

Title: **Eskom – Nampower 2nd 400 kV interconnector OPGW and Hardware Scope of Work**

Template Unique Identifier: **240-98155775**

Document Unique Identifier: **LES1500**

Project Unique Identifier: **TX.2019-027**

Area of Applicability: **Engineering**

Documentation Type: **Report**

Revision: **1**

Total Pages: **40**

Next Review Date: **N/A**

Disclosure Classification: **CONTROLLED DISCLOSURE**

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Date: 13-06-2022

Supported by

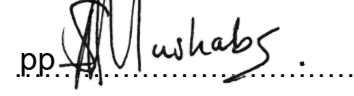


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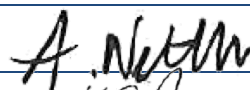


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Date: 28 June 2022

ESKOM – NAMPOWER 2ND 400 KV INTERCONNECTOR

OPGW and HARDWARE SCOPE OF WORK

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Revision Control

Project No.	Lines Engineering Document No.	Revision no.	Date
TX.2019-027	LES1500	1	June 2022

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1. PROJECT DESCRIPTION

1.1 OVERVIEW

The line will run in a northerly direction from the Eskom Oranjemond substation near Alexander Bay in the Northern Cape to the remote substation in Namibia. The substation in Namibia, Obib, is approximately 95 km away however Eskom will only be responsible for the design and construction of the first 2 km of the line. The line is a single circuit 400 kV line and will utilise the 517 series strain towers. In addition to this the line will also make use of the 540B double circuit structure in a semi-delta single circuit configuration.

In order to achieve this 400 kV connection, the Eskom network in the area will require some modifications. The newly built Gromis – Oranjemond 1 line was built at 400 kV but is currently operating at 220 kV since there is currently no 400 kV injection at Oranjemond substation. To achieve a 400 kV injection at Oranjemond substation the Gromis – Juno line, which is currently at the very early stages of its construction phase, will have to be built. Along with this, the Gromis and Oranjemond substations will require new 400 kV yards. The Gromis – Oranjemond 1 line will also have to be deviated at Gromis and Oranjemond substations to terminate at the 400 kV yard instead of the 220 kV yard. The deviations at both ends of this line will be included in the scope of work of this project. This deviation will make use of the 518 series towers.

At the Gromis and Oranjemond ends of the OPGW cables, the duct cables to the equipment rooms and patch panels will need to be installed as defined in the secondary plant document. This will be for the Gromis - Oranjemond 1 400 kV line deviation.

At the Oranjemond end the OPGW cables, the duct cables to the equipment rooms and patch panels will need to be installed as defined in the secondary plant document. This is for the Nampower interconnector section.

This document specifies the OPGW, hardware and accessories for the installation as well as the Scope of work. The OPGW and hardware will be provided by Eskom and given to the installer.

1.2 SCOPE OF WORK

- 1.2.1 The Scope of Work covers the installation of an OPGW cable system, including the installation of OPGW cable and matched hardware in accordance with this document.
- 1.2.2 Install a 16 kA 48 core greased OPGW cable on the deviated sections of the Gromis Oranjemond 1 400 kV line from T270 to new gantry at Oranjemond side and from T2 to new gantry at Gromis side.
- The new section/deviations are:
GRO/ORA 002 (existing tower) up until ORA 400 kV Gantry: 1053m (Figure 1-3) and
GRO/ORA 270 (existing tower) up until 400 kV Gantry: 415m (Figure 1-2)
- 1.2.3 Install a 12 kA 48 core greased OPGW cable on the Nampower 400 kV line from Oranjemond gantry to T1 – this section consists of Gantry and 5 new towers in total having a line length of approximately 2.3 km (Figure 1-1)
- 1.2.4 The cable and hardware will be free-issue.
- 1.2.5 The project manager can decide between using the main line contractor to install the OPGW or a contractor from the panel of OPGW installers.
- 1.2.6 For the new line (2.3km) into Namibia the OPGW will be installed on the western peak (left). For deviation of the existing Gromis Oranjemond line, the new OPGW shall be installed on the same side of the tower as the existing OPGW on the line. This must correlate with the PLSCADD model. If there is any discrepancy the contractor can confirm this information with the project manager.
- 1.2.7 This SOW report should be read in conjunction with the latest revision “**Eskom – NamPower 2nd 400 kV Interconnector Detailed Design Report and Line Specification**” (LES1227)

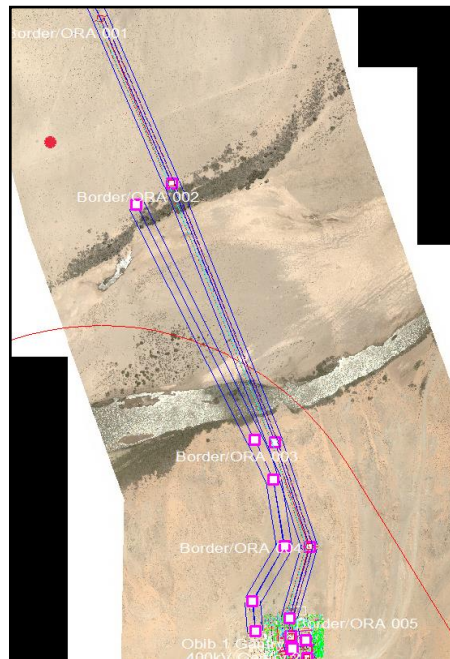


Figure 1-1: NamPower 400 kV interconnector line route (2.3km of new line)

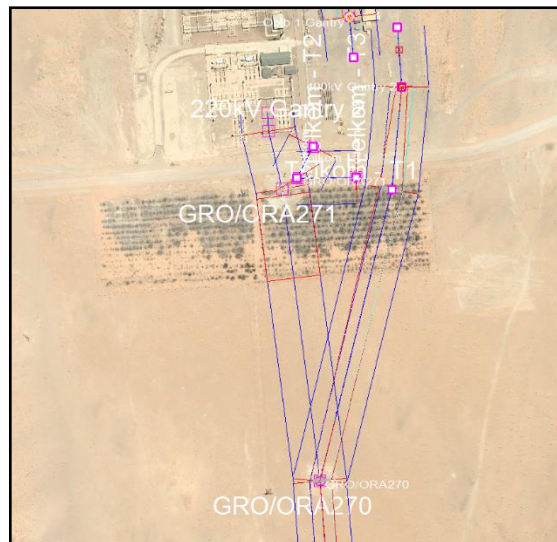


Figure 1-2: Gromis – Oranjemond 1 line deviation at Oranjemond (T270 until new gantry)

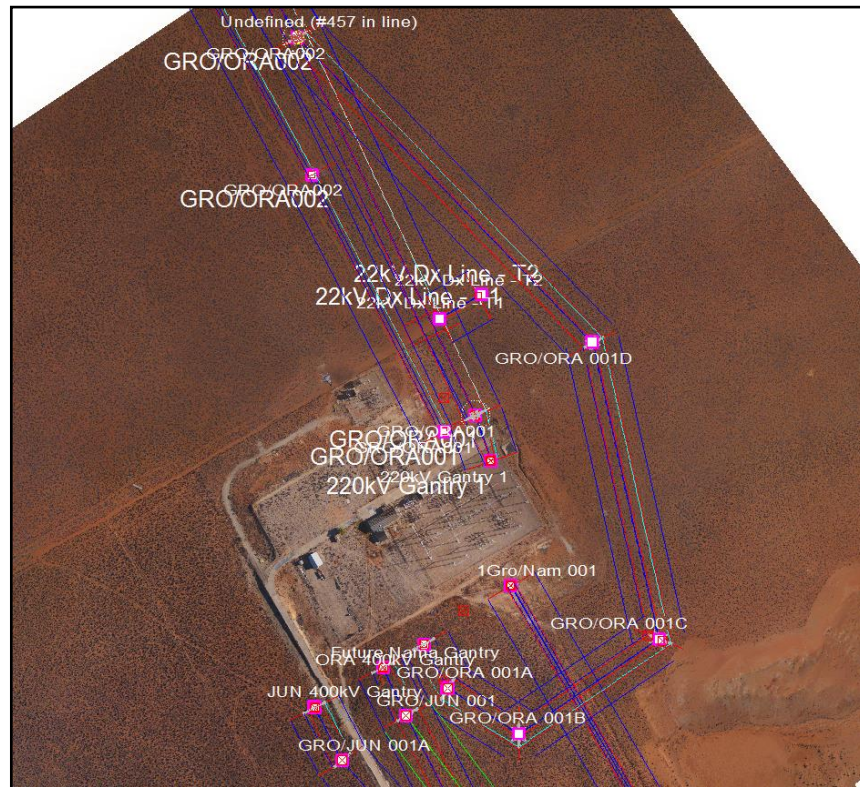


Figure 1-3: Gromis – Oranjemond 1 line deviation at Gromis (T2 until new gantry)

1.3 GENERAL

- 1.3.1 The detailed project plan must be agreed between the Contractor and Project Manager prior to commencement of work. This will include amongst others, finalisation of attachment points, hardware fittings, substation entries, patch panels, cabinet locations etc.

Note that a site visit with the Project Manager must be undertaken to finalise the exact details.

- 1.3.2 Contractors must note that all entry into substations and high-voltage yards must comply with the relevant regulations.
- 1.3.3 All lengths of OPGW must be confirmed by the Contractor prior to commencement of work.
- 1.3.4 The drum size(s) and the locations of joints must be agreed between the Contractor and the Employer to optimise the installation.
- 1.3.5 All jointing must be performed by the Contractor.
- 1.3.6 All fibre cable off-cuts must be disposed of in accordance with TST32-245, Eskom's Waste Management Procedure.
- 1.3.7 Aircraft warning spheres will be free-issued by the Project Manager if required and must be installed either to replace existing spheres, or in new locations as instructed. Existing spheres may be re-used if required.
- 1.3.8 The contractor will install their own cables at the substation ends. However, should they opt to install their infrastructure at the same time as the substations are being equipped, fibre terminations amongst all parties will be co-ordinated by the Project Manager.

1.4 LINE PARAMETERS

Line Route:	<p>The line will run in a northerly direction from the Eskom Oranjemond substation near Alexander Bay in the Northern Cape to the remote substation in Namibia. The substation in Namibia, Obib, is approximately 95 km away however Eskom will only be responsible for the design and construction of the first 2 km of the line. The line is a single circuit 400 kV line and will utilise the 517 series strain towers. In addition to this the line will also make use of the 540B double circuit structure in a semi-delta single circuit configuration.</p> <p>This line is required to provide a redundancy to the existing 400 kV line to the NamPower network via the Aries – Kokerboom line and was requested for by NamPower.</p>
Network Changes	<p>In order to achieve this 400 kV connection, the Eskom network in the area will require some modifications. The newly built Gromis – Oranjemond 1 line was built at 400 kV but is currently operating at 220 kV since there is currently no 400 kV injection at Oranjemond substation. To achieve a 400 kV injection at Oranjemond substation the Gromis – Juno line, which is currently at the very early stages of its construction phase, will have to be built. Along with this, the Gromis and Oranjemond substations will require new 400 kV yards. The Gromis – Oranjemond 1 line will also have to be deviated at Gromis and Oranjemond substations to terminate at the 400 kV yard instead of the 220 kV yard. The deviations at both ends of this line will be included in the scope of work of this project. This deviation will make use of the 518 series towers.</p>
Line Length:	Approximately 2 km
Conductor:	<ul style="list-style-type: none"> • 3 x Tern ACSR, 403.77-A1/S1A-45/3.38+7/2.25 • Sub-conductor spacing: 450 mm
Groundwire:	<ul style="list-style-type: none"> • 1 x 19/2.7 steel wire (Greased) • 1 x 12 kA 0.215 Ω/km OPGW 48 Core for NamPower line (Greased) • 1 x 16 kA OPGW 48 core for the Gromis – Oranjemond line deviation (Greased)
Insulators:	Composite long rod insulators at 31 mm/kV will be used as the area is within 10 km of the coast and is deemed as a high marine pollution area.

	<p>2 x 210 kN insulators will be used for all structures except the 540B structures. The 540B structures used for the long span river crossing will utilize 2 x 300 kN insulators.</p> <p>Standard earth wire composite longrod insulators will be utilized where required</p>
Hardware:	<p>Standard strain structure hardware.</p> <ul style="list-style-type: none"> For existing towers 270 and 2 on the Gromis – Oranjemond line existing hardware will be used but new dead ends on the sides facing the new sections will be installed Existing jumpers on T270 and T2 will be used (new dead ends to match existing dead ends so that old flags has no issues) <p>Special care should be taken when looking at the long span when conducting a vibration study as a C-value of 1950m and 2250m are used for the phase conductor and the earth wire respectively.</p>
Towers:	<p>The following tower families will be used:</p> <ul style="list-style-type: none"> 518C self-supporting strain (0°-45°) 518D self-supporting strain (45°-70°) 517F self-supporting strain (35°-60°) 540B self-supporting double circuit strain (0°-25°) (to be used as a single circuit delta configuration). The option of the 543B tower is also a possibility but this tower is currently still under development.
Foundations:	<p>Soil types: Type 1, 2, 3, 4, soft rock and hard rock. Soil nominations to be conducted by the contractor and reviewed by LES for acceptance.</p> <p>Self-supporting towers: Conventional concrete pad and column foundations, augured piles (vertical only), micro piles and driven piles. Rock anchors will be incorporated into the foundation design where warranted as per the latest revision of Eskom Specification 240-47172520: TRMSCAAC 6.</p> <p>Due to the prevailing soil conditions in the area the preferred foundation option is piling.</p>
Corrosion protection:	<p>The estimated corrosion category for this line is C4.</p> <p>Corrosion protection required:</p> <p>Tower members – Medium duty galvanising</p> <p>Hardware Components - Standard Galvanising with alternative coated fasteners</p> <p>Tower Fasteners – Duplex system or alternative coatings</p> <p>Considerations should also be made for heavy duty galvanising (140 micron) once more information is available. This will be for steel work only</p>

Crossings	<ul style="list-style-type: none"> All proposed crossing systems must take into account weight of the conductor and equipment as well as impact loading should a failure occur. Orange River crossing 1x 220 kV line crossing 1x Distribution line crossing
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2. STANDARDS, SPECIFICATIONS AND DRAWINGS

2.1 STANDARDS

The standards within this section provide for the design and technical requirements for the line:

IEC 60120	Dimensions of ball and socket couplings of string insulator units.
IEC 60372	Locking devices for ball and socket couplings of string insulator units.
IEC 60383	Insulators for overhead lines with nominal voltage above 1000V.
IEC 60471	Dimensions of clevis and tongue couplings of string insulator units.
IEC 60815	Guide for the selection of insulators in polluted conditions
IEC 60826	Loading and strength of overhead transmission lines.
IEC 61089	Round wire concentric lay overhead electrical stranded conductors
IEC 61109	Composite insulators for AC overhead with nominal voltage greater than 1000V
IEC 61284	Overhead lines – Requirements and tests for fittings.
SANS 1556-1	ISO Metric screw threads part 1
SANS 1700	ISO Metric screw threads part 2
SANS 121	Hot-dip galvanized coatings on fabricated iron and steel articles specification.
SANS 935	Hot-dip zinc coatings on steel wire specification.
ISO 9001 ; 2000	Quality management systems – Requirements

2.2 SPECIFICATIONS

The line specification must take precedence if there is any conflict between it and the following specifications:

NRS 061-1:2012	Specification for Overhead Ground Wire with Optical Fibre – Part 1: Product Specification
NRS 061-2:2015	Specification for Overhead Ground Wire with Optical Fibre – Part 2: Installation Guidelines

NWS 1612 Rev 0	Specification for composite insulators.
SANS 10280	Code of practice for overhead power lines for conditions prevailing in South Africa.
240-70732888	Fibre Optic Cable System Acceptance Testing Procedure
32-245	Waste Management Procedure
TPC41-701	Approval and registration of drawings submitted by Contractors
NRS 088	Duct and Direct Buried underground Fibre Optic Cable
240-70733995	Optical Distribution Frames
240-47172520	The standard for the construction of overhead powerlines
240-60777474	Specification for suspension and strain assemblies and for hardware for transmission lines.
240-72274816	Fibre Optic Joint Enclosures For Aerial Cables
TST41-168	Quality requirements for the procurement of assets, goods and services.
240-130615862	Earthing of Transmission Line Towers
240-110403330	OPGW Hardware and Installation Requirements for Overhead Lines

2.3 DRAWINGS

LES-GEN-OPGW-1	OPGW insulated strain assembly for joint towers
LES-GEN-OPGW-2	OPGW insulated strain assembly
LES-GEN-OPGW-3	OPGW non-insulated strain assembly
LES-GEN-OPGW-4	OPGW non-insulated strain assembly for joint towers
LES-GEN-OPGW-5	OPGW non-insulated suspension assembly
LES-GEN-OPGW6	OPGW insulated suspension assembly
LES-GEN-OPGW7	Earth bonds
LES-GEN-OPGW8	Non-insulated down-lead clamps
LES-GEN-OPGW9	Insulated down-lead clamps
Gen-OPGW10	Junction box
Drawing 3	Joint Box arrangement on line Tower
OPGW-STR-NON	Non insulated assembly for conversion of suspension tower to joint position

- The drawings LES – GEN - OPGWx are for reference only and are simply indicative of the Employer's requirement.

- All OPGW hardware and Cable to be acquired from Eskom pre-approved suppliers. For further information on these suppliers, Eskom can make these details available.
- Before any hardware or OPGW cable is acquired, Eskom needs to accept the drawings first. If new OPGW cable is being used, compatibility tests are required to check the strain assembly loading with the new OPGW cable. Also, the supplier of the OPGW cable must submit the latest PLSCADD data to Eskom for checking of the profile.

3. SECTION A - OPGW

3.1 OPGW REQUIREMENTS

3.1.1 OVERVIEW

This section contains the installation requirements for the OPGW cables. For specifications relating to the fault current capacity, diameter and UTS refer to the concept design report. The OPGW cable is free-issue and will comply with all specifications in NRS 061-1, unless improved upon below. The OPGW must be tested before and after stringing according to the test specifications in NRS061-2.

Note that the Optical requirements of the OPGW and Duct cables are the same.

3.2 OPGW HARDWARE REQUIREMENTS

3.2.1 SPECIFICATIONS

All work must be carried out in accordance with the Standards, Specifications and Drawings listed in Section 2 and this document.

3.2.2 TECHNICAL DETAILS

The Contractor is encouraged to optimise (in terms of improved solutions and quantities) all insulation and hardware assemblies, but must nevertheless maintain overall connecting lengths of hardware assemblies, mechanical strengths, and electrical parameters.

The assemblies must be such that they can be coupled directly to the standard tower shackle provided with the tower.

Additional items may be required in the assemblies to suit the Contractor's designs. All conceptual drawings provided give critical dimensions only, and must not be considered as the final solution.

Test certificates for all vibration damping devices to be used must be submitted to the Employer by the Contractor before delivery commences, indicating the damper performance test(s) that have been conducted on the damping devices.

The strength requirement as indicated by the drawings refers to hardware material strength. In the case of suspension and earth wire strain assemblies, it does not refer to the slipping strength between the conductors and clamp for example.

With reference to specification NRS061-2, “Specification for Overhead Ground Wire with Optical Fibre – Part 2: Installation Guidelines”, particular attention must be paid to the hardware arrangements at splicing towers. Furthermore, all the requirements in terms of grounding connectors, down-lead clamps, support insulators, earth tails with crimped on lugs, bending radius, grounding cable connection to towers, cleaning of OPGW and towers, must be observed and adhered to.

3.2.2.1 Suspension Assembly for OPGW (See Drawings LES-GEN-OPGW-5 & LES-GEN-OPGW -6)

Conceptual assemblies are shown on the drawing for both standard and insulated OPGW suspension assemblies. When selecting hardware for OPGW great care must be taken not to apply excessive stresses on the conductor under any circumstances. Preference will be given to armour grip suspension clamps. The hardware strength requirements are indicated on the drawing.

3.2.2.2 Non-Insulated Strain Assembly for OPGW (See Drawing LES-GEN-OPGW-3)

Conceptual assemblies are shown on the drawing for standard OPGW strain assemblies. When selecting hardware for OPGW great care must be taken not to apply excessive stresses on the OPGW under any circumstances.

3.2.2.3 OPGW Non-Insulated Strain Assembly at Joint Tower (See Drawing LES-GEN-OPGW-4)

Continuous earth connection with adequate rating between the spans and to the tower steelwork must be established in accordance with Section 3.2.2.11. Non-insulated OPGW down-lead clamps must be used to support the OPGW to the splicing box. These down-lead clamps must be spaced no more than 2 metres apart and be installed at every tower member intersection and crossing with the OPGW conductor.

3.2.2.4 OPGW Insulated Strain Assembly (See Drawing LES-GEN-OPGW-2)

Continuous earth connection with adequate rating between the spans must be established in accordance with Section 3.2.2.11. Depending on the geometry of the tower, a support insulator might be required to prevent the ground cable from touching the tower structure under all environmental conditions.

3.2.2.5 OPGW Insulated Strain Assembly at Joint Tower (See Drawing LES-GEN-OPGW-1)

Continuous earth connection with adequate rating between the spans must be established in accordance with Section 3.2.2.11.

Depending on the geometry of the tower, a support insulator might be required to prevent the ground cable from touching the tower structure under all environmental conditions. Insulated OPGW down-lead clamps providing a minimum creepage distance of 50mm must be used to support the OPGW to the splicing box, including any slack loops. These down-lead clamps must be spaced no more than 2 metres apart and be installed at every tower member intersection and crossing with the OPGW conductor.

The splicing box must also be fitted with suitable stand-off insulators similar to those fitted to the down-lead clamps.

- OPGW cable lengths must be selected to avoid the necessity (as far as possible) of having any joints at a tower where the earth-wire/OPGW is required to be insulated from the tower steelwork.
- Where a joint at an “insulated earth-wire” tower is unavoidable, the installation must be carried out strictly as specified in the document NRS061-2, “Specification for Overhead Ground Wire with Optical Fibre – Part 2: Installation Guidelines”. A 50mm clearance to the tower steelwork must be observed for the cable, joint box and slack-loop by the application of approved insulation hardware, as prescribed above.
- The two sections of OPGW cable must be properly bonded so that fault current flow is unimpeded.
- Note on Drawing LES-GEN-OPGW-1 that a stand-off insulator must be mounted on the tower, and connected to the OPGW as shown in a similar manner to how the Shunt Cable is terminated. This is to support earthing of the OPGW by operating staff without causing damage to the OPGW. The stand-off insulator must be connected to the line side of the slack loop, but as close to the joint box as possible. This must be done per download.
- See also Drawing Gen-OPGW11 showing the safety earthing stand-off connections that are to be applied, and on the line side of the slack loop.

In the case of an existing line where the joint box needs to be lowered to ground level the points listed below shall apply:

- An earth must be applied at a point that will not be affected when lowering the Joint Enclosure. The Earth must be applied in such a manner that it connects both OPGW down-leads to the Tower at a common point .If it is necessary to cut the OPGW back, the earth must be applied at a point above the work area.
- It is preferable not to connect the earth clamp to the OPGW, but to connect it to the “sacrificial conductor” (see Section E) if one is fitted as conventional earthing techniques could damage

the Aluminium Cladding/Aluminium Alloy outer strands and, in the former case, accelerate corrosion.

- Once the Joint has been lowered to ground level an additional working earth should be applied as close as possible to the work place and connected to the common grounding point on the Tower.
- Once all work has been completed and the Joint has been reattached to the tower and all personnel are clear the earth may be removed.

3.2.2.6 Typical Installation At Non-Insulated Splicing Tower

Detail arrangements depending on the type of tower must be supplied on how the splicing boxes must be installed above the anti-climbing devices. The minimum bending radius of 500mm, or as recommended by the cable manufacturer, must be adhered to at all times.

To allow sufficient slack for the joint to be brought to ground level for splicing, the OPGW downlead length at a joint tower must be equal to a minimum of the tower height plus 5m.

Should a duct cable be present at such a joint tower, then a minimum length of 10m should be allowed above the anti-climb guard.

For duct cables, a minimum slack loop of 5m must be allowed for.

All slack to be taken up in a proper manner.

Note that the tower clamps (down-lead & joint box) must be fitted with pinch bolts with "swivel seats" to avoid damaging the galvanising of the tower.

In the case of an existing line where the joint box needs to be lowered to ground level the points listed below shall apply:

- As the entire installation (OPGW. down-leads, slack-loop and joint box) is bonded to the tower, both at the tower peak and at each down-lead clamp down the tower as well as the joint box, only a working earth is applied as close to the work place as possible.
- Once all work has been completed and the Joint has been reattached to the tower and all personnel are clear the earth may be removed.

3.2.2.7 Substation Gantries

At Gromis and Oranjemond gantries, the OPGW cable must terminate on the substation gantries, not the terminal tower. Installation must be in general accordance with 3.2.2.6 above.

Note that the OPGW must be clamped on the outside of the gantry structure, and not threaded through the structure.

3.2.2.8 Earth-wire Insulators

These insulators must be applied to the installations depicted in drawings LES-GEN-OPGW-1, LES-GEN-OPGW-2, LES-GEN-OPGW-6 and FISTAJT.

3.2.2.9 Vibration Dampers For OPGW Conductor

The offer must include a schedule of required spacing for spans 200m to 1000m for the product offered. In cases where spans exceed 1000m the hardware supplier should be contacted to determine the correct damper spacing to be used on the line.

The OPGW cable will typically be strung to the specified C-value, or to a value matching the sag of existing earth wires when applicable.

Where:

$$C = H/W$$

H = final horizontal tension (N)

W = vertical weight of conductor (N/m)

The requirements for damping aeolian vibration for the OPGW conductor strung at the specified C-value or any other C-value as agreed to with manufacturer, are that the maximum allowable stress in the OPGW outer layers must not exceed the safe bending limit set by the manufacturer. For the calculation of placement of Stockbridge type aeolian vibration dampers a wind speed of 7m/s perpendicular to the OPGW cable can be used. **Only multi-frequency type Stockbridge dampers must be used.**

Contractors must supply the results of a detailed vibration analysis on the positioning of Stockbridge-type dampers, based on the everyday tension provided and the characteristics of the cable offered, for the project manager's approval, prior to commencement of stringing.

3.2.2.10 Materials

OPGW:

The material and construction of the OPGW will be specified as per the offer.

FITTINGS

Tension & suspension assemblies and current transfer tab:

Only pre-formed type suspension and strain assemblies must be used. The choice of material for tension and suspension assemblies, as well as the earth bond mechanism, must be specified by the

OPGW manufacturer to match the material of the OPGW and will take precedence over this specification. In order not to initiate galvanic type couplings using dissimilar materials and thereby enhancing corrosion of the materials, the following must be observed. If the OPGW outer layer is of steel, the fitting material will be of steel material. When the OPGW outer layer is of aluminium or aluminium clad steel material, the fitting material will be of either an aluminium alloy or aluminium clad steel material. In all cases the correct lay direction of the fittings in relation to the OPGW must be observed. Normally the lay direction of the fitting wire is opposite to the outer OPGW layer direction.

3.2.2.11 Grounding Cable or Earth Bonds (See Drawings)

- The OPGW must be correctly bonded to earth at the terminal station gantries and at all non-insulated earth-wire towers. Type Test Certificates for proposed earth bonds must be available on request.
- The type of material and size will be adequate to safely handle the required short circuit rating and requirements of the OPGW as specified. The choice of material must also consider compatibility with the OPGW and current transfer tab, not to initiate galvanic corrosion.
- All earth bonds must be of the flexible type and be corrosion resistant. Earth bonds must be of sufficient length to connect the OPGW to the tower steel work. To accommodate this, one end of the earth bond must be fitted with a crimped lug enabling connection to the tower steel work by means of an M16 bolt. Before connecting the crimped lug or fitting to the tower members, the tower steelwork shall be cleaned to remove paint or grease (or both) to ensure proper electrical connection. After connection the exposed area(s) shall be re-painted or cold galvanized to prevent corrosion of the tower steel members. The other end of the earth bond must be fitted with a suitable clamp arrangement for connection to the OPGW.
- The pre-formed type “pig tail” earth bond is not acceptable. However connection of the earth bond to the OPGW or OPGW armour rods by means of pre-formed helical attachment, a current transfer tab or a parallel groove type (PG clamp) connection, will be acceptable on condition that results of electrical testing be submitted. The electrical testing must be performed not on the earth bond in isolation but on the complete connected assembly including the OPGW simulating a typical fault current in field conditions. The type of material and size must be adequate to safely handle the required short circuit rating requirements of the OPGW as specified. The choice of material must also consider compatibility with the OPGW not to initiate galvanic corrosion. When using parallel groove type clamps, the design must be such that no excessive stresses, that will affect the performance of the OPGW under any circumstances, will be induced.

- The companion earth-wire must be continuous from gantry to gantry. It may be necessary to install additional jumper straps on this earth-wire. The Contractor must allow for this eventuality, and perform the necessary work.

3.2.2.12 Tensile Type Test

A tensile type test must be performed on the OPGW, **together with the line hardware to be used on the actual system**, to prove that the combination will achieve a tensile performance of a minimum of 95% of the stated UTS of the OPGW cable. (Note: UTS= ultimate tensile strength). A type test report, witnessed by the Employer or its appointed representatives, must be submitted after tender award and prior to installation.

Note: the Contractor should ensure that when the relevant strain hardware and OPGW cable are tested and eventually installed, the relative movement between inner and outer layers (in the case of a multi-layer construction) should be the minimum possible. This may either be achieved by selecting the appropriate cable construction for the intended hardware to be used or selecting appropriate hardware for the suggested cable construction.

The OPGW cable plus hardware may be considered to be a system. The Contractor must therefore supply the hardware correctly matched to the OPGW cable to minimise installation and operational problems during the life of the cable, under all conditions.

3.2.2.13 Joint Boxes

All the joint boxes for the OPGW must be in accordance with 240-72274816.

Joint boxes must have 4 re-sealable ports, which remain sealed until required. The joint boxes must be capable of multiple re-entries without damaging the sealing mechanism.

Joint boxes must be accepted by the Employer.

All joint boxes must be mounted as high in the tower as practical, to avoid theft. It must be ensured that the mounting height of the joint box is such that the safe working clearance from any of the phase conductors to the joint box is not less than the distance as specified below:

- 400kV - 4.0 metre + 1 metre = 5.0 metre

4. SECTION B – CABLE SPECIFICATIONS

Three OPGW cable suppliers are currently on the Eskom OPGW national contract and each supplier provides cables with parameters. The design leader should ensure that in instances where specific cable parameters are required from a design perspective, the project manager is made aware of

these requirements so that the cable from the correct supplier is procured. The cable supplier should ensure that the cable can be strung up to a C-value of 2100m which ensures a similar sag profile to the parallel earthwire and therefore ensures adequate clearance to the phase conductors. **For this particular application, 1 x 16 kA grease 48 core OPGW and 1 x 12 kA greased 48 core OPGW cables are required as specified in Section 1.2.**

5. SECTION C – TESTING

5.1 TESTING REQUIREMENTS

5.1.1 Joint Testing

All joints must be tested in accordance with the latest revision of Eskom Fibre Acceptance Test Procedure 240-70732888, Class B.

5.1.2 For requirement of the testing of secondary plant equipment please refer to the secondary plant document.

6. SECTION D– SUMMARY OF HARDWARE QUANTITIES & OPGW JOINT POSITIONS

6.1 NAMPOWER 400KV-ORANJEMOND TO NAMPOWER BORDER OPGW INSTALLATION

Table 6.1.1: Summary of Hardware Quantities

Item	Description	Unit	Quantity (m)	Quantity With Spares (m)	Comments
1	OPGW cable (material only)				
1.1	Supply of 48-core, 12kA OPGW cable	m	2288	2516,80	
2	Aerial Hardware				
2.1	Standard Strainer assemblies non insulated (FNISTA)-one for each side of tower	ea	2	3	
2.2	Standard Strainer assemblies complete for joint towers (FNISTA-JT) - one set for a tower comprising of two strain assemblies and other items.	ea	2	3	
2.3	Insulated Strainer assemblies complete for joint towers (FISTA-JT)-complete assembly for one tower comprising of two strain assemblies and associated hardware	ea	0	0	
2.4	Insulated Strainer assemblies complete (FISTA)	ea	6	7	
2.5	Standard suspension assemblies (FNISUA)	ea	0	0	0

2.6	Insulated suspension assemblies complete (FISUA)	ea	0	0	0
2.7	Standard Crossrope assemblies (FNISUA)	ea	0	0	0
2.8	Insulated Crossrope assemblies complete (FISPA)	ea	0	0	0
2.9	Standard down lead clamps Non Insulated	ea	30	35	
2.10	Insulated down-lead clamps	ea	0	0	
2.11	Double Tab Earthbonds (XREB)	ea	0	0	
2.12	Current Transfer Saddles (CTS)	ea	3	4	
2.13	Current Transfer Saddles Double Shunt (CTS-DS)	ea	0	0	
2.14	Earthwire Insulators	ea	6	7	
2.15	Extension Links	ea	4	6	Only required if non-insulated strainer don't come with extension links
2.16	Supply and install Vibration dampers (based on stockbridge dampers)	ea	12	14	
2.17	Joint Boxes insulated	ea	0	0	
2.18	Joint Boxes Non insulated	ea	2	3	
2.19	Assembly for joint on suspension (Non-Insulated) - supplied from PLP as a complete unit no need to order two (FNISTA-DST)	ea	0	0	
2.20	Assembly for joint on suspension (Insulated) - supplied from PLP as a complete unit no need to order two (FISTA-DST)	ea	0	0	

Table 6.1.2: Summary of Drum Lengths and Joint Positions

Eskom drum lengths		
Structure numbers	Drum Lengths (m)	With Spares (m)
Obib 1 Gantry	0	
Border/ORR 001	2288	2516,8
Total	2288	2516,8

**ESKOM – NAMPOWER 2ND 400 KV
INTERCONNECTOR
OPGW AND HARDWARE SCOPE OF WORK**

Table 6.1.3: Tower by tower BOQ

OPGW kA Rating =	12					Downlead Clamps		Strainer Assemblies		Suspension Assemblies		Crossrope Assemblies		Earth bonds					
	Span ahead	Tow er type	Strain or suspension	Insulated	OPGW Joint Boxes	Std	I n s u l a t e d	Std	Ins u l a t e d	Std	I n s u l a t e d	Std	I n s u l a t e d	X R E B	C T S	CTS-DS	Vibration Dampers	Joint Assembly Type	Other Assembly Type
Obib 1 Gantry	65,62	400k	Gantry	0	1	10									1		2	FNISTAJT	
Border/OR A 005	257,79	517F	Strain	Insulated					2								2		FISTA
Border/OR A 004	380,42	517F	Strain	Insulated					2								2		FISTA
Border/OR A 003	965,05	540 B	Strain	Insulated					2								2		FISTA
Border/OR A 002	619,90	540 B	Strain	0				2									2		FNISTA
Border/OR A 001	0,00	517F	Strain	0	1	20									2		2	FNISTAJT	
Total					2	30	0	2	6	0	0	0	0	0	3	0	12		

6.2 GROMIS ORANJEMOND 400 KV LINE DEVIATION OPGW INSTALLATION

Table 6.2.1: Summary of Hardware Quantities

Item	Description	Unit	Quantity (m)	Quantity With Spares (m)	Comments
1	OPGW cable (material only)				
1.1	Supply of 48-core, 16kA OPGW cable	m	1468	1614,80	
2	Aerial Hardware				
2.1	Standard Strainer assemblies non insulated (FNISTA)-one for each side of tower	ea	8	9	
2.2	Standard Strainer assemblies complete for joint towers (FNISTA-JT)- one set for a tower comprising of two strain assemblies and other items.	ea	3	4	
2.3	Insulated Strainer assemblies complete for joint towers (FISTA-JT)-complete assembly for one tower comprising of two strain assemblies and associated hardware	ea	1	2	
2.4	Insulated Strainer assemblies complete (FISTA)	ea	2	3	
2.5	Standard suspension assemblies (FNISUA)	ea	0	0	0
2.6	Insulated suspension assemblies complete (FISUA)	ea	0	0	0
2.7	Standard Crossrope assemblies (FNISUA)	ea	0	0	0
2.8	Insulated Crossrope assemblies complete (FISPA)	ea	0	0	0
2.9	Standard down lead clamps Non Insulated	ea	40	45	
2.10	Insulated down-lead clamps	ea	20	25	
2.11	Double Tab Earthbonds (XREB)	ea	0	0	0
2.12	Current Transfer Saddles (CTS)	ea	12	13	
2.13	Current Transfer Saddles Double Shunt (CTS-DS)	ea	2	3	
2.14	Earthwire Insulators	ea	4	5	
2.15	Extension Links	ea	13	14	if not supplied as complete assemblies for not insulated strainers
2.16	Supply and install Vibration dampers (based on stockbridge dampers)	ea	18	20	
2.17	Joint Boxes insulated	ea	1	2	
2.18	Joint Boxes Non insulated	ea	3	4	
2.19	Assembly for joint on suspension (Non-Insulated) - supplied from PLP as a complete unit no need to order two (FNISTA-DST)	ea	0	0	
2.20	Assembly for joint on suspension (Insulated) - supplied from PLP as a complete unit no need to order two (FISTA-DST)	ea	0	0	

Table 6.2.2: Summary of Drum Lengths and Joint Positions

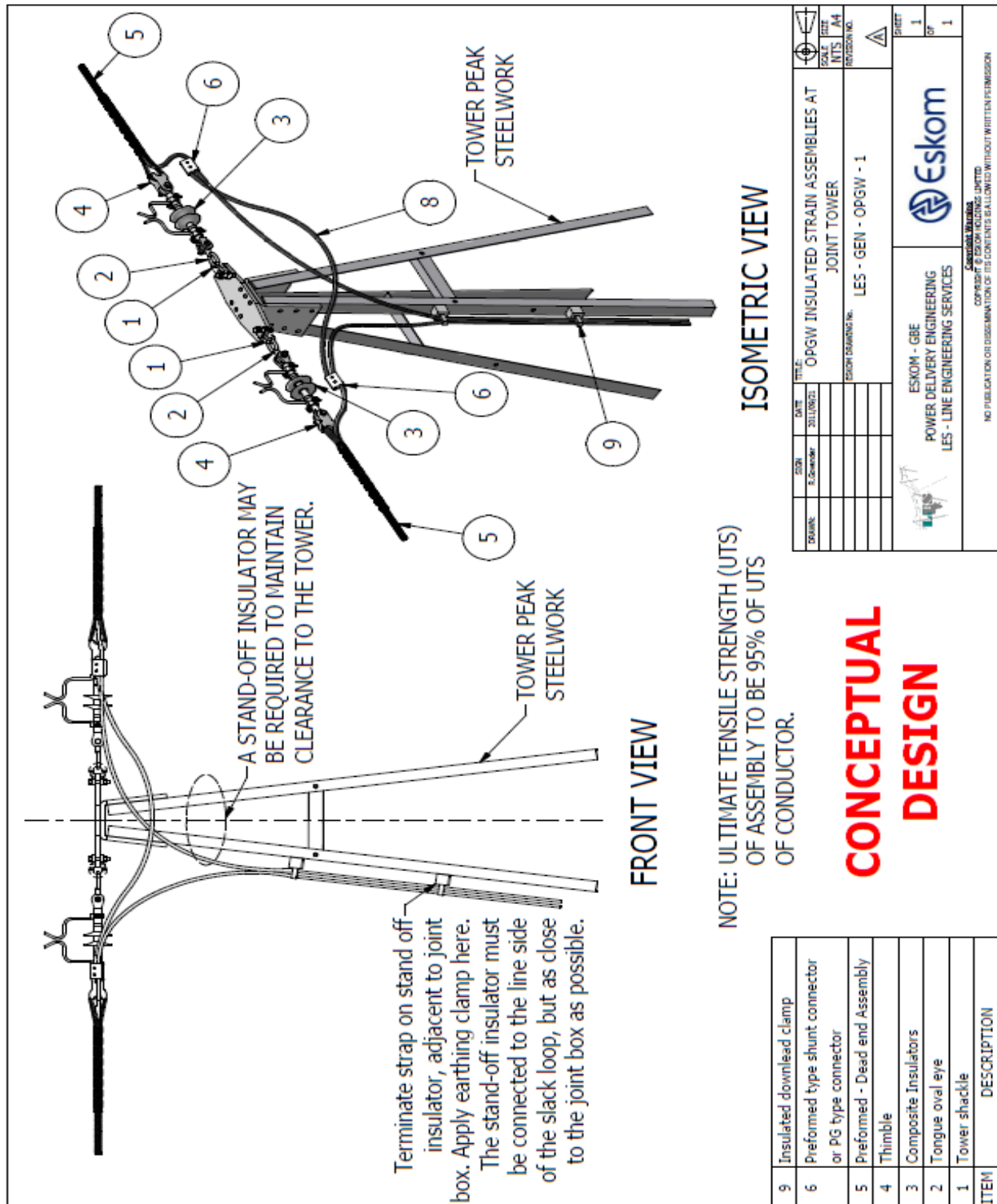
Eskom drum lengths		
Structure numbers	Drum Lengths (m)	With Spares (m)
GRO/OR A 002-existing	0	0
ORA 400kV Gantry	1053	1158,3
GRO/OR A270-existing	0	0
400kV Gantry 1	415	456,5
Total	1468	1614,8

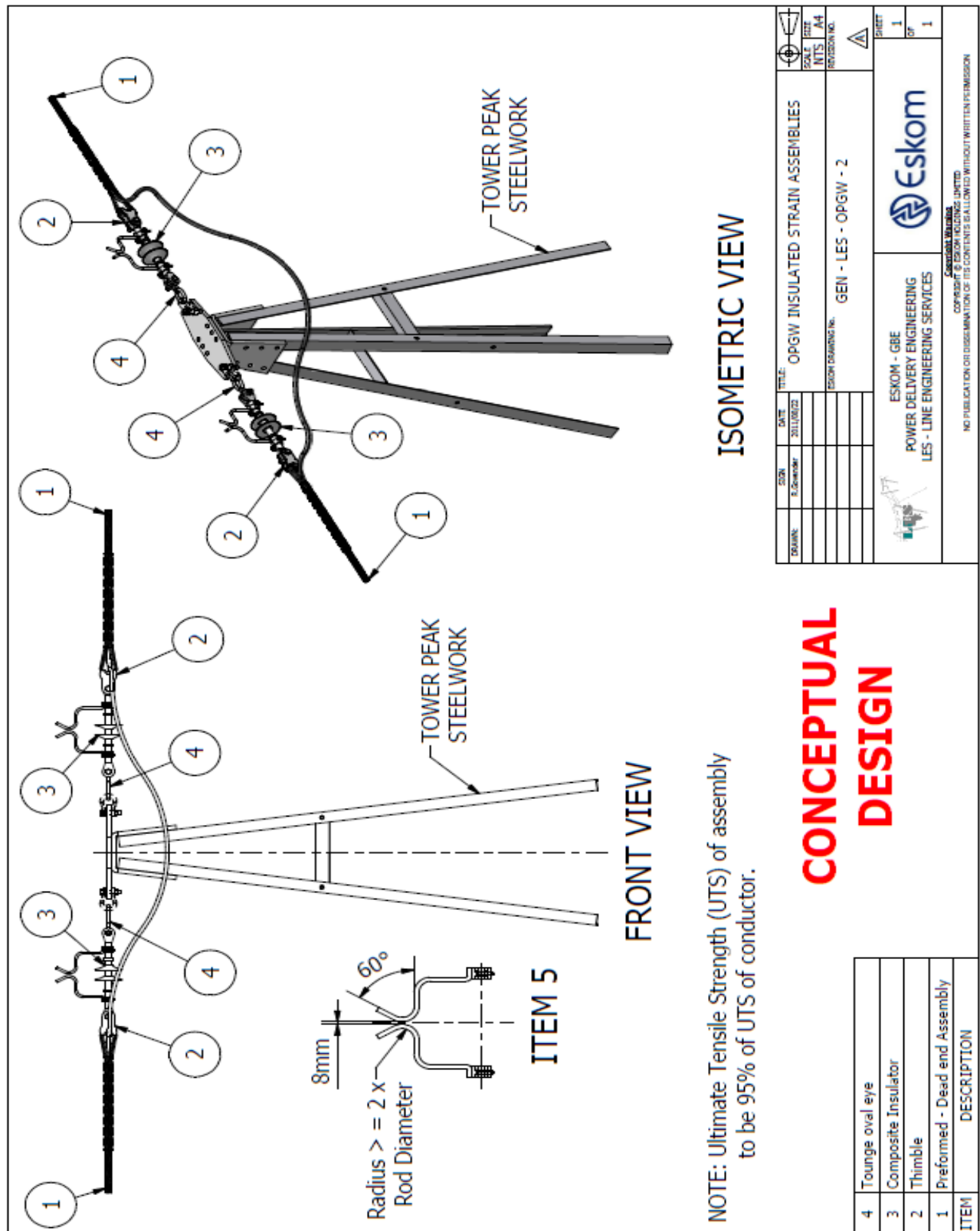
**ESKOM – NAMPOWER 2ND 400 KV
INTERCONNECTOR
OPGW AND HARDWARE SCOPE OF WORK**

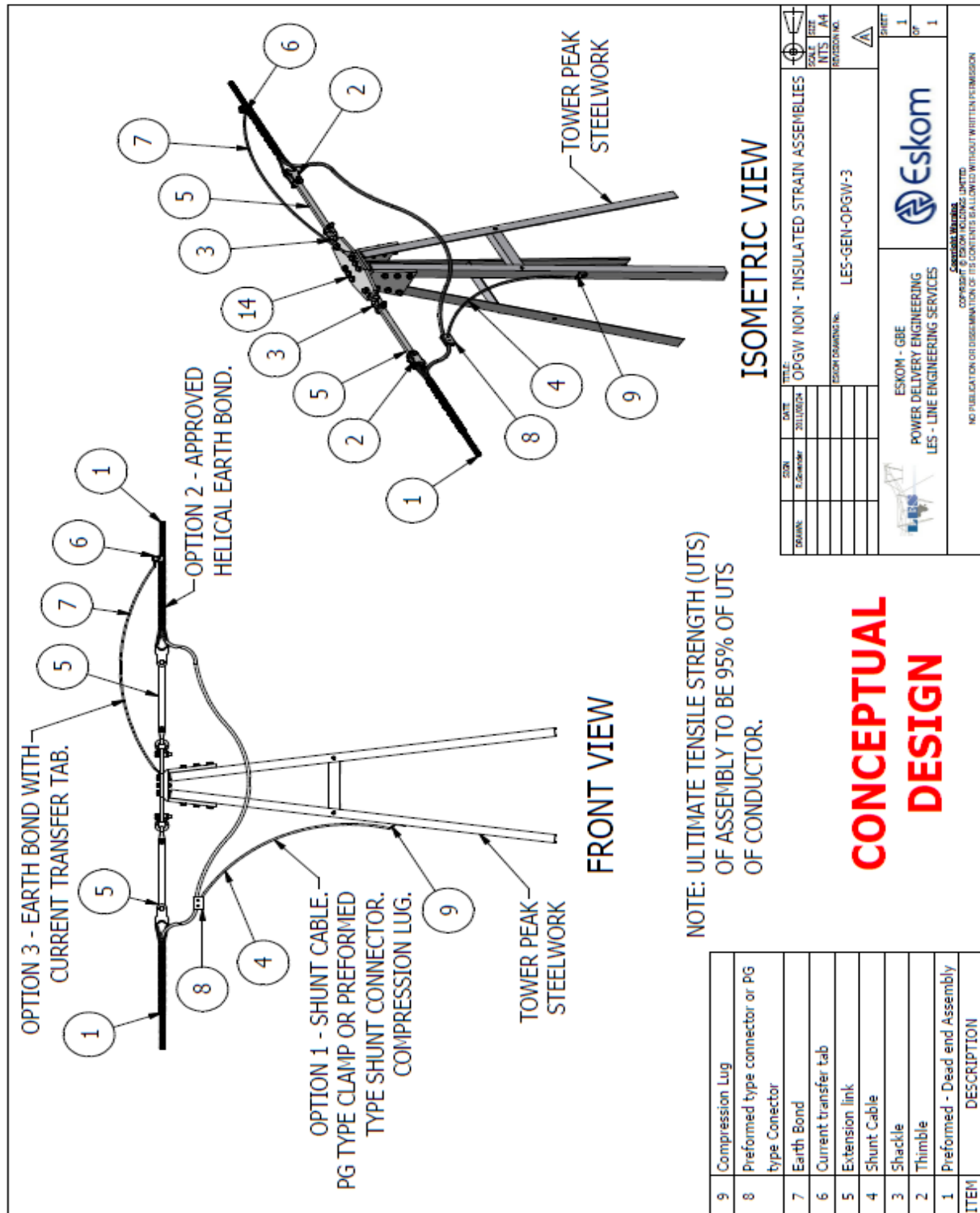
Table 6.2.3: Tower by tower BOQ

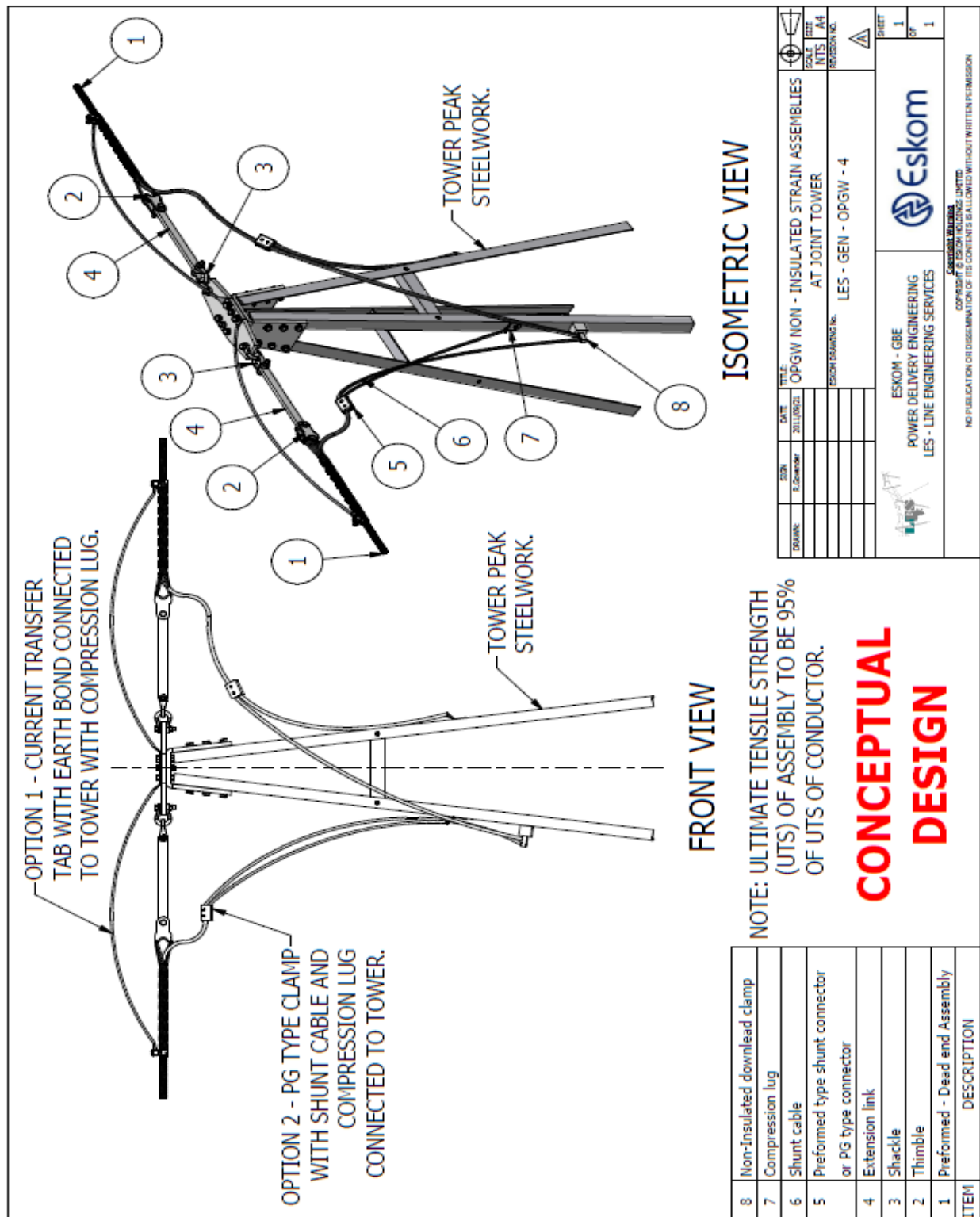
OPGW kA Rating =	16					Downlead Clamps		Strainer Assemblies		Suspension Assemblies		Crossrope Assemblies		Earth bonds			Vibration Dampers	Joint Assembly Type	Other Assembly Type
						Std	Insulated	Std	Insulated	Std	Insulated	Std	Insulated	XREB	CTS	CTS-DS			
GRO/ORA 002-existing	433,83	517E	Strain	0	1	20									2		2	FNISTAJT	
GRO/ORA 001D	309,56	518C	Strain	0				2							2		2		FNISTA
GRO/ORA 001C	172,67	518D	Strain	0				2							2		2		FNISTA
GRO/ORA 001B	86,18	518D	Strain	0				2							2		2		FNISTA
GRO/ORA 001A	51,36	518D	Strain	0				2							2		2		FNISTA
ORA 400kV Gantry	0,00	400k	Gantry	0	1	10									1		2	FNISTAJT	
GRO/ORA2 70-existing	308,99	517E	Strain	Insulated	1	20										2	2	FISTAJT	
GRO/ORA2 71	106,10	517F	Strain	Insulated				2									2		FISTA
400kV Gantry 2	0,00	400k	Gantry	0	1	10									1		2	FNISTAJT	
					4	40	20	10	0	0	0	0	0	0	12	2	18		

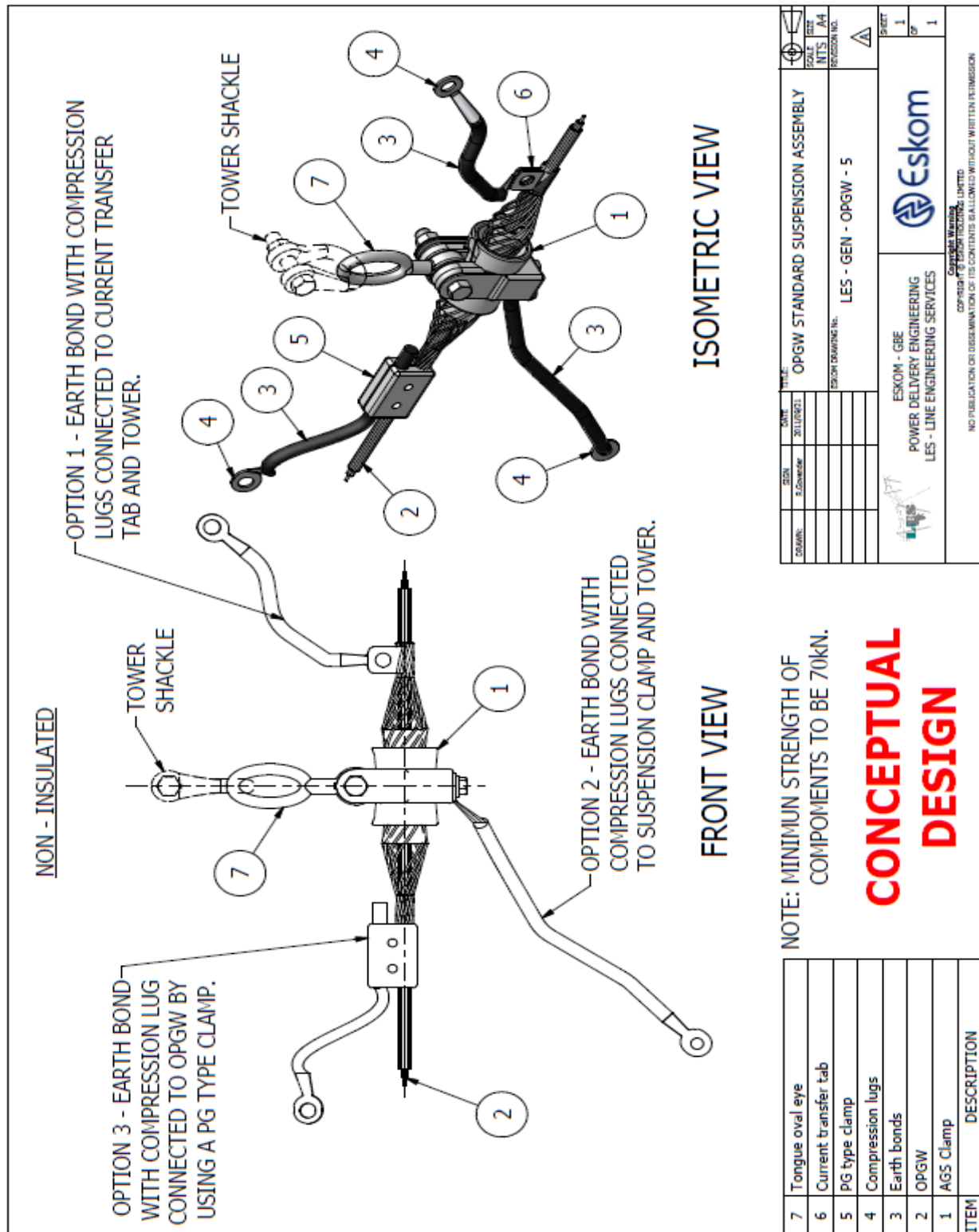
7. SECTION E – DRAWINGS

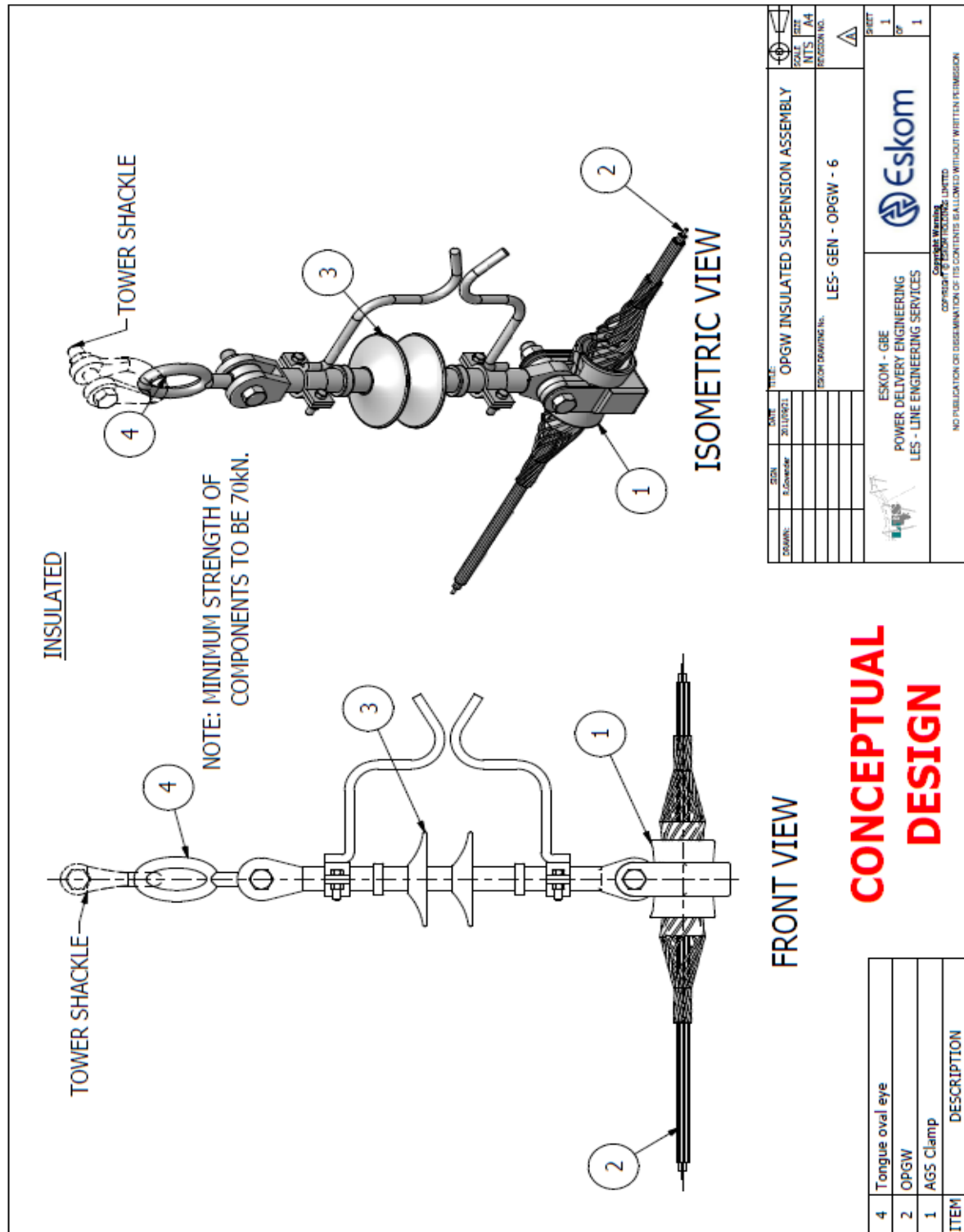












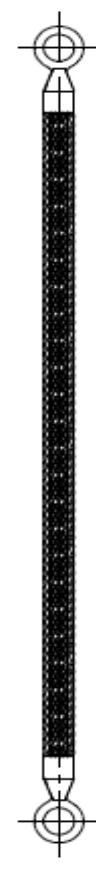




TOP VIEW



ISOMETRIC VIEW





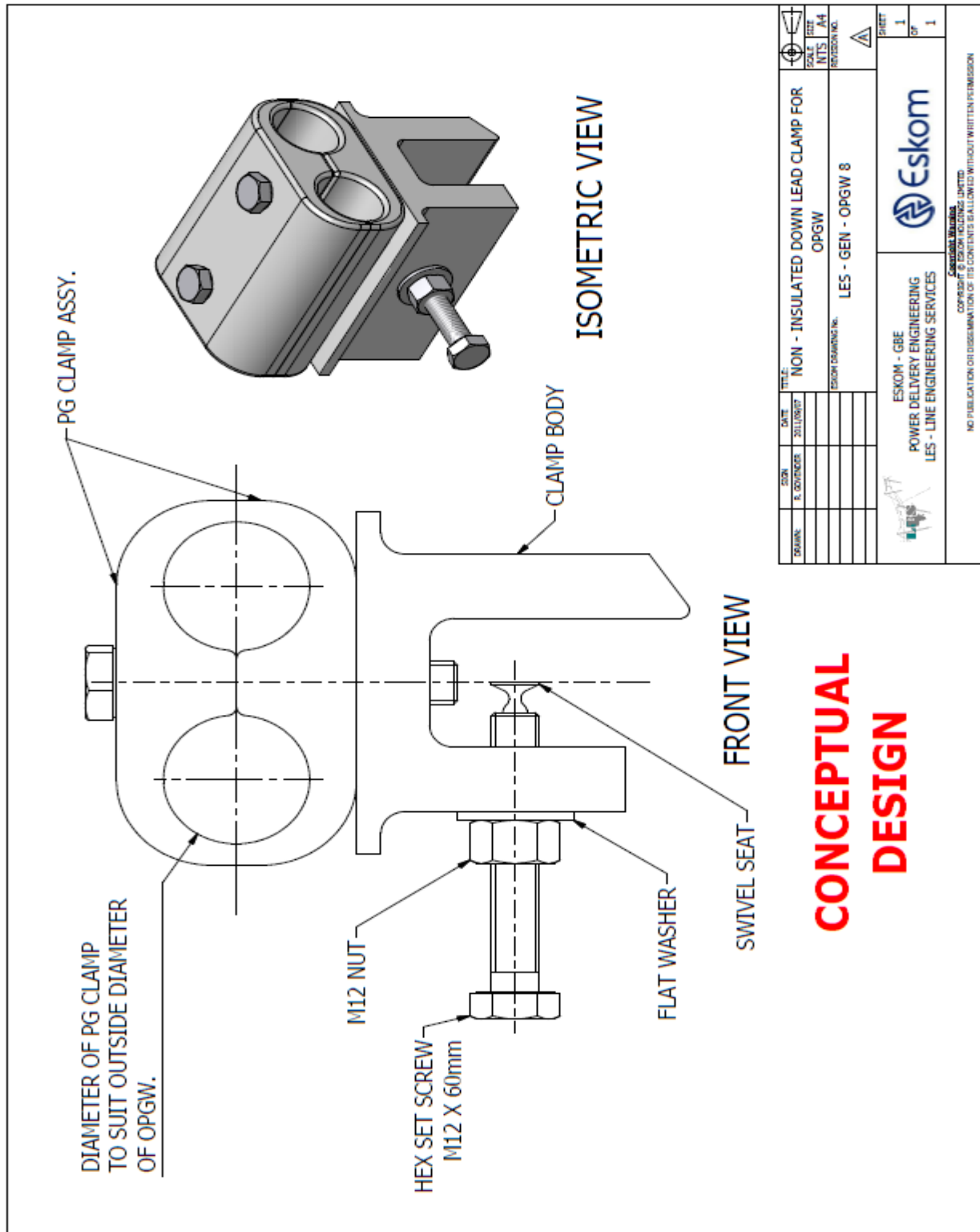
FRONT VIEW

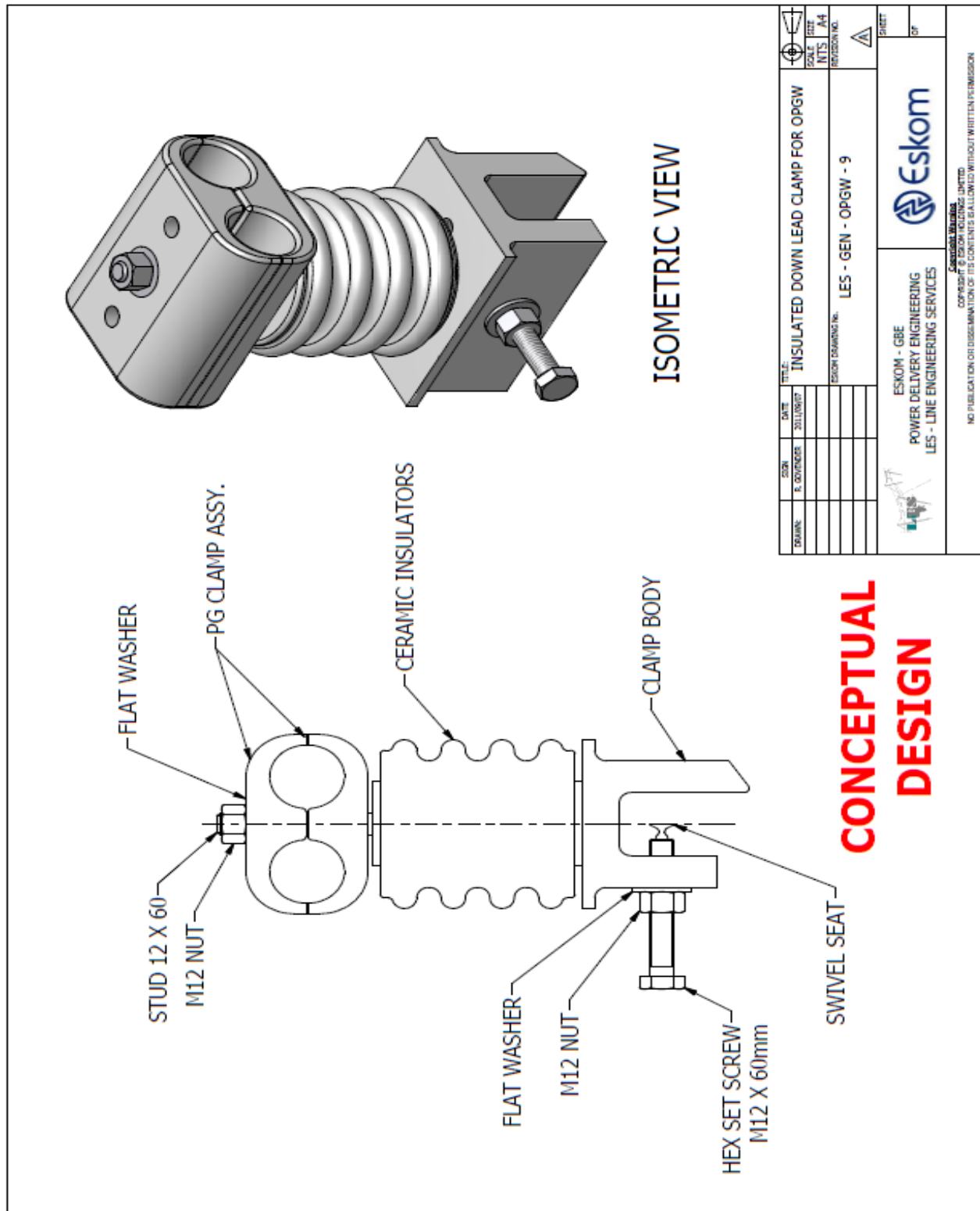
CONCEPTUAL DESIGN

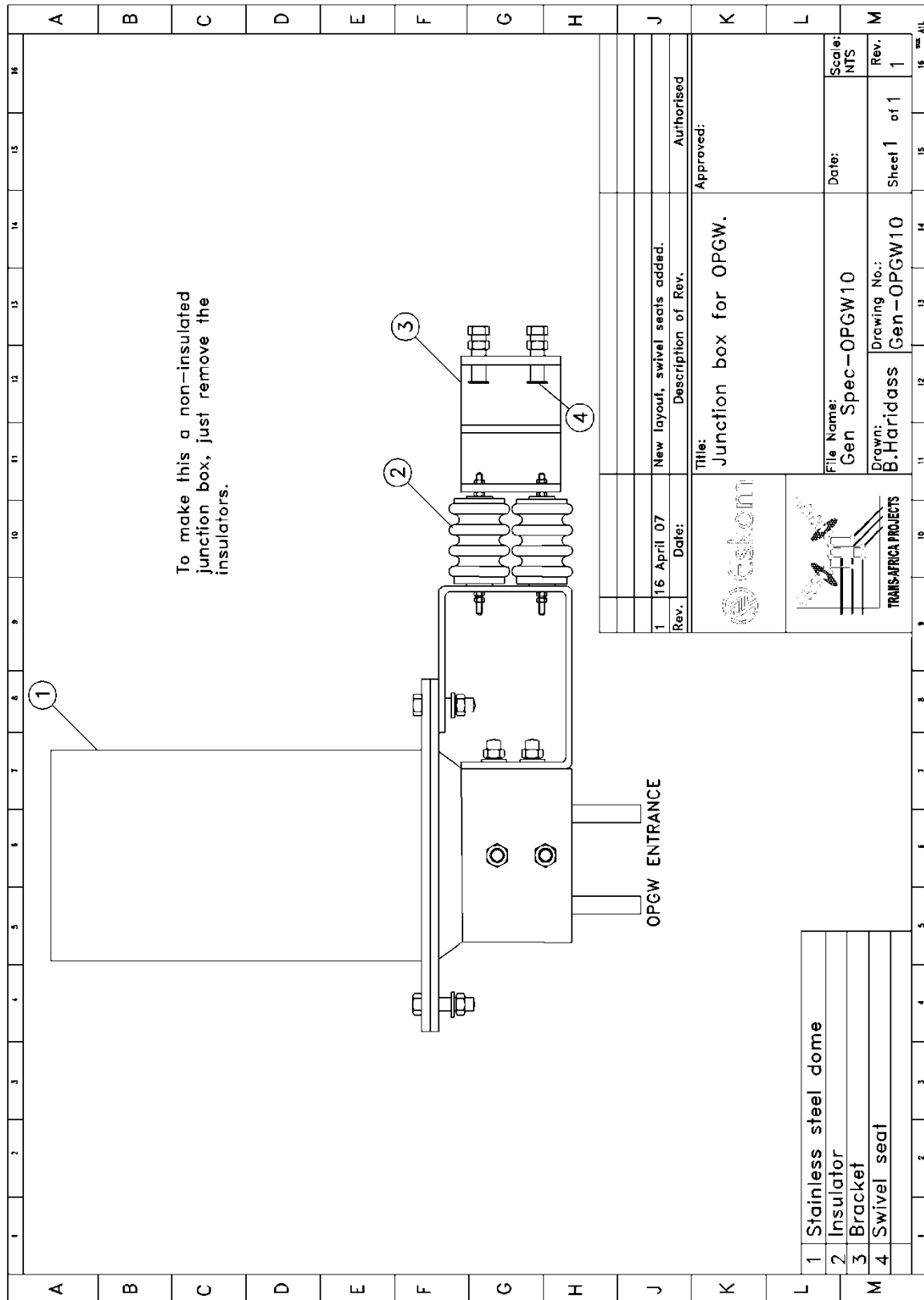
NOTE: The earth bond should be having the following specifications:

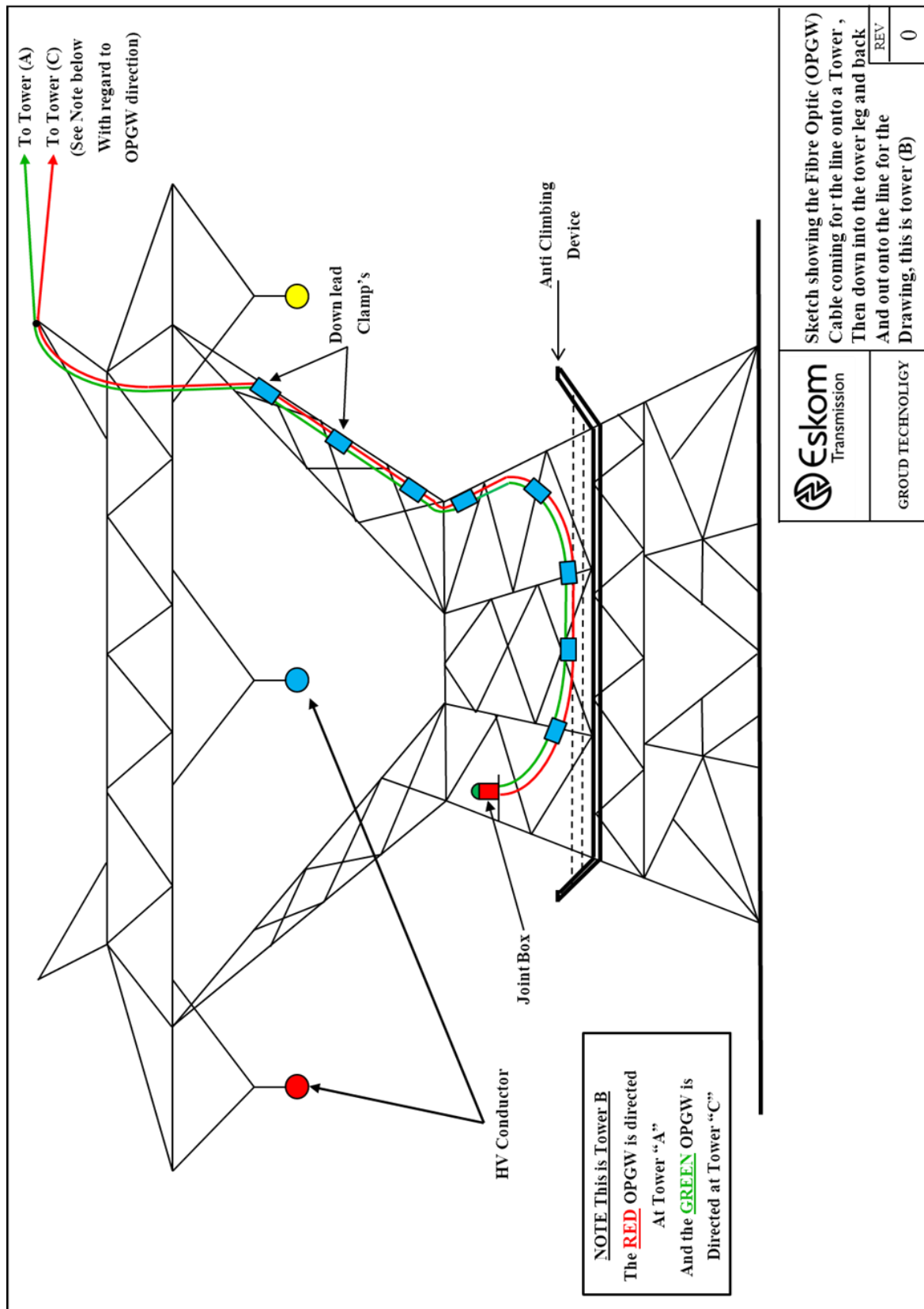
1. Suitable to match OPGW diameter - 9 to 16mm.
2. Lengths - 1m, 1.5m, and 1.8m.
3. Lugs should have a 16mm diameter hole for attachment to tower bolt.
4. Be of flexible type. (AAAC Conductor to be used)

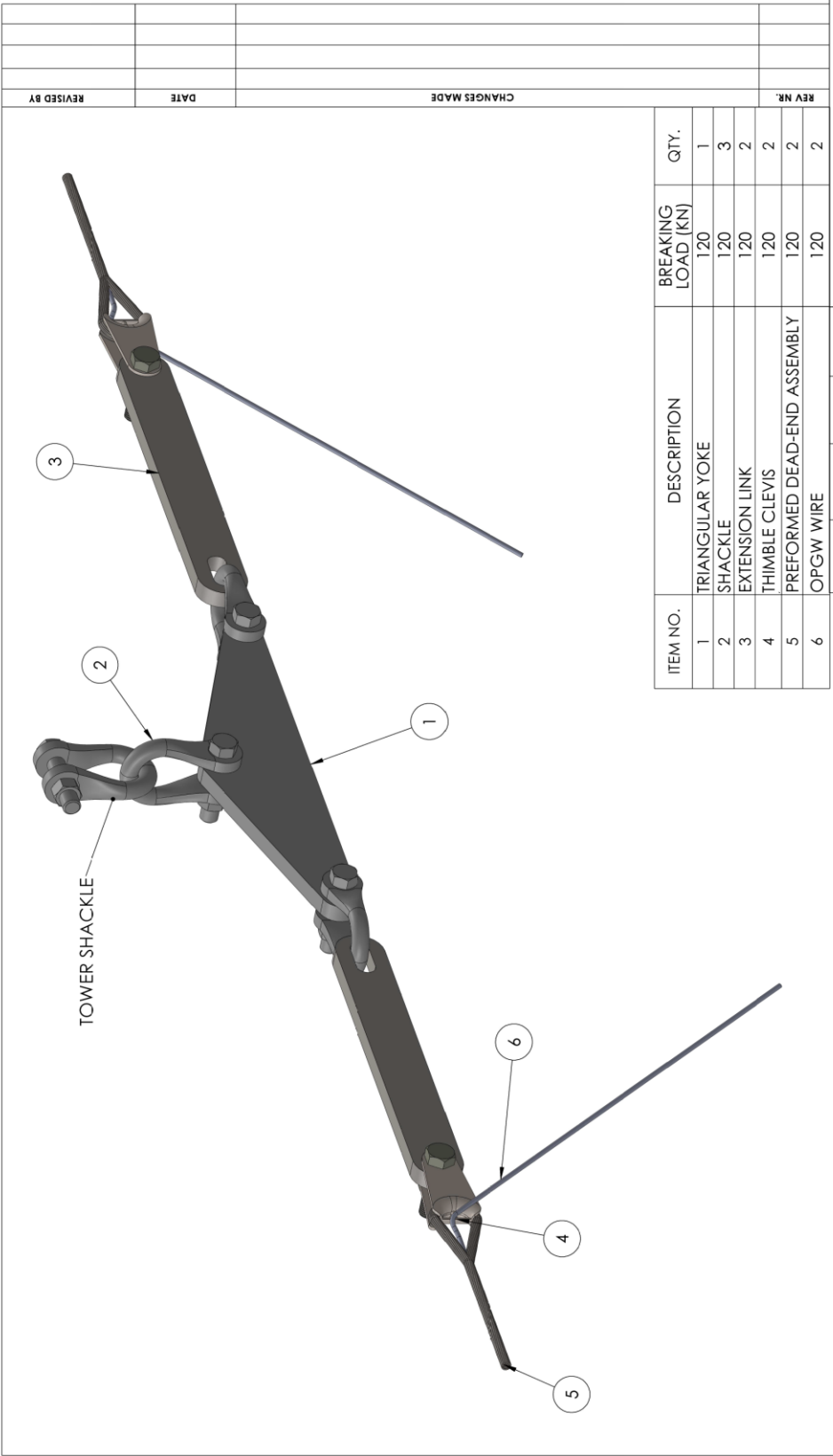
DRAWING NO.	DATE	TITLE	SCALE	SHEET	REVISION NO.
LES - GEN - OPGW - 7	20/11/2018	OPGW - Earth Bond	1:1	1	1
<p style="text-align: center;">  ESKOM - GBE POWER DELIVERY ENGINEERING LES - LINE ENGINEERING SERVICES </p>			<p style="text-align: center;">  ESKOM </p>		
NO PUBLICATION OR DISSEMINATION OF ITS CONTENTS ALLOWED WITHOUT WRITTEN PERMISSION COPYRIGHT © ESKOM HOLDINGS LIMITED					









REVISED BY		DATE		CHANGES MADE		REV NR.					
											
ITEM NO.	DESCRIPTION	BREAKING LOAD (KN)	QTY.								
1	TRIANGULAR YOKE	120	1								
2	SHACKLE	120	3								
3	EXTENSION LINK	120	2								
4	THIMBLE CLEVIS	120	2								
5	PREFORMED DEAD-END ASSEMBLY	120	2								
6	OPGW WIRE	120	2								
				UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN MILLIMETERS							
				DESCRIPTION: 120KN OPGW NON-INSULATED DOUBLE STRAIN ASSEMBLY							
DRAWN		SIGNATURE		DATE							
S DUDHIA		[Signature]		17/08/2018							
CHECKED		SIGNATURE		DATE							
B HARIDAS		[Signature]		17/08/2018							
				ESKOM - GROUP TECHNOLOGY				ESKOM DWG NO.			
				LES - LINE ENGINEERING SERVICES				OPGW-STR-NON			
				[Eskom Logo]				REVISION			
				1.0				A4			
				N.T.S.				SHEET 1 OF 1			
<p>CONCEPTUAL DRAWING</p> <p style="font-size: small;">NO PUBLICATION OR DISSEMINATION OF ITS CONTENTS IS ALLOWED WITHOUT WRITTEN PERMISSION</p>											

8. SECTION F - RISKS

No	Risks Identified	Eskom mitigation proposal	Contractor proposal
1	Earthing risks – Possibility of induced voltages.	Contractor to follow Eskom safety practises stipulated in 240-47172520, Annex D and all other relevant Eskom safety practises.	
2	Line Crossings	A proper mitigation method must be provided by the contractor in terms of how they will mitigate against the earthwire falling during stringing, regulation and clamping in.	
3	Wildlife in the area	Contractor to monitor the wildlife in area, which could vandalise equipment and be a safety risk.	
4	A full schedule of sections to be done and must be highlighted to identify areas where equipment, start and end of each section will be done.	Contractor to provide a schedule based as to where they will start and end each section based on drum lengths. This will now determine how each tower will be stabilised during the pulling of this section.	
5	Safety considerations during stringing	Contractor to ensure all safety considerations outlined in 240-110403330 with special attention to earthing considerations.	
6	Conversion of suspension tower to joint position	Contractor to provide detailed methodology on the dressing and stringing of conversion towers.	
7	Working and stringing with <u>GREASED OPGW</u>	Care should be taken, not to remove too much grease while stringing, and not to clog up the stringing machines.	

9. STATEMENT OF COMPLIANCE

The material and equipment supplied on this contract complies in all respects with the requirements of the specification.

For each paragraph mark Noted, Comply, Partially Comply, Don't Comply (Wherever there is partial or non-compliance the tenderer should together with this returnable submit an appendix indicating what the exact deviation from compliance is):

Paragraph	Noted, Comply, Partially Comply, Don't Comply	Paragraph	Noted, Comply, Partially Comply, Don't Comply
1.1		3.2.2.7	
1.2.1		3.2.2.8	
1.2.2		3.2.2.9	
1.2.3		3.2.2.10	
1.2.4		3.2.2.11	
1.2.5		3.2.2.12	
1.3.1		3.2.2.13	
1.3.2		Section B	
1.3.3		Section C	
1.3.4		5.1.1	
1.3.5		5.1.2	
1.3.6		6.1	
1.3.7		LES-GEN-OPGW-1	
1.3.8		LES-GEN-OPGW-2	
2.1		LES-GEN-OPGW-3	
2.2		LES-GEN-OPGW-4	
2.3		LES-GEN-OPGW-5	
3.1.1		LES-GEN-OPGW-6	
3.2.1		LES-GEN-OPGW-7	
3.2.2		LES-GEN-OPGW-8	
3.2.2.1		LES-GEN-OPGW-9	
3.2.2.2		Gen-OPGW10	
3.2.2.3		Gen-OPGW11	
3.2.2.4		Joint box arrangement	
3.2.2.5		Section F	
3.2.2.6			

10. LIST OF RETURNABLES

No.	Schedule	Returned?
1	Statement of Compliance	
2	Manufacturers' Brochures	
3	Letters of accreditation from the OPGW manufacturers	