (77 towers). The conductor bundle on the line is Twin Goat with a single earthwire + ADLash. Table 5.1 summarizes the line details.

Table 5.1: Summary of Line Details

Line details	
Line name	Everest - Makalu 275 kV
Construction completion year	1956 (KV/10) and 1978 (430)
Line length	183.3 km
Voltage	275 kV
Structure types	85% of line uses KV/10 while 15% uses 430 structures
Conductor	85% of line uses twin Goat while 15% uses twin Zebra
Ground wire	19/2.65 + 19/2.65 with ADLash

5.2 PROJECT SCOPE

The scope of the project entails the replacing of the collapsed tower 237 with a new 424A tower, installation of 16 kA OPGW between tower 233 and 241, replacing the damaged earth peak on tower 238 and dismantling the KEMA (ERS) towers. Table 5.2 shows a summary of the project scope.

Table 5.2: Scope Summary

Item number	Scope	Action by	Comments
1	Survey, pegging of new T237 foundations	Eskom/contractor	As per staking table
2	Installation of new T237 foundations	Contractor	As per design
3	Supply and assembly new T237 tower-type 424A	Contractor	As per design
4	Procurement of: <ul style="list-style-type: none"> Glass insulators OPGW 	Eskom	Use prepared BOM

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	<ul style="list-style-type: none">OPGW hardware		
5	Phase conductor hardware	Contractor	
6	Erection of new 424A tower	Contractor	
7	Disconnect phase and earthwire from KEMA and connect to new 424A tower	Contractor	
8	Replace earthpeak on tower 238	Contractor	
9	String, regulate and clamp in new OPGW from tower 233 to 241	Contractor	
10	Decommission KEMA towers	Contractor	

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Replacing tower 237 (KV/10) with new tower 424A.

A single 424A tower shall be supplied and installed by the contractor. The following is a list of activities that will be done on site by the contractor:

- Removal of old grillage foundations (steel grill foundation) on collapsed tower 237.
- Design of Soil Type 3 foundations for new 424A tower according to TRMSCAAC 6. Contractor to confirm the soil type on site.
- Installation of foundations including all necessary tests
- Supply and delivery to site of a new 424A tower.
- Assemble of the 424A tower. The tower needs to be assembled under and in between the existing conductors
- The 424A suspension tower to be erected such that the conductors do not need to be dropped to the ground – 424A.
- Installation of shackles and stubs. Legs are approximately 7m in length, contractor to confirm.
- •Installation of anti-climb ,
- Dressing of tower 237 with new phase assemblies and OPGW assemblies
- Removal of phase conductors from the KEMA towers to the new tower 424A.
- Installation of spacers or vibration dampers and dampers on phase conductors.
- Installation of dampers on earth conductors.
- Supply and install new labels for tower 237.

The contractor will submit safe working procedures for all activities to LES for acceptance prior to any work commencing.

5.2.1 Replacing damaged earth peak on tower 238

The earthpeak on tower 238 has been damaged and needs to be replaced. The earthpeak from tower 237 (if in good condition) will be used to replace the damaged earthpeak on tower 238. The earthpeak is at Everest Substation.

5.2.2 Installation of 16 kA OPGW between tower 233 and 241

OPGW will be strung from tower 233 to 241. Table 5.4 details tower information for the Everest Makalu 275 kV line from tower 233 to 241.

Table 5.3: Tower details from 233 to 241

Line details	Tower number	bend	Tower type	Towers
EVE/MAK	233	N	KV/10	A
EVE/MAK	234	N	KV/10	A
EVE/MAK	235	N	KV/10	A
EVE/MAK	236	N	KV/10	A
EVE/MAK	237	N	New 424	A
EVE/MAK	238	N	KV/10	A
EVE/MAK	239	N	KV/10	A
EVE/MAK	24	N	KV/10	A
EVE/MAK	240	N	KV/10	A
EVE/MAK	241	N	KV/10	A

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Table 5.4: Spans from 233 to 240

Line details	Tower from	Tower to	Span length
EVE/MAK	233	234	435
EVE/MAK	234	235	432
EVE/MAK	235	236	442
EVE/MAK	236	237	447
EVE/MAK	237	238	442
EVE/MAK	238	239	454
EVE/MAK	239	240	441
EVE/MAK	240	241	439

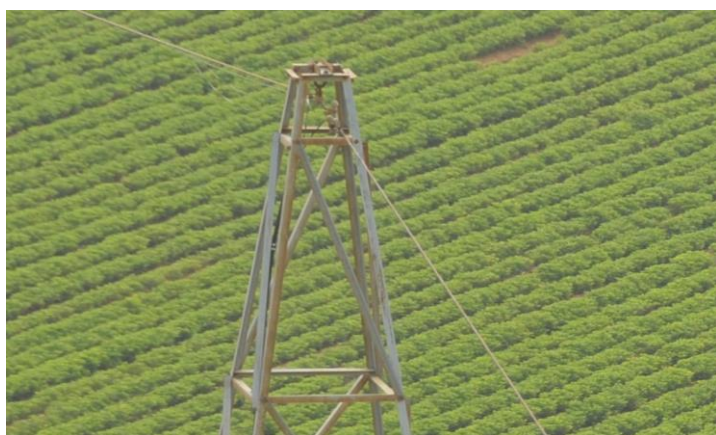


Figure 5.1: Tower 233 peak showing existing joint box position where ADLash goes down the tower.



Figure 5.2: Tower 241 where existing joint box is.

The scope is to install new 16 kA OPGW between existing joint positions which are at tower 233 and 241. At these towers, the new OPGW will come down the tower and be spliced into a new joint box. The existing joint box will be removed and the existing one side of old ADLash fibre will be re-spliced into the new joint box at towers 233 and 241.

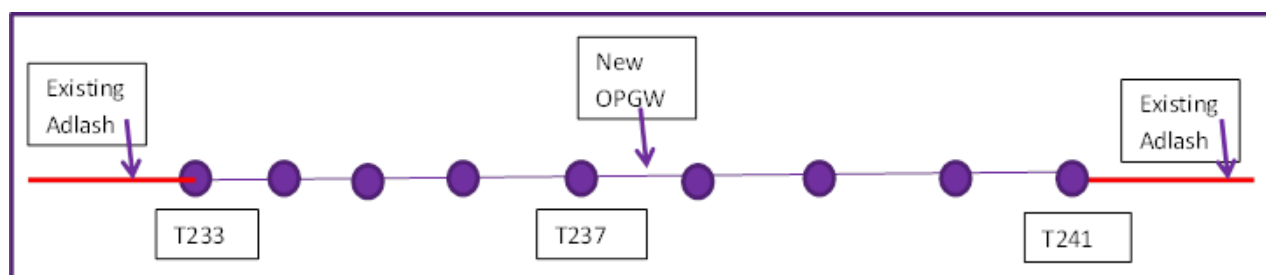


Figure 5.2: The line diagram for the new OPGW and existing ADLash

At towers 233 the ADLash from tower 232 will be spliced into the new joint box. At tower 241, the ADLash from tower 242 will be joined into the new joint box.

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Table 5.5: Assemblies per tower

Line details	Tower number	Joint position	Tower type	Suspension	Assembly	COMMENTS
EVE/MAK	233	Y	KV/10	Yes	FNISTA DST	one side to have preformed deadend for OPGW, other side to accommodate deadend for steel 19/2.7 earthwire, supplied also with chainlink
EVE/MAK	234		KV/10	Yes	FNISUA	with tongue oval eye to accommodate u-bolt on existing landing late
EVE/MAK	235		KV/10	Yes	FNISUA	with tongue oval eye to accommodate u-bolt on existing landing late
EVE/MAK	236		KV/10	Yes	FNISUA	with tongue oval eye to accommodate u-bolt on existing landing late
EVE/MAK	237		424A	Yes	FNISUA	with twisted tongue oval eye
EVE/MAK	238		KV/10	Yes	FNISUA	with tongue oval eye to accommodate u-bolt on existing landing late
EVE/MAK	239		KV/10	Yes	FNISUA	with tongue oval eye to accommodate u-bolt on existing landing late
EVE/MAK	240		KV/10	Yes	FNISUA	with tongue oval eye to accommodate u-bolt on existing landing late
EVE/MAK	241	Y	KV/10	Yes	FNISTA DST	one side to have preformed deadend for OPGW, other side to accommodate deadend for steel 19/2.7 earthwire, supplied also with chainlink

5.2.3 Removal of KEMA (ERS) towers

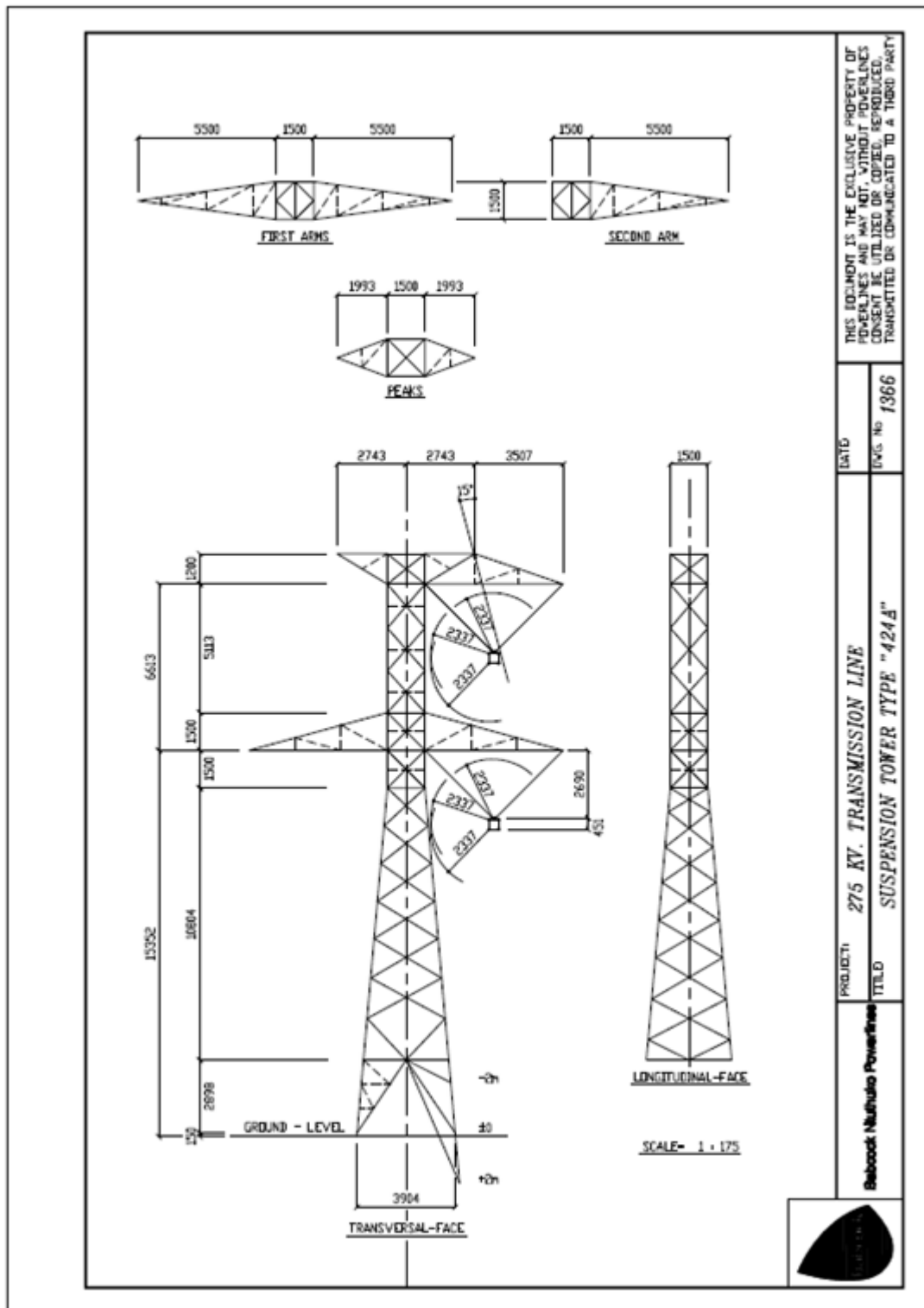
The KEMA towers will be dismantled after the conductor has been remove from the towers, the ERS structures need to be dismantled and removed from site. The Grid will provide the contractor with the KEMA containers for the storage of the towers and the location where the towers will be stored. The following activities shall apply to the removal of ERS towers.

- Removal of the conductors.
- Removal of earthwire on the two ERS structures.
- Dismantling of ERS structures using a crane.
- Excavation and removal of the temporary anchors stays.
- Packing of material into the cargo containers.
- Transportation of the 2xcontainers Beta Substation.

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APPENDIX A: TOWER 424A LAYOUT DRAWING



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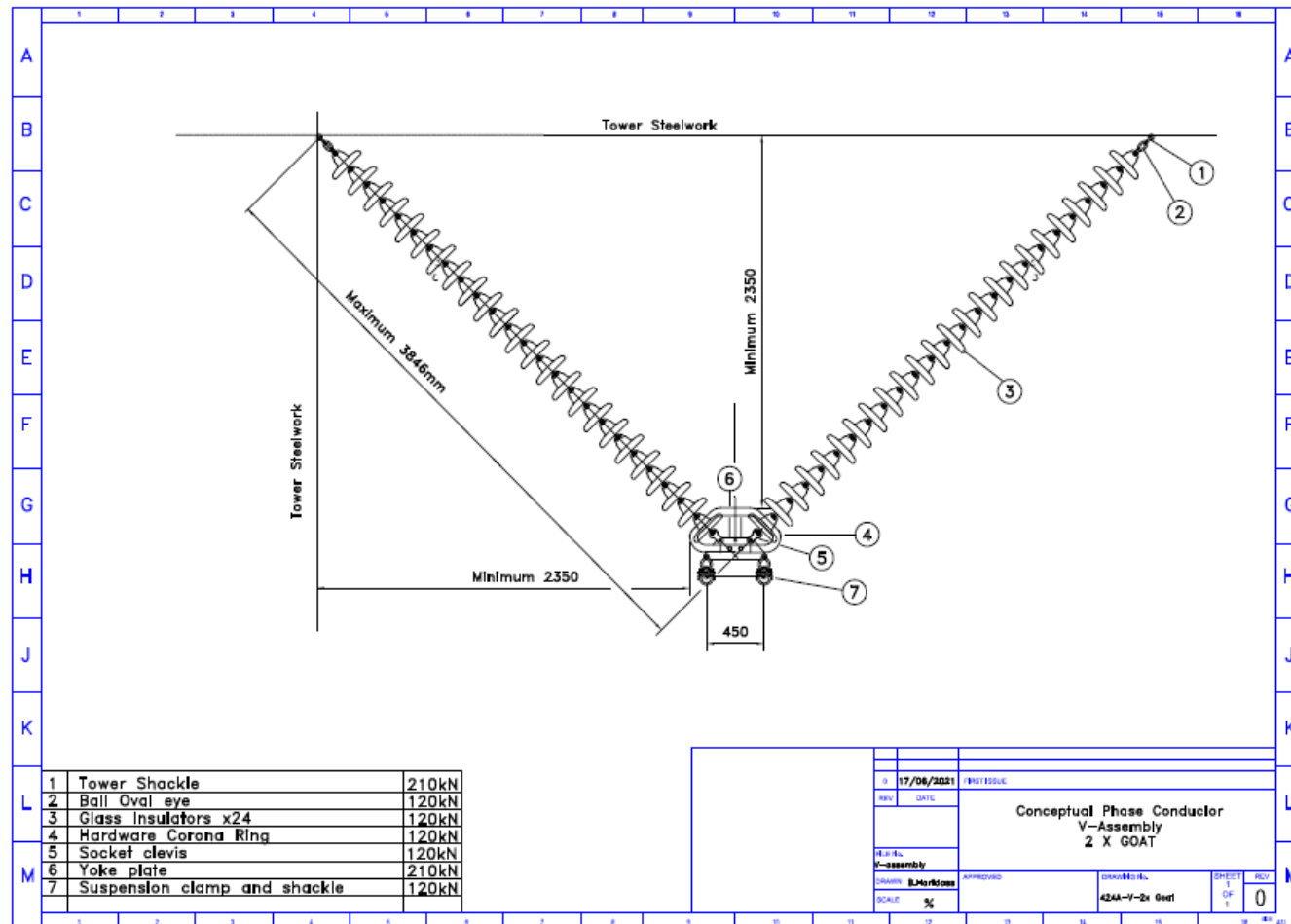
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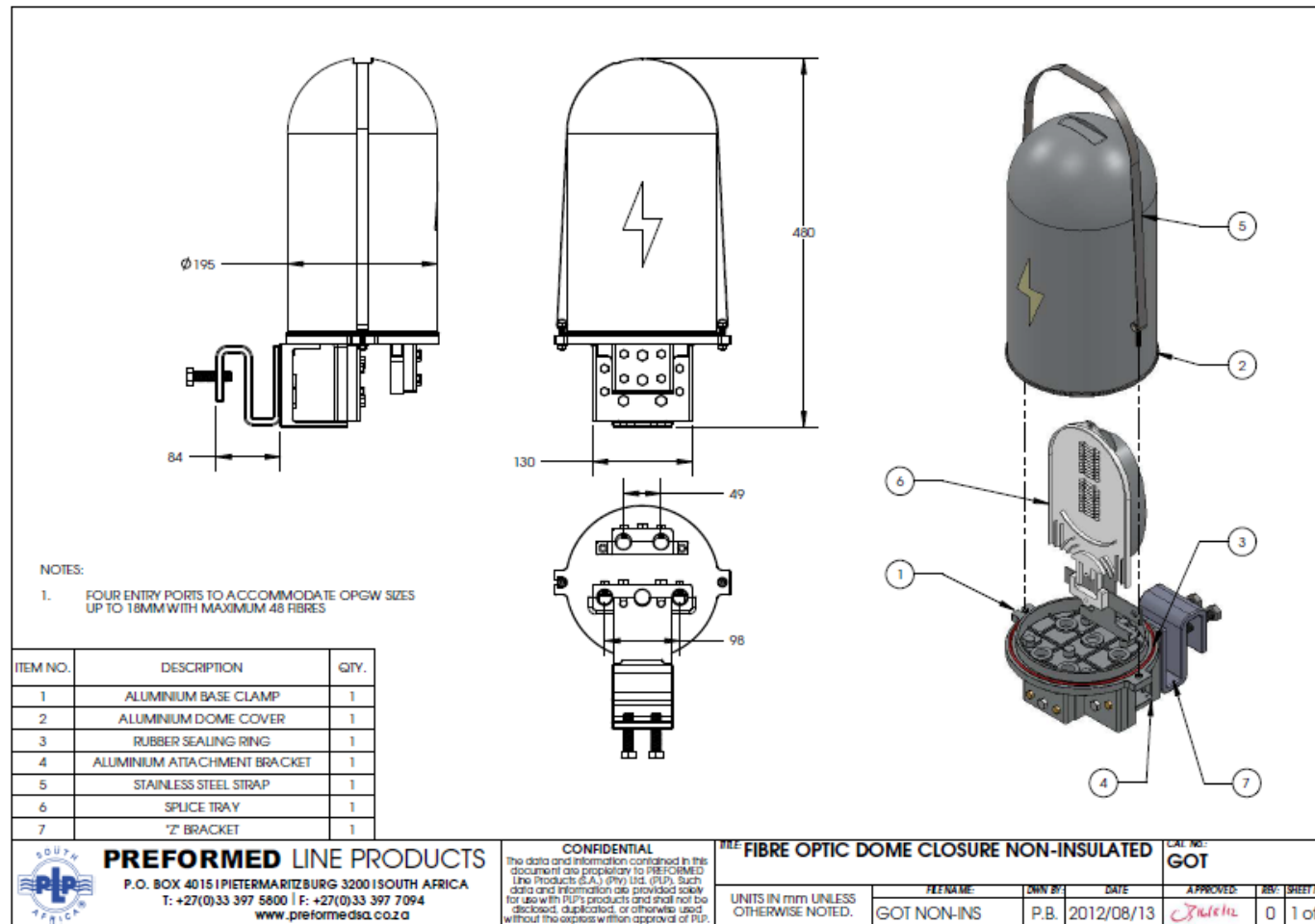
APPENDIX B: OPGW - BILL OF MATERIALS

	Bill of Materials for Everest Makalu 275KV Permanent Solution - Towers used 424A				Template Unique Identifier	340-95118949
	Document Unique Identifier:	1851887			Document Type	Template
	Project Unique Identifier:	N/A			Revision	1
	Line Length:	1,3km			Effective Date	01 July 2025
	Design Leader:	Pavlos Tsimba			Transmission	
		Amount	Unit/Rating	Type	Drawing number	Comments
Amount of Towers						
Suspension:						
424A - CAH = 19.2		1				
Total NEW Suspension Towers:		1				
Strain:						
N/A						
Total NEW Strain Towers:		0				
Total Towers:		1				
Suspension Assemblies for Phase Conductor						
Suspension Assemblies for 2X Goat for 424A tower		3	210kN	424A	424A-V-2xGoat	
Insulators:						
Glass Insulators		144	120kN			
Spacer, Rigid and Vibration Dampers:						
Spacer Dampers - 2xGoat		20	(450mm)	2XGoat		
VIBRATION Dampers - Goat		20		Goat		
Earth Wire:						
16 kA OPGW		4.5	km	16kA		
FMSTA DST - modified		3				To be supplied with preformed deadends for OPGW on one side and compression type deadend for 19/2.7 steel earthwire, plus chainlink
FMSTA		9				To be supplied with 7x tongue oval eye to accommodate existing tower shackles and 1x twisted tongue oval eye.
Vibration dampers for 16kA OPGW		40				
Non-insulated downlead clamps for 16kA OPGW		40				
Non-insulated joint boxes for towers 233 and 241 to accommodate Adflash on one side and OPGW on the other.		2				
Earthbond to connect 19/2.7 steel earthwire to OPGW for continuity		2				Used at tower 233 and 241 to bond the two sides together.
Earth Wire Assemblies						
Earth Wire 1: 19/2.7						
N/A						
Miscellaneous:						
Tower Labels		1				
Line Designation Labels		0				
Line Crossing Labels		0				
Tower Design Sign Labels 2 per new tower on either side		2				
Bird Perch Diverters (150m per tower)		150	m			assumed 150m per a suspension tower

APPENDIX C: HARDWARE DRAWINGS



APPENDIX D: OPGW DRAWINGS

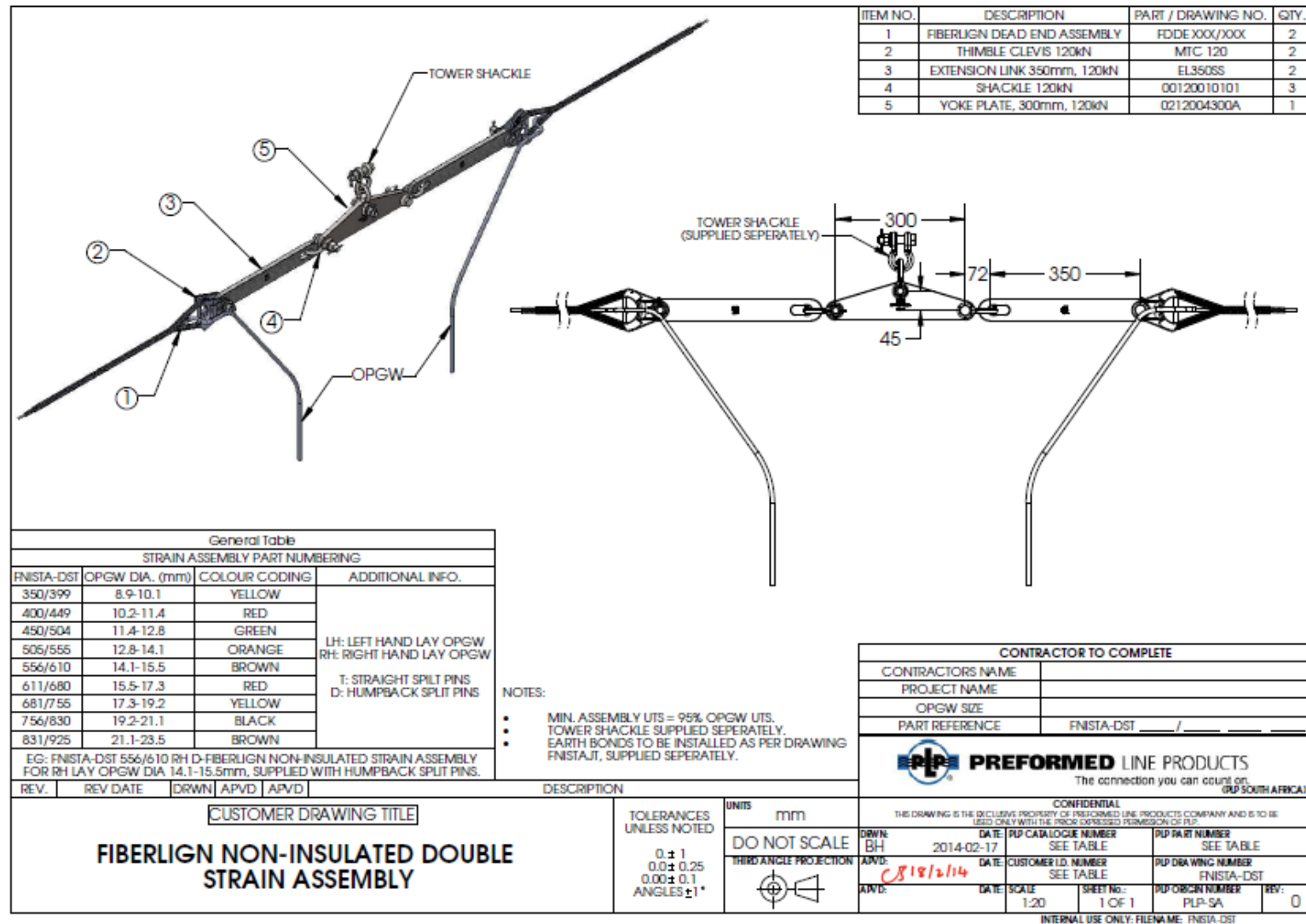


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SUSPENSION ASSEMBLY PART NUMBERING				ITEM	DESCRIPTION	DRAWING / PART NO.
PART REF. FNISUA...	OPGW DIAM. (mm)	COLOUR CODING	ADDITIONAL INFO. ADD SUFFIX AS FOLLOWS:	1	TONGUE OVAL EYE 120KN - PLATE TYPE OR TWISTED TONGUE OVAL EYE 120KN	TOE 120 P TTE 120
354/381	8.9-9.7	GREEN	LH : LEFT HAND LAY OPGW RH : RIGHT HAND LAY OPGW V : SUPPLY WITH TTE 120 H : SUPPLY WITH TOE 120P T : STRAIGHT SPLIT PINS D : HUMPBACK SPLIT PINS	2	FIBERLIGN SUSPENSION UNIT	PAGE XXX/XXX
382/398	9.7-10.1	BROWN		3	HELICAL REINFORCING ROD SET	
399/418	10.1-10.6	YELLOW		4	HELICAL ARMOUR ROD SET	
419/439	10.6-11.2	RED		5	M12 STAINLESS STEEL FLAT WASHER	
440/458	11.2-11.6	BLUE		6	M12 STAINLESS STEEL SPRING WASHER	M12S/WASHSST
477/503	12.1-12.8	GREEN		7	M12 STAINLESS STEEL NUT & BOLT	M12X40SETSST
512/536	13.0-13.6	ORANGE		8	AAC EARTH BOND	XREB 2L XX-XX X.XXXM
537/559	13.6-14.2	BROWN		9	M10/M12/M16 COMPRESSION LUG	
566/573	14.4-14.6	BROWN/WHITE		10	M10/M12/M16 COMPRESSION LUG	
574/598	14.6-15.2	BLUE				
599/625	15.2-15.9	ORANGE				
626/666	15.9-16.9	RED				
667/710	16.9-18.0	YELLOW				
729/750	18.5-19.0	RED				
751/786	19.1-20.0	BLACK/GREEN				
787/814	20.0-20.7	GREEN				
908/916	23.1-23.3	ORANGE				

EG: FNISUA 599/625 RH VD - Fibrelign Non-Insulated Suspension Assembly for RH Lay OPGW Diameter 15.2-15.9mm, supplied with TTE 120 and humpback split pins.

ADDITIONAL EARTH BOND IS REQ. FOR EXPECTED FAULT LEVELS ABOVE 16.5kA/s

EARTH BOND LENGTH: AT LEAST ONE PIG TAIL LOOP REQUIRED

DETAIL A SCALE 1:2

NOTES:

- FNISUA PART REF INCLUDES ITEMS ONE OFF EITHER 1 OR 2 AND ONE OFF EACH ITEMS 3 - 8.
- XREB PART REF INCLUDES ITEM 9-11 PRECRIMPED. SUPPLIED SEPARATE. SEE DRAWING XREB FOR DETAIL.
- FOR EXPECTED FAULT LEVELS > 16.5kA/s, TWO CURRENT TRANSFER EARTH BONDS MUST BE APPLIED.
- SLIP LOAD 10-20% OPGW UTS WHEN NEW, SIGNIFICANTLY HIGHER AFTER A PERIOD OF TIME.

PREFORMED LINE PRODUCTS
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FIBERLIGN NON-INSULATED SUSPENSION ASSEMBLY

REF NAME:	DWN BY:	DATE:	APPROVED:	REV:	SHEET No.:
FNISUA	P.B.	2012/03/28	CS 11/11/12	6	1 of 1

APPENDIX E: STRINGING CHART

Section #4 from structure #1EVE/MAK 233 to structure #1EVE/MAK 241, start set #1 'EW1', end set #1 'EW1'
Cable 'C:\PLS\pls_cadd\My Projects\Everest - Makalu T237 Emergency\Restore\cables\ztt 48 core 16ka opgw ungreae
Ruling span (m) 441.998
Sagging data: Catenary (m) 2098.9, Horiz. Tension (N) 15324.1 Condition C Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 24.1 (deg C) temperature increase
Weather case for final after load -5°C 0Pa Ice 10mm, Equivalent to 8.5 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag -5 C (m)	Mid Span Sag 0 C (m)	Mid Span Sag 5 C (m)	Mid Span Sag 10 C (m)	Mid Span Sag 15 C (m)	Mid Span Sag 20 C (m)	Mid Span Sag 25 C (m)	Mid Span Sag 30 C (m)	Mid Span Sag 35 C (m)	Mid Span Sag 40 C (m)	Mid Span Sag 45 C (m)	Mid Span Sag 50 C (m)	Left Struct Number	Span Vertical Projection (m)
435.7	9.61	9.81	10.00	10.20	10.39	10.58	10.78	10.97	11.16	11.35	11.53	11.72	1EVE/MAK 233	0.59
432.7	9.48	9.67	9.86	10.05	10.24	10.43	10.63	10.82	11.00	11.19	11.37	11.56	1EVE/MAK 234	1.54
442.3	9.91	10.11	10.31	10.51	10.71	10.90	11.10	11.30	11.50	11.69	11.89	12.08	1EVE/MAK 235	0.83
447.1	10.12	10.33	10.53	10.74	10.94	11.14	11.35	11.55	11.75	11.95	12.14	12.34	1EVE/MAK 236	-3.35
442.1	9.89	10.09	10.29	10.49	10.69	10.89	11.09	11.29	11.48	11.68	11.87	12.07	1EVE/MAK 236A	4.99
454.6	10.46	10.68	10.89	11.10	11.31	11.52	11.73	11.94	12.14	12.35	12.55	12.76	1EVE/MAK 238	-1.45
441.5	9.87	10.07	10.27	10.47	10.67	10.87	11.06	11.26	11.45	11.65	11.84	12.04	1EVE/MAK 239	-1.02
438.9	9.75	9.95	10.15	10.34	10.54	10.74	10.93	11.13	11.32	11.51	11.70	11.89	1EVE/MAK 240	-1.07

Horiz Tension -5 C (N)	Horiz Tension 0 C (N)	Horiz Tension 5 C (N)	Horiz Tension 10 C (N)	Horiz Tension 15 C (N)	Horiz Tension 20 C (N)	Horiz Tension 25 C (N)	Horiz Tension 30 C (N)	Horiz Tension 35 C (N)	Horiz Tension 40 C (N)	Horiz Tension 45 C (N)	Horiz Tension 50 C (N)
18038	17680	17339	17007	16692	16388	16094	15812	15546	15286	15037	14794

Catenary Constant -5 C (m)	Catenary Constant 0 C (m)	Catenary Constant 5 C (m)	Catenary Constant 10 C (m)	Catenary Constant 15 C (m)	Catenary Constant 20 C (m)	Catenary Constant 25 C (m)	Catenary Constant 30 C (m)	Catenary Constant 35 C (m)	Catenary Constant 40 C (m)	Catenary Constant 45 C (m)	Catenary Constant 50 C (m)
2471	2422	2375	2329	2286	2245	2204	2166	2129	2094	2060	2026