



Scope of Work

Technology

Title: **WESKUSFLEUR 400 KV CABLE
SYSTEM AND GIL PROJECT
REQUIREMENTS**

Unique Identifier: **240-171000310**

Alternative Reference Number: **n/a**

Area of Applicability: **Engineering**

Documentation Type: **Scope of Work**

Revision: **1**

Total Pages: **18**

Next Review Date: **n/a**

Disclosure Classification: **Controlled
Disclosure**

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1. Background

This document was compiled to provide the project specific scope and technical requirements for the 400 kV EHV cable systems required as part of the new Weskusfleur indoor GIS substation project.

The existing Koeberg GIS substation is currently equipped with two 400 kV gas insulate lines (GIL's), installed in tunnels, that connect the Generation station step up transformers (from the GT room) with the existing indoor 400 kV gas insulated switchgear (GIS) substation. These feeders are designated as Generator 1 (Gen1) and Generator 2(Gen2) respectively.

Once the Weskusfleur GIS substation is completed, two interconnector 400kV cables will be installed to energise the 400kV double busbar from the existing Koeberg GIS station. This will allow for the commissioning of the new Weskusfleur GIS as well as to accommodate the 400kV overhead lines supply.

Sometime thereafter, the Gen1 and Gen2 GIL feeders will be replaced by two 400kV cables which will connect to the new Weskusfleur GIS substation. The replacement of the GIL feeders will occur independently and at different time periods, to ensure continuity of supply and to limit any adverse operating constraints on the Koeberg Power station.

The four new 400 kV cable systems continuous load requirements shall be as follow:

- 1) 400 kV Generator 1(Gen1) Koeberg GIL to Weskusfleur GIS connection - 1100 MVA (estimated cable route length 1000 m);
- 2) 400 kV Generator 2(Gen2) Koeberg GIL to Weskusfleur GIS connection - 1100 MVA (estimated cable route length 1000 m);
- 3) 400 kV Koeberg interconnection 1 -1100 MVA (estimated cable route length 800 m); and
- 4) 400 kV Koeberg interconnection 2 -1100 MVA (estimated cable route length 800 m);

Other than differences in length all four cables will have the same rating and design to ensure interchangeability.

Once the Gen1 and Gen2 cables are installed and successfully commissioned, the temporary interconnector cables and accessories will be repurposed for spares.

Albeit that the tenderer shall propose the optimal solution for the cable systems, the preferred solution for the Gen1 and Gen2 cables will ideally, limit or remove the need for excessive lengths of GIL. That is, these cables should ideally terminate at a point close in or at the GT GIS isolator.

2. Supporting clauses

2.1 Scope

The scope of the document is to specify the minimum technical requirements for the 400 kV cable systems required as part of the new Weskusfleur 400kV GIS indoor substation at Koeberg Power station.

2.1.1 Purpose

This document contains the technical requirements for the 400kV cable system design, manufacturing, supply, installation and testing as part of the Weskusfleur 400kV GIS project. The 400kV cable systems are required to replace the existing Koeberg 400kV GIL connections between the GIS GT room to the Koeberg 400kV indoor GIS. The new 400kV cable systems will interconnect the GIS GT room to the new Weskusfleur 400kV indoor GIS.

2.1.2 Applicability

This document shall apply for Eskom Holdings Limited, Transmission division wherein Eskom has a controlling interest.

2.2 Normative/informative references

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

2.2.1 Normative

- [1] SANS/IEC 62067 Power cables with extruded insulation and their accessories for rated voltages above 150 kV ($U_m = 170$ kV) up to 500 kV ($U_m = 550$ kV) — Test methods and requirements
- [2] IEC 6227-209 High-voltage switchgear and controlgear - Part 209: Cable connections for gas-insulated metal-enclosed switchgear for rated voltages above 52 kV - Fluid-filled and extruded insulation cables - Fluid-filled and dry-type cable-terminations
- [3] IEC 6227-204 High-voltage switchgear and controlgear - Part 204: Rigid gas-insulated transmission lines for rated voltage above 52 kV
- [4] IEC 60229 Test on cable over sheaths which have a special protective function and are applied by extrusion
- [5] IEC 61914 Cable cleats for electrical installations
- [6] IEC 60287 Calculation of the continuous rating of cables (100% load factor)
- [7] IEC 60811 Common test methods for insulation and sheathing materials of electric cables
- [8] IEC 61443 Short circuit temperature limits of electric cables with rated voltages above 30 kV (U_m 36 kV)
- [9] IEC 60332-1-2 Tests on electric and optical fibre cables under fire conditions – Part 1-2: Test for vertical flame propagation for a single insulated wire or cable – Procedure for 1 kW pre-mixed flame
- [10] IEC 60754-1 Test on gases evolved during combustion of materials from cables – Part 1: Determination of the halogen acid gas content
- [11] SANS 986 Precast reinforced precast culverts
- [12] IEEE Std 400 IEEE Guide for Field Testing and Evaluation of the Insulation of Shielded Power Cable Systems Rated 5 kV and Above

2.2.2 Informative

None

2.3 Definitions

2.3.1 General

Definition	Description
Cable system	Cable with installed accessories (i.e. joints if applicable, terminations, earthing and bonding system)
Concrete culvert	Concrete structure to prevent external damage to cable systems that may be a pre-cast reinforced manufactured culvert or on-site constructed solution. The structure shall consist of side walls and a lid or cover slab construction.

2.3.2 Disclosure classification

Controlled disclosure: controlled disclosure to external parties (either enforced by law, or discretionary).

2.4 Abbreviations

Abbreviation	Description
AME	Asset Management Execution
DTS	Distributed Temperature Sensing
DCR	Dynamic Current Rating
EHV	Extra High Voltage
GIL	Gas Insulated Line
GIS	Gas Insulated Switchgear
GT	Generator Transformer
SVL	Surge Voltage Limiter
TOV	Temporary Overvoltage
XLPE	Cross Linked Polyethylene

2.5 Roles and responsibilities

The appointed Eskom Technical representatives are responsible for the compilation and review of this document.

2.6 Process for monitoring

Not applicable.

2.7 Related/supporting documents

Refer to clause/ section 2.2.

3. Sequence of Execution of Scope of Work

All four 400kV cables will be housed in concreted culverts or wall trenches which will be purposely designed and built to accommodate the cables. The tenderer shall determine the optimal cable routing and installation configuration for the cables which meets the loading requirements. Additionally, on the Gen1 and Gen2 culverts only, and where there is not sufficient space within the culverts for future joints, at least three(3) joint bays per circuit will be installed at approximately a quarter of the route length or as appropriate. It is envisaged that these concreted culverts/trenches and/or joint bays will be completed as part of the overall civil works for the new Weskusfleur GIS substation, but before installing the temporary 400kV interconnector cables and commencing the decommissioning of Gen1 and Gen2 GIL feeders. Once the Weskusfleur GIS are completed or near completion, two 400kV interconnector cables will be installed to energise the Weskusfleur 400kV busbar on a temporary basis ensuring commissioning of the GIS station can occur and continuity of supply ensured for the 400kV overhead lines.

Thereafter, the first GIL feeder will be decommissioned and the first 400kV cable installed and commissioned before commencing with the next GIL feeder. The sequence in which these GIL feeders will be replaced are dependent on the available Koeberg outages at the time. The Koeberg outage periods should, as far as is feasible, be used to terminate and commission the 400kV cables and new GIL/GIS sections.

The 400 kV cable systems projects scope of work can be broadly defined in the following phases:

- a) Phase I: Installation of concreted culverts or walled trenches and joint bays(where applicable).
- b) Phase II: The installation of two interconnector 400 kV cables from the new Weskusfleur 400kV GIS to the existing Koeberg 400kV GIS. This is to energise the new Weskusfleur 400kV GIS double busbar on a temporary basis.

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- c) Phase III: Decommissioning and removal of first(1st) generator GIL feeder.
- d) Phase IV: Installation and commissioning of the first 400kV cable and new GIL/GIS sections to the first decommissioned generator GIL feeder.
- e) Phase V: Decommissioning and removal of the second(2nd) generator GIL feeder.
- f) Phase VI: Installation off the second 400kV cable and new GIL/GIS sections to the second decommissioned generator GIL feeder.

4. Civil Works (Culverts, walled trenches and Joint bays)

The related civil works for the culverts, walled trenches and joint bays shall conform to the following requirements;

- a) Compilation of a Project plan/schedule for execution of the civil works detailing design engineering and all installation activities.
- b) Civil engineering design and installation organisation/project team composition and organogram.
- c) Appropriate civil design standards, such as SANS986 or equivalent national and international standards shall be used as basis of the culvert designs.
- d) Scanning and surveying of the proposed routes to detect any underground utilities and services.
- e) The culverts or walled trenches shall be designed by the tenderer to accommodate the required ampacity(load) rating of the cables.
- f) The culverts or walled trenches shall be designed with adequate drainage systems.
- g) The culverts or walled trenches can be designed to accommodate individual or multiple cable circuits.
- h) If the culverts are sized to accommodate more than one cable circuit, the individual cable circuits should preferably be installed on opposite side walls and measures put in place to prevent common mode failure of the adjacent cables.
- i) Where the cable trench concrete culvert or wall design are not large enough to permit direct human access and traversal, the manufacturing and installation method shall include removable lids or covering slabs. Attachments such as lifting hooks or handles shall be provided to enable removal of the lids or covering slabs.
- j) Where the culverts or walled trench designs are not sufficiently wide to accommodate future joint installations, at least three(3) joint bays shall be added, to the Gen1 and Gen2 cable trenches only, spaced approximately a quarter along the cable trench route or as deemed appropriate.
- k) In instances where the trenches cross under existing main or access roads, the design shall make provision for adequate reinforcement and fill to maintain and not compromise, the existing carrying capacity of those roads.
- l) Complete civil engineering designs inclusive of set of drawings complete with labels and dimensions for all sections of the concreted culverts and joint bays(where applicable) shall be provided.
- m) A complete Method statement for the civil works shall be provided after contract award.

5. GIL/GIS scope of works for Generator 1 and 2 400kV cables

The GIL/GIS related supply and works shall be done in accordance with IEC 62271-209 for the GIS cable terminations and IEC 62271-204 for the GIL respectively. The GIL feeders will be decommissioned per feeder circuit, removed and the respective EHV cable installed and completely commissioned before commencing with the next circuit.

5.1 GIL/GIS preparation, removal and installation works

- a) Compilation of a Project plan/schedule for execution of the GIL/GIS works detailing design engineering and all installation activities.
- b) Design engineering and installation organisation/project team composition and organogram.
- c) GIS termination of the two interconnector cables at the new Weskusfleur GIS.
- d) GIS termination of the two interconnector cables at the spare Koeberg GIS feeder bays.
- e) De-gassing of GIL on 1st feeder (Gen1 or Gen2).
- f) Dismantling and removal of GIL sections on 1st feeder up to the GIS termination point.
- g) Any remaining section of GIL will be replaced with new GIL(where required) from the GT house up to the termination point.
- h) The layout and dimensions of this new GIL section shall be provided as drawings or illustrations.
- i) Preparatory works, such as clearing out remaining steelworks, brackets, and other services, to enable the cable installation.
- j) Installation of supporting structures/ frames.
- k) Installation of cable GIS termination compartment/enclosure at GIL/GIS termination point.
- l) Installation and termination of Gen1/Gen2 400kV cable at both ends.
- m) The GIL/GIS terminations shall have a means of isolation(isolator) to enable isolation and voltage withstand testing of the EHV cable.
- n) GIL/GIS commissioning and testing requirements.
- o) The works for the second GIL feeder will entail similar steps as above.
- p) Full set of drawings complete with labels and dimensions for all installed GIL/GIS components shall be provided.
- q) A complete method statement for the GIS/GIL works shall be provided after contract award.
- r) All installation and maintenance manuals shall be provided after contract award.
- s) All operating instructions shall be provided after contract award.

6. Minimum cable system design and installation requirements

In the request for proposal, the cable systems suppliers are required to sufficiently optimise the 400 kV XLPE cable system design, engineering, manufacturing and installation, for the prevailing conditions and constraints that may arise from on-site conditions or as specified in this document. All cable and accessories details, datasheets, drawings, cable routing and configurations, culvert and trench designs, foundations, racking and support designs, applicable calculations with assumptions and results, test plans, quality inspection test plans and any other requirements contained in this specification shall be included in the final cable systems design package.

The cable systems shall be designed to comply with the following minimum criteria:

- a) Only cable having been prequalified or meeting the extension of prequalification in accordance with IEC62067 shall be accepted.
- b) Only cable having been type tested as a system, that is with the associated accessories supplied as part of this tender, in accordance with IEC62067 shall be accepted.
- c) No lead sheathed cables will be accepted. CAS, extruded, welded, lapped laminated sheaths with copper or aluminium wires are acceptable.

- d) The EHV cable manufacturing facility shall have the following characteristics;
- True triple head extrusion in a Continuous Vulcanising (CV) line.
 - Dry curing of XLPE extrusion.
 - In-production quality monitoring systems employed to monitor curing and scorching characteristics of XLPE compound as well as insulation and screen thickness.
 - Appropriate ISO class clean room/enclosures for handling of insulation compounds.
- e) Separate designs, bill of material and costing for each individual cable system shall be submitted.
- f) The XLPE cable system shall have a minimum design life of 40 years. Cable systems suppliers shall submit calculations and/or assumptions supporting the system design life criteria, considering thermal, electrical and mechanical ageing of the cable system, i.e. both the cable and accessories.
- g) The XLPE cables shall be installed in concreted culverts, walled trenches or tunnels which emanates from the existing GIL tunnels to the new Weskusfleur GIS building. The lids and culvert enclosures shall be sufficiently reinforced to enable it to withstand, and as far as possible, not protrude excessively above ground level, to enable vehicles to traverse over them. Where required, the lids or cover slab shall be removeable to enable access to the cables.
- h) Each XLPE cable system shall meet the specified maximum continuous current rating at a daily load factor of 1 (100%) for the Eskom defined maximum conductor continuous current temperature limit of 90°C. A minimum continuous current rating of 1588 A is required for this installation. This is to coincide with a 1100 MVA cable system continuous loading. The emergency current ratings at 105 °C shall be provided and also for a four hour, two hour and one hour rating. The minimum symmetrical three phase fault level requirement is 50kA for 1 second and the minimum single phase to earth fault level requirement is 40kA for 1 second.
- i) All four cables shall have the same size and design to ensure interchangeability. The installation conditions of the interconnector and generator cable, however can be different.
- j) The proposed installation method, such as in air, buried, ducts, culverts etc. as well as configurations upon which the ampacity calculations are based, i.e. vertical or horizontally spaced, trefoil etc. shall be clearly stated or illustrated, with axial distances between cores indicated.
- k) For in air installation, the cable shall comply with the fire and flammability requirements of IEC 60332-1-2 and shall be low smoke halogen free in accordance with IEC 61034 and IEC 60754-1 respectively or equivalent standards. If the tests have not previously been conducted on the cable offered, the test shall be conducted at time of manufacturing to proof conformance.
- l) Calculation of the cable system ampacity (rating) shall show all the rating factors that were considered. The applicable ambient and soil/backfill temperature range as stated in schedule A. Cable system ampacity (rating) calculations are required for an ambient temperature of 35 °C for direct burying or alternatively 40°C for in air culvert/tunnel installations. Calculations with all relevant assumptions and conditions considered shall be submitted.
- m) Insulation coordination and electrical studies shall be performed to ascertain the appropriate cable system behaviour under lightning impulse, switching, TOV, inrush and mitigation against resonance conditions which may arise.
- n) Special backfill materials may be used within the concreted culverts to optimise the cable system design. The backfill material used and its properties shall be stated.
- o) The cable system design and length should be optimised to prevent using any cable joints and should be limited to a single core cable per phase circuit design arrangement.
- p) Single end point bonded methods shall be used to minimise sheath currents and maintain sheath voltages within acceptable limits. The open circuited sheath standing voltage shall be calculated and specified. Where this value exceeds 65 V, the tenderer shall specify and provide adequate touch and step potential mitigating measures.

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- q) The SVL shall be adequately rated to withstand temporary power frequency or transient over voltages induced during maximum fault current conditions, switching and lightning events. Detailed calculations shall be submitted for the sheath standing voltage for steady state and transient currents, and for the SVL rating selected.
 - r) The cable system supplier and installation contractor shall be responsible for surveying the final cable route in accordance with the preliminary routing information provided.
 - s) The cable length shall make provision for snaking, where applicable, of the cable along its route, bending and passage of the cable through the termination support structures and at the termination ends.
 - t) Adequate slack shall be provided along the cable length and on each end of the cables to allow for the installation of straight joints and terminations after a cable failure and/or termination replacement.
 - u) The cable system design shall make provision for all trenching where applicable, steel support frames, termination support structures, termination foundations, termination cleats, cable racking and cable cleats and clamps in accordance with the expected thermal mechanical behaviour of the cable. All final drawings, appropriately referenced, related to these items shall be provided as part of the final design file.
 - v) Detailed calculations, finite element(FE) or multiphysics simulations results shall be submitted to show the calculated electromechanical force design considerations where applicable for cable racking/support and cleat designs.
 - w) Detailed calculations of the forces employed and mitigated during the installation of the cable shall be submitted.
 - x) Installation of cleats and clamps to ensure correct and proper cable support to keep the cable in position during fault conditions. All cleats to comply with IEC 6191,"Cable cleats for electrical installations" or equivalent specification.
 - y) Bonding and earthing of all support frames and structures, cleats and clamps, inclusive of semiconductive surfaces as required, shall be done, in order to limit any adverse induced voltages due to various operating conditions such as inrush, loading rejection or switching.
 - z) Single end point bonded methods shall be used to minimise sheath currents and maintain sheath voltages within acceptable limits. The open circuited sheath standing voltage shall be calculated and specified. Where this value exceeds 65 V, the tenderer shall specify and provide adequate touch and step potential mitigating measures.
 - aa) The SVL shall be adequately rated to withstand temporary power frequency and transient over voltages induced during maximum fault current conditions, switching and lightning events. Detailed calculations shall be submitted for the sheath standing voltage for steady state and transient currents, and for the SVL rating selected.
 - bb) Transportation of all cable system components to site and removal of construction debris and waste to registered disposal sites.
 - cc) A DTS system with DCR tool shall be supplied and installed, on the Gen1 and Gen2 cable system circuits only, to measure and display the real time cable system temperature and provide current ratings along the complete cable route. The DTS system shall be compatible, and integrated with, Eskom SCADA and control system architecture and protocols.
 - dd) Installation of fibre optic ducting and fibre optic cable for DTS system along the Gen1 and Gen2 cable routes only.
 - ee) Installation of 32mm fibre optic ducting and fibre optic cable for the cable protection system along all cable routes.
 - ff) Reinstatement of surfaces, buildings and related civil works, where applicable.

7. EHV Cable Scope method statement

The method statement and procedure for the execution of the cable and accessories design, manufacturing, installation, testing and measurements shall be provided covering the following minimum aspects:

- a) The manufacturing plant locations for all offered cable systems and accessories shall be provided.
- b) Project Plan/schedule indicating time frames of all related activities.
- c) Cable system design and installation project team and roles: Relevant EHV cable experience of designers, jointers and cable installation teams must be provided. Where applicable, subcontractor's experience with regard to the services offered need to be submitted as part of the tender. Organograms for all relevant project teams, and roles to be submitted.
- d) Final design, design review and engineering phase time allowance after contract award.
- e) Factory acceptance testing and inspections for the cable and all cable accessories at the manufacturing plants.
- f) Final site and route surveying and site preparation.
- g) Erection of steel bracing and supporting structures and installation of foundations (civil works).
- h) Cable trenching where applicable.
- i) Cable pulling and installation methods to be employed.
- j) Cable structural support racking and installation design
- k) Cable cleats and clamps design and installation methods.
- l) Backfilling materials and installation methods to be employed (where applicable).
- m) GIS terminations installation methods.
- n) Sheath Bonding Arrangement, bonding lead, link disconnecting boxes and SVL installations.
- o) DTS and DCR design, supply, installation and training proposal.
- p) Quality assurance tests and measurements to be conducted during installation such as;
 - Bonding lead current measurements
 - Sheath-bonding verification
 - Contact resistances for earth and bonding connections
 - Positive and zero sequence impedance measurement.
- q) After installation testing, and commissioning method.
- r) A complete method statement for the EHV cable works shall be provided after contract award.
- s) All cable installation on site quality inspection plans shall be submitted after contract award.
- t) All cable accessories installation instructions, and on-site quality inspection plans shall be submitted after contract award.

8. Other requirements

- a) A three (3) day training of Eskom personnel shall be offered locally pertaining to the following:
 - 1) Design and Engineering pertaining to this project
 - 2) Manufacturing and testing of HV and EHV cables
 - 3) Installation of cable and all accessories
 - 4) Maintenance and Operation of all associated equipment
 - 5) DTS and DCR operating principles overview

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- b) DTS and DCR operating training for personnel pertaining to the configuration, operating and maintenance and analysis/diagnostics using the system.
- c) A ten (10) year system guarantee will be required for the cable systems, supplied, installed and commissioned. This ten-year system guarantee will be required for the operating conditions as stipulated in this report and the normal scheduled maintenance prescribed and agreed to by Eskom for this project.
- d) Additional requirements and/or parameters that will be required after contract award are contained in Appendix B.

9. Type tests and Pre-qualification tests

- a) Type tests, including the water penetration tests, shall have been performed on the cable and accessories as a system, in accordance with clause 12 of IEC 62067. Range of approval covered by the type test shall be in accordance with clause 12.2 of IEC 62067. The type test reports shall clearly identify the cables and accessories according to clauses 6 and 7 of IEC 62067. The type test reports shall include fully detailed and dimensioned drawings of the cable and accessories tested.
- b) Outdoor terminations with composite insulators shall be designed and tested according to IEC 61462.
- c) GIS dry-type terminations shall be designed and tested according to IEC 62271-209 for XLPE cables.
- d) Pre-qualification tests, including the water penetration tests, shall have been performed on cable and accessories tested as a system, in accordance with clause 13 of IEC 62067. Range of approval covered by the pre-qualification shall be in accordance with clause 13 of IEC 62067. The Pre-qualification reports shall clearly identify the cables and accessories according to clauses 6 and 7 of IEC 62067. Including the raw materials used and the manufacturing line and manufacturing plant location used. The Pre-qualification reports shall include fully detailed and dimensioned drawings of the cable and accessories tested.

10. Quality Assurance tests and measurements

The following quality assurance tests and measurements shall be conducted during or after installation as applicable;

- a) Bonding lead current measurements
- b) Sheath-bonding verification
- c) Contact resistances for earth and bonding connections
- d) Positive and Zero sequence impedance measurements

11. The cable system after installation tests

The Contractor shall conduct the following after installation tests. These tests shall comply with SANS/IEC 62067, IEEE400 and its 'point' documents or as per the guidance provided in Cigre TB841 for the specific test methodologies used. These proposals, inclusive of method statement, shall be provided with the tender. All test and measurement data and results shall be provided to Eskom in a final report.

- a) DC over sheath integrity test
- b) AC Voltage withstand test with test level at 1.7 U₀ for 60 min or equivalent per phase.
- c) Partial discharge (PD) measurement. PD test methods, detection systems as well as pass/fail criteria to be provided.

12. Risks identified for the Weskusfleur 400kV project:

- a) There are ongoing projects being executed at Koeberg Nuclear Power station which could influence the execution of this project.
- b) Various services and infrastructure may be located in the vicinity of the cable route, which can impact the works execution.
- c) Electrical clearances and safe working clearances need to be considered for the cable terminations to cater for the cable system installation and commissioning testing that will be performed on site.

13. Tender Submissions

The following documents must be submitted as part of the tender submissions.;

- 1) Completed Schedule B in Appendix A.
- 2) Supply and installation history since year 2010 of at least 5 projects where 320kV and above XLPE Cable systems were supplied and installed. Project name, voltage level, conductor sizes and Client company details inclusive of contact person, email and telephone/mobile numbers.
- 3) A brief overview of manufacturing plant and conformity to clause 6(d).
- 4) Project Plans for Civil works and GIS/GIL works highlighting all project activities.
- 5) Project team compositions for Civil works and GIS/GIL works of design, installation, supervisor and project management organisation/functionaries with organograms.
- 6) Concept design and drawings of culverts, walled trenches or tunnel and joint bays(where applicable) aligned to clause 4.
- 7) Preliminary GIS/GIL outline drawings with dimensions and appropriately labelling of all key components.
- 8) Method statement for the EHV cable scope aligned to the scope in clause 7.
- 9) Designers and Jointers shall have more than 5 years' experience in EHV cable design and installation. Brief CVs to be provided demonstrating EHV cable projects involvement.
- 10) Successfully passed Prequalification report.
- 11) Successfully passed Type Test Report for cable and terminations.
- 12) Cable construction drawing(s) with layer labels and dimensions.
- 13) Ampacity calculations.
- 14) Preliminary cable support and cleats design for installation.
- 15) GIS termination drawings with labels and dimensions.
- 16) Accessory drawings: link boxes, bonding leads, SVL and ECC.
- 17) DTS and DCR design, supply, installation and operator training proposal for Gen1 and Gen2 circuits.

14. Conclusion

This report contains the requirements for the EHV (400kV) cable systems to replace the existing 400kV GILs as part of the new Weskusfleur 400kV GIS project. The cable systems supplier and installation company must complete and submit Annex A technical schedule B as part of the tender deliverables.

15. Authorization

This document has been seen and accepted by:

Name and surname	Designation
Bheki Ntshangase	Senior Manager: Asset Management: SED
Christy Thomas	Senior Engineer: Substation Engineering
Riccardo Mosia	Project Manager
Salman Minhas	Project Manager: Integration

16. Revisions

Date	Rev	Compiler	Remarks
Nov 2023	1	F Witbooi	Revise technical requirements in line with new procurement strategy and scope. Added Civil and GIL/GIS scopes. Revise evaluation criteria. Replaces 240-124665640.

17. Development team

The following people were involved in the development of this document:

- Fernando Witbooi: Chief Technologist Engineering : Asset Management :SED
- Sihle Msweli: Engineer: Asset Management
- Sanele Miya: Engineer: Asset Management

18. Acknowledgements

Not applicable.

Annex A – Schedules A and B for the Weskusfleur 400 kV XLPE-insulated cable systems

Schedule A: Purchaser's specific requirements

Schedule B: Guarantees and technical particulars of equipment offered - to be completed by tenderer

Item	Description		Schedule A	Schedule B
1	Ambient and installation parameters			
1.1	a) altitude	m	1800	xxxxxxxx
	b) ambient air temperature	°C	0°C to 35 °C	xxxxxxxx
	c) culvert/tunnel in air ambient temperature	°C	0°C to 40 °C	xxxxxxxx
	d) soil temperatures	°C	-5°C to 25 °C	xxxxxxxx
	e) backfill material		Specify	
	f) backfill thermal resistivity	K·m/W	Specify	
	g) depth of burial (of cable)	m	Specify	
	h) configuration(flat/trefoil)		Specify	
	i) special bonding applied		single end point bonded	
	j) lightning ground flash density		severe (14 flashes/km ² /yr)	xxxxxxxx
	k) solar radiation	W/m ²	1 100	xxxxxxxx
	l) ultraviolet radiation		High	xxxxxxxx
	m) relative humidity		10 % to 95 %;	xxxxxxxx
	n) wind pressure and seismic		+700 Pa (34 m/s) and 3g	xxxxxxxx
	o) pollution severity defined by IEC 60815:		Very heavy	xxxxxxxx
	p) specific creepage distance required for external insulation	mm/kV	31	
	q) maximum conductor operating temperature	°C	90°C (@ 1120MVA)	
1.2	Minimum Load current	A	1617A (1120 MVA)	
1.3	Rated voltage cable and accessories (U as per IEC 62067)	kV	400	
2	Cable specifications			
2.1	Conductor cross-sectional area	mm ²	Specify	
2.2	Conductor material	Cu/Al	Specify	
2.3	Ampacity (at 90°C)			
	a) (100 % load factor; thermally independent circuit)	A	Provide	
	b) 110% for 4 hours	A	Specify	







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	c) 120% for 2 hours	A	Specify	
	d) 130% for 1 hour	A	Specify	
	e) at 105°C	A	Specify	
2.4	Symmetrical short-circuit fault level	kA	50	
2.5	Fault level duration	s	1	
2.6	Nominal thickness of XLPE insulation	mm	xxxxxxxx	
2.7	Actual conductor screen radial stress at U_0	kV/mm	Specify	
2.8	Actual core screen radial stress at U_0	kV/mm	Specify	
2.9	Type of Metallic sheath		Specify	
2.10	Earth fault level	kA	40	
2.11	Fault level duration	s	1	
2.12	Nominal thickness of Al or Cu sheath and/or nominal thickness of copper wire strands and number of copper wire strands	mm	Provide drawing(s)/ document reference	
2.13	Details of water barriers/blocking applied		Provide drawing(s)/ document reference	
2.14	Type of outer sheath (PVC/PE/HDPE etc.)		Specify	
2.15	Outer sheath has flame retardancy (low smoke and halogen free)		Yes	
2.16	Conductive coating applied		Graphite or alternative (specify)	
2.17	Estimated Cable route length for 400kV Gen1 and Gen2 cables	m	1000	
2.18	Estimated Cable route length for 400kV interconnector cables	m	800	
3	Culvert and Joint bay Designs			
3.1	Details of culvert/wall trench/tunnel design		Drawing(s)/ document reference	
3.2	Details of joint bay design (where applicable)		Drawing(s)/ document reference	
4	Cable supporting structures, Cleats and Clamps			
4.1	Details of cable support structures		Drawing(s)/ document reference	
4.2	Details of cleats		Drawing(s)/ document reference	
4.3	Details of intermittent clamps		Drawing(s)/ document reference	
5	Terminations			

5.1	Details of the GIS cable terminations		Drawing(s) reference	
5.2	Details of cable termination/ end support structure (where applicable)		Drawing(s) reference	
5.3	Pollution Severity		Very heavy	Xxxxxxxx
5.4	Insulator material type		Silicone composite	
5.5	Required specific creepage distance	mm/kV	31	
5.6	Measured creepage distance	mm	Provide	
6	Bonding/ECC Leads			
6.1	Type of bonding lead (single core/concentric)		Specify	
6.2	Bonding lead conductor material (Cu/Al)		Specify	
6.3	Bonding lead conductor cross-sectional area	mm ²	Specify	
6.4	Thickness of bonding lead insulation	mm	Specify	
6.5	Dimensional details of Bonding lead		Drawing(s) reference	
6.6	Estimated length of bonding leads	m	Specify	
7	Other Accessories			
7.1	Details of Link disconnecting box		Drawing(s) reference	
7.2	Details of SVL link box		Drawing(s) reference	
7.3	Details of SVL		Drawing(s) reference	
7.4	Details of the cable joints for spares		Drawing(s) reference	
7.5	No of spare joints required		4	

Annex B – Additional requirements after contract award

Item	Description	
1	Additional cable drum and installation information required:	
	a) Cable drum design and material	
	b) Method of wood treatment (if applicable)	
	c) Details of pulling eye offered (if applicable)	
	d) Maximum permissible pulling tensions	kN
	e) Details of haulage equipment	
2	Additional cable parameter information required:	
	a) rated voltage	kV
	b) nominal diameter of conductor	mm
	c) nominal thickness of conductor screen	mm
	d) nominal thickness of core screen	mm
	e) nominal overall diameter of cable	mm
	f) mass of cable	kg/m
	g) d.c. resistance of conductor at 20 °C	$\Omega/\kappa\mu$
	h) a.c. resistance of conductor at 70 °C and 90 °C	$\Omega/\kappa\mu$
	i) a.c. resistance of sheath with conductor at 70 °C and 90 °C	$\Omega/\kappa\mu$
	j) reactance per phase	$\Omega/\kappa\mu$
	k) capacitance per phase	nF/km
	l) zero sequence impedance	$\Omega/\kappa\mu$
	m) zero sequence capacitance	nF/km
	n) rated continuous current	A
	o) rated symmetrical fault withstand current	kA.s
	p) rated earth fault withstand current	kA.s
	q) conductor temperature at specified load	°C
	r) conductor temperature after symmetrical fault (1 s) assuming operation at specified load prior to fault	°C
	s) sheath temperature after earth fault	°C
	(1 s) assuming operation at specified load prior to fault	
	t) conductor losses at maximum conductor operating temperature	kW/km
	v) dimensioned drawing of the cable cross-section	
	w) minimum installation bending radius	mm
	x) emergency current rating (IEC 60853-2)	A

Item	Description	
	y) cyclic current rating in accordance with IEC 60853-2	A
		
3	Miscellaneous requirements	
	a) MCOV characteristic curves	
	b) installation instruction and maintenance manual for joints offered	
	c) installation instruction and maintenance for terminations offered	
	d) Specialized tools required for jointing and terminating	
	e) Quality inspection and control test plans for all components (GIS terminations, GIL sections, cables, supports, cleats and clamps, other accessories, link disconnecting boxes) and installation processes	