Eskom	Report	Transmission

Title: **EMERGENCY RESTORATION SYSTEM FUNCTIONAL SPECIFICATION – FOR 400 KV AC SYSTEM ONLY**

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1	November 2021	First issue	F. Mokhonoana
2	April 2023	Updated technical requirements	F. Mokhonoana

Copyright Warning

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1. PROJECT DESCRIPTION

1.1. Executive Summary

Eskom Transmission plans to procure a series of emergency restoration structures to improve repair times during emergencies.

This specification is for the procurement of 400 kV alternative current (AC) vertical Emergency Restoration System (ERS) structures for the purpose of supplementing the strategic spares. The ERS system should be packaged such that one hoisting tower is coupled with 3 ERS structures. Each structure/tower should be able to be configured as a suspension or strain depending on the emergency requirements.

The structures and it's hosting tower should always be treated as one system to meet the needs of the client. All technical drawings of the consumables used as connectors, hardware, and insulators; should be supplied to ESKOM for maintenance spares and replacements.

1.2. Overview

The functional specification covers the supply of one system which has one hoisting tower and three single mast structures including the following:

- Tower/ structure, hardware, and cables/guys.
- Tower position surveying equipment
- Foundation systems and foundation installation equipment,
- Hardware assemblies and Insulators for three phase conductor Type (Quad "Zebra") and 2 x Earthwire (19/2.7) steelwire
- Erection equipment to enable self – deployment of structures without the use of cranes or helicopters.
- Containers suitably equipped for the transport and deployment of all material and equipment needed to erect the structure.
- Structure to include easy access platforms to conductors during stringing and regulation.
- Structure to include rigging points when ESKOM have access to a crane.
- Ease of maintenance on all equipment and tools.
- Corrosion protection on all the equipment and container.
- Local production of replacement of equipment and tools.
- All technical drawings, sketches and schematics should be supplied in a readable ISO:A2 page size format.

2. SUPPLY OF RESTORATION SYSTEM

2.1. Steelwork, Hardware and Guy wire

All material contained in the completed superstructure of the ERS must be provided.

As the bypass conductors may need to be joined to a suspension tower, it is envisaged that temporary arresting stays may be needed to prevent I-string assemblies from swinging into the bodies of undamaged suspension towers on either side of the failed tower, as indicated in Figure 1 below. This can also be used for arresting live phase conductor (Quad Zebra) to ground during the recover.

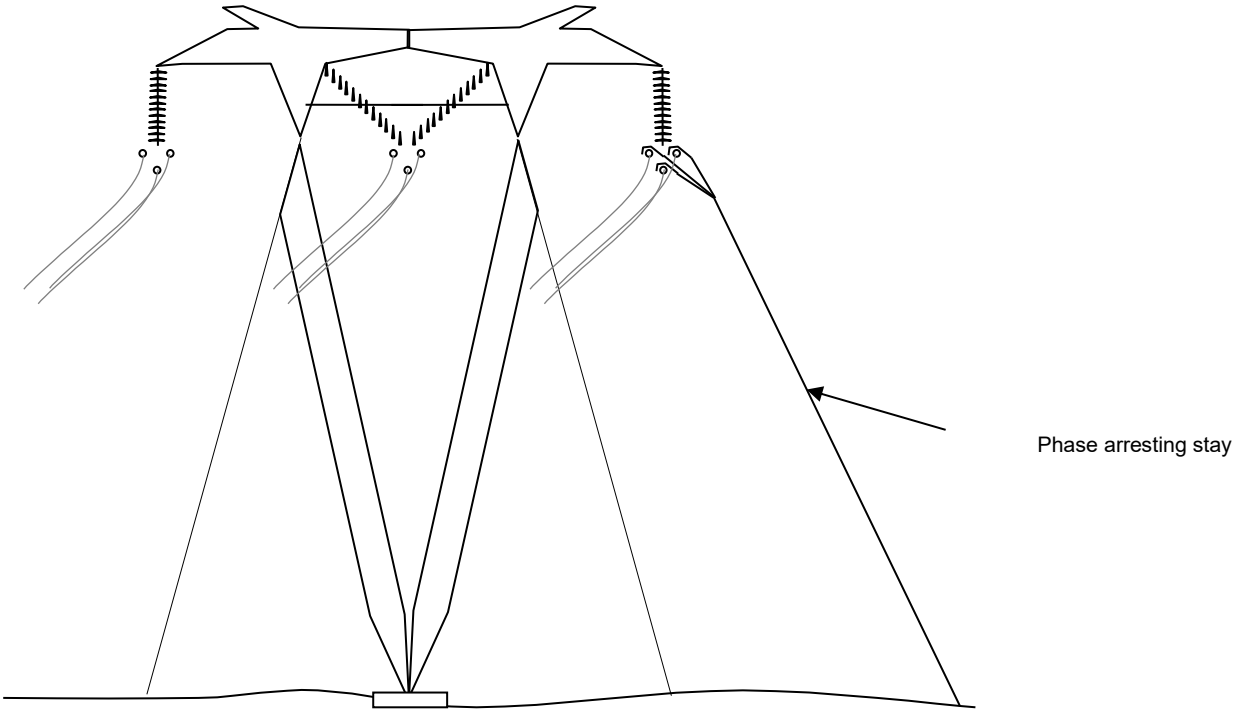


Figure 1: Phase arresting stays needed for connection of line deviation to healthy suspension tower.

Six phase arresting stays will be needed to arrest the middle and outer phases on the healthy suspension towers on either side of the tower. Six phase arresting stays for back-staying live conductors (Quad Zebra).

The base plate should be separated in sections to enable compaction and ease of handling. No degradable material should be used as part of the base, i.e., all materials should be reusable. The mast foot/bottom section should contain weep holes to allow adequate drainage and no accumulation of water at the foot and base of the structure.

Detailed outline drawings must be provided, indicating the general arrangement of the structure.

Each tower should be able to be hoisted using the same hoisting tower, and the stay wires of the hoisting tower should be re-usable for decommissioning the tower.

2.2. Foundations and Foundation Installation Equipment

Prefabricated foundation system must be provided for all guy anchors and centre plinths i.e., augured and or plate systems acceptable.

A separate or a combination of the tower guy anchor foundations should be used to hoisting up the hoisting tower on each tower location.

Engineering drawings must be provided, indicating the general arrangement of the foundations.

The installation equipment must incorporate a system for determining the uplift capacity of guy anchors.

The installation equipment must incorporate a system for determining the uplift capacity of guy anchors.

Foundation systems must be suitable for use in three separate soil conditions:

- Competent (Type 1)
- Intermediate soils (Type 2),
- Soft / loose (Type 3) soil.

The geotechnical design parameter for the above soil types can be obtained on Section 4.2.3 of TRMSCAAC.6. (240-47172520). The foundation systems should incorporate an expandable or modular system to suit varying soil conditions.

2.3. Conductor, Earthwires and OPGW strain and suspension assemblies including Insulators.

The hardware assemblies and insulation for three phases of quad (4) Zebra conductor must be provided. In addition, working platforms, which swings out onto the conductor (live-attachment of the insulator assemblies) from the tower body should be provided to permit access to the live-end end fittings and prevent climbing onto the insulators (during installation).

The supplier to design hardware assemblies for the phase conductor and earthwire that is applicable to the structure using ESKOM standard 240-60777474, “Specification for Suspension and Strain assemblies And for Hardware for Transmission Lines”. The hardware will be accepted by the client prior to ordering of the ERS.

The hardware must also include insulated and non-insulated hardware assemblies for 19/2.7 steelwire.

Engineering drawings must be provided with the tender indicating the general arrangement and key dimensions.

All hardware and equipment items as part of the ERS should be supplied with their **type test** reports and certificates as per SANS requirements.

Maintenance guideline and testing for each assembly items and insulators to be supplied.

2.4. Erection Equipment to enable self – deployment.

The structures must have the ability to **self-deploy**, without the use of cranes or helicopters (although such methods may be used in the field where logistics permits).

No specific self-deployment system will be preferred, but the system should be clearly described, with emphasis on any specific relative advantage inherent in the system.

All winches and hoisting equipment required to perform the self-deployment should be included together with a detailed service and maintenance schedule. Where use of vehicle mounted winches or cranes is required, this must be clearly indicated in the Technical Data Sheet. Other specialised or heavy equipment needed for erection must be clearly specified in the Technical Data Sheet, to be completed by the supplier.

The structure should also provide detailed rigging attachment when ESKOM has a crane onsite. This includes the protection against swing and damage of hardware and insulator assemblies during lifting.

The erection equipment will be used during Emergency Exercises (field practical training) to train and re-fresh ESKOM personnel every two years. This system needs to have the same lifespan as the main tower. The supplier to identify components which should be replaced over a period of 5 and 10 years, respectively.

The erection equipment should also have the capabilities to pause erection for over-night and or severe weather to subdue during the erection of the main tower.

All erection and or hoisting equipment should be clearly marked so that they can be packed closer to the door of the container.

2.5. Transportation Containers

Containers must be supplied, which are suitably equipped for the transport and deployment of the material and equipment needed to erect the structure. Furthermore, containers are to be provided to allow the orderly and proper storage of all components, tools, hardware items and material.

Specifications for the Containers must be indicated in the Technical Data Sheet.

Packing order of the material should be such that no lifting equipment is required for workers to load all materials and tools. If this cannot be done, the container should come with a lifting and packing system.

Platforms to reach high equipment inside the containers should be supplied, this should be used by workers during off-loading and loading of the container.

Tools should all be fitted in solid containers/boxes (steel or other material) with markings on and proper storage to prevent damage during transport.

All required hardware assemblies should be packed such that no need to undo them and can be stored as a fully fixed assembly.

All insulators to be stored inside PVC pipes where damages of the insulators (shed/sheath/housing) are preventable. For big/long insulators the pipes should be such that the top-cover can be removed to allow for the insulator to be inspected without pulling it out.

Container should be designed for ease of auditing and maintenance of tools without unpacking the entire container.

All surveying and foundations systems equipment should be packed close to the doors for ease of access once the container is onsite.

Each item in the container should have a permanent marked (e.g., steel tag) code which correlates to the packing schedule.

Transport containers should be fitted with internal packaging or fastening systems which prevent damage to material and equipment during transport over rugged terrain. Containers should be corrosive resistant with automatic – nonelectric powered air vents for circulation.

Rigging points for the container to be loaded onto a truck or vehicle. These points should be designed to not flip the container and or disturb the contents of the container and its packaging.
The weight of the container and its content should be cleared marked with a proposed crane size for loading and off-loading.

The containers should be marked with large format boards on both sides, as per Figure 2, which clearly indicate the tower type and contents of the container. Labelling and boards are to be constructed from durable, UV and weather resistant material.

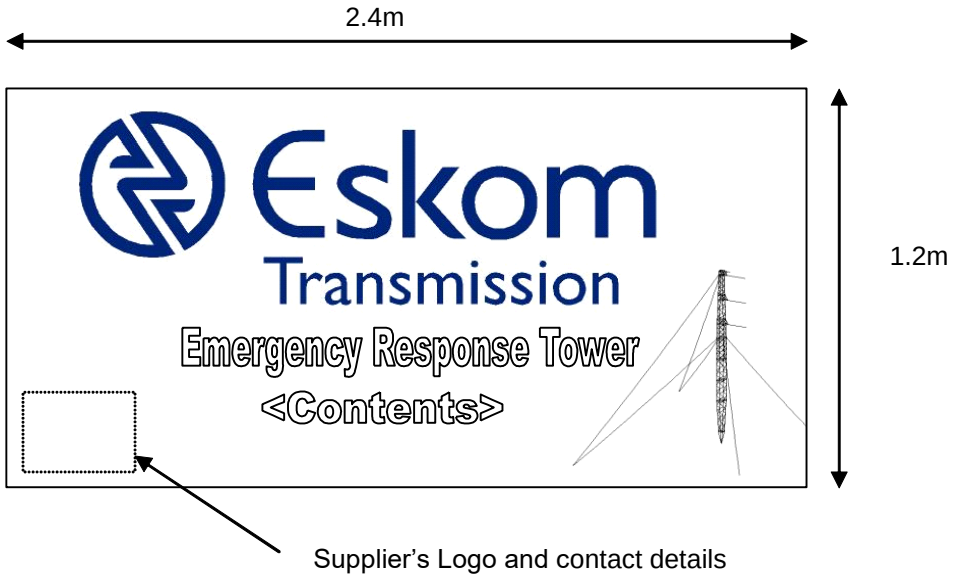


Figure 2: Container label format

Each container is to include a separate documentation holder on the inside of the left door, including the following duplicate documents (these will also be supplied as a soft copy):

- Material inventory
- Detailed drawings for all material components
- Operating instructions for equipment (where applicable)
- Erection manual applicable to contents

Functional dimensions for the container are listed below.

- Height = 2.4 m
- Length = 6 m
- Width = 2.5 m

2.6. Software and Documentation

2.6.1 User manual (hardcopy and electronic)

The solution must also contain easy to use design check software package that can be used by engineers on site to perform design for the emergency solution without much reliance on the data/ network as the lines are often in remote areas i.e., provide both desktop (Windows OS) and mobile (Android OS and IOS) versions of the software.
The conductors to be used on the software should be based on the conductor standard for ESKOM refer to 240-152844641, “Phase Conductor Standard for Eskom Overhead Lines”.

Alternative conductors should be able to be loaded on a case by case.

2.6.2 Packing schedule (electronic and hardcopy)

This will detail each item packed inside the container and should correlate to what is being offered. This will be used for the auditing of the containers on an annual basis and for service or maintenance history for each component.

2.6.3 Type test reports

All hardware should have a type test report.
load bearing equipment certificates and operation routine maintenance requirements.
All insulators should have type test reports as per the ESKOM standards (all insulator standards will be shared with the suppliers). Refer to SECTION 3.2

2.6.4 Structure test reports

These should include the design of the tower and the criteria used.
It should also include the material and connection strengths used on the model of the structure. If no testing was done, then the structure should have a model detailing the capacity and the reason testing was not done.

2.6.5 Finite element analysis (FEA)

Each component should have a fully drawn FEA and electronic file for structural analysis and stress during loading of the structure. Submissions without this data should be provided 3-months after delivery of the system with the backup to the modelling of the system.

The software should be able to use the following minimum information to determine a desired solution:

- Conductor, Earth wire and OPGW information (type, size, and bundle)
- Wind and weight spans
- Weather loading (Wind, Ice, Snow)
- Safety factors or code selection
- Space limitations for staywires
- Angle of deviation

And the critical outputs from the software; -

- Stay attachment positions on tower
- Stay locations (coordinates)
- Stay tensions and slope
- Foundation design sketch including depth based on soil type
- Conductor attachment height and spans
- Ground clearance at various loading considerations
- Report: The format should easily be customizable to highlight important parameters of the design

All software outputs should be compatible with PLS-CADD, and all tower configurations should have a separated seed-file for simulating on PLS-CADD.

The originals of all documents and software are to be submitted in a separate package. Duplicates of relevant documents (where applicable) are to be provided in each container.

3. EMERGENCY STRUCTURE REQUIREMENTS

3.1. Failure Scenario

ESKOM has several structure types on their network which dates back as 1960's. These structures are lattice (self-support and guyed) and monopoles. For guyed structures ESKOM uses guyed-vee, cross-rope and compact cross-rope suspension and strain towers. On some of the corridor's, ESKOM has multi-circuit towers (two different voltage levels systems on one tower) and double circuit towers. The system should be able to cater for single line, multi circuit and double circuit recovery scenarios.

The ERS solution is to be designed around the following (most common) scenario:

- As illustrated in **Figure 3**, one suspension tower will be assumed to have collapsed.
- An ERS with three single mast structures will be required to erect a bypass rapidly, while work progresses to recover and restore the collapsed structure at the same position.
- The tower replacement solution may use the same tower type or a much stronger and cost-effective tower.

The AC system line has 3-phases and two earthwire and ESKOM wants to connect all 5-conductors onto the ERS towers. The structures to be deployed should have a 0-to-90-degree strain angles depending on the servitude and spans to connect the line.

The construction of the new replacement tower should continue without any power outages on the main bypass until conductors are ready to be joint on the repaired section.

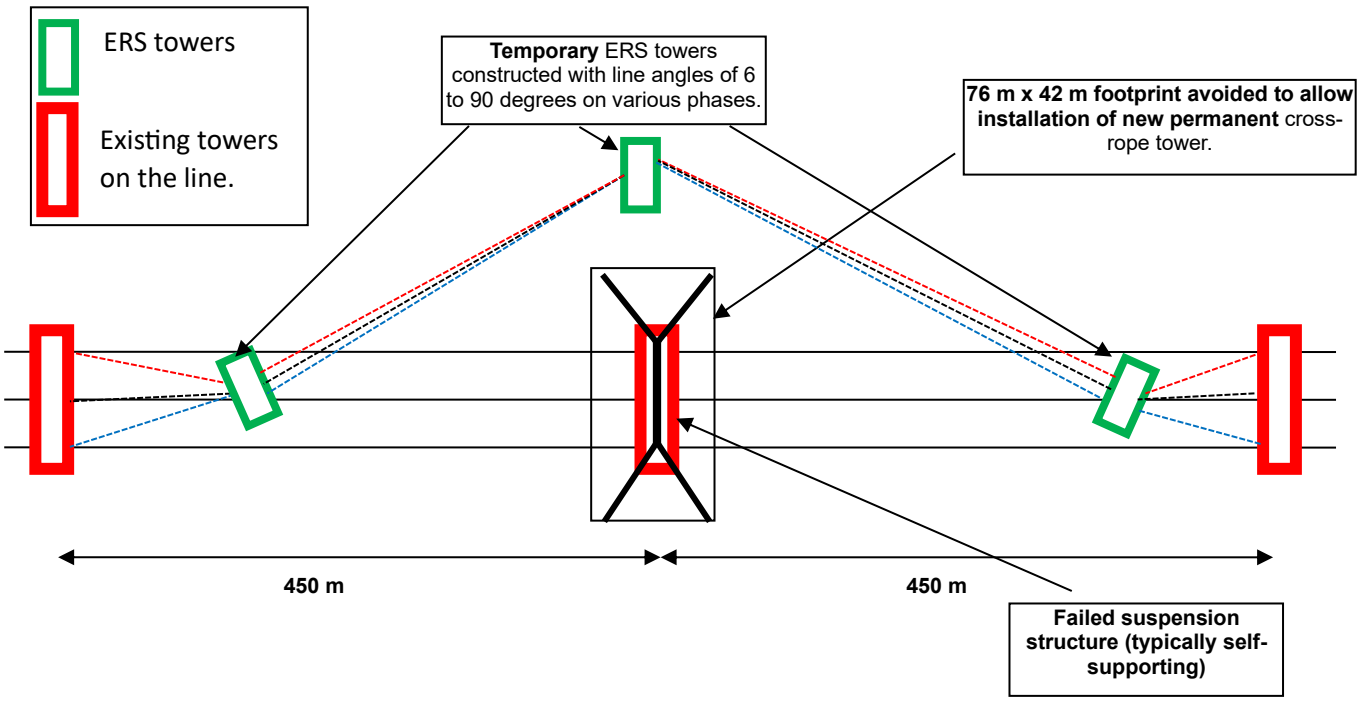


Figure 3: Suspension Structure Failure scenario for design purposes

3.2. Electrical Design Criteria and Profiling requirements

Voltage (Umax)	420 kV
Min Dry-arcing distance (phase to ground	3.2 m
Min Clearances between conductors (tower and midspan)	4.8 m
Conductor selection	4 x Zebra
Earthwire	2 x 19/2.7 Steelwire
Nominal span	450 m
Minimum conductor att. Height*	23 m on lowest phase
Phase to ground clearance (tower top) *	
Still air	3.2 m
Moderate wind (125 Pa):	2.9 m
Max wind (575 Pa):	1.0 m

*** The main offer solution should conform to the above dimensions. Where the Supplier has developed and tested a 400 kV solution which is does not meet the above dimensions/requirements, this should be presented in an alternative offer.**

3.3. Insulator Selection and design

For all the required parameters for phase insulation, for both long-rod and post, see schedules listed in all the relevant standards below. For the procurement of this 400 kV system the schedules are included in Appendix B.

In addition to radio-interference limits and power arc protection, it is important that the E-field on the insulator surface be limited to avoid the possibility of aging due to dry and water-induced corona. For this reason, the E-field on the insulator sheath should not be permitted to exceed 0.42 kV/mm for more than 10 mm along the insulator surface. On the end-fitting seal, the E-field should not exceed 0.35 kV/mm. Configurations should be modelled using 3-D E-field simulations and/or laboratory testing can be considered.

For all insulation, the insulators proposed should meet ESKOM polymeric and post insulators standards listed below. **NO CERAMIC MATERIAL** will be considered for phase and earthwire assemblies.

1. 240-131060721 “Standard for line post insulators for 220 kV and above.”
2. 240-77125772 “Specification for polymeric long rod insulators for AC transmission voltages of 220 kV and above.”
3. 240-75883384 “Stay Insulators Porcelain or equivalent used for medium and low voltage overhead lines standard.” If required by the supplier to protect equipment.
4. 240-75883896 “Outdoor post and long rod insulators for new and refurbished powerlines for 66 kV and 132 kV standard.” If required by the supplier to protect equipment.
5. 240-75883174 “Outdoor post and long rod insulators for new and refurbished power lines up to and including 33 kV.” If required by the supplier to protect equipment.

3.4. Phase Insulation Design

For both the post insulator and the braced post insulator assembly the insulators should also have these minimum requirements:

Max operating voltage (Umax)	420 kV
Minimum dry arcing distance	3.2 m
Creepage distance	31 mm/ kV
Minimum insulation strength post: Vertical cantilever tip Load	40 kN
Braced post tension insulator: Tension	210 kN
Braced post tension insulator: Tension	Supplier to provide the maximum compression loads for insulators to fail

Basic insulation level (BIL):	1425 kV
Basic insulation switching level (BISL)	1050 kV
End fitting sizes	20 mm SANS 60120 (for clevis assemblies, supplier to make sure the assemblies can fit on the 19mm thick drop-eye post insulator assembly.)
Corona rings Fitment	1 x Live end fitting (275 kV voltage and below)
	1 x Dead end fitting (400 kV voltage and above)

All braced post insulator assemblies need to have the following required construction attachments and or holes for construction loads.

- All holes on the end-fitting to be min 24 mm and rated for 300 kN assemblies
- The supplier to include a rigging hole rated and sized at 24 mm for attachment of lifting and construction equipment.
- Both live and dead-end assemblies should be universal and easily accessible.
- Composite Dry-Arcing Distances (DAD) should always be met with the use of corona and field grading rings on the assemblies.
- Insulators should preferably have the capability to fail partially under high longitudinal loads by swinging out, but the mechanical link to the conductor may not be broken.

3.5. Earthwire Insulation Design

INSULATOR TYPE	GROUNDWIRE / EARTHWIRE INSULATOR
PARAMETER	**USER REQUIREMENTS**
Shed Material	Silicone-based
Standards	Comply with IEC60815, IEC61109
Core cover Thickness	≥ 3 mm
Insulator Class	Class A
Connecting Length	375 (±12) mm
Creepage length	≥ 174 mm
Pf. Dry, one minute withstand	50 kV (without arcing horns)
Pf. Wet, one minute withstand	25 kV (without arcing horns)
Lightning positive impulse withstand	80 kV (without arcing horns)
Minimum mechanical strength	120 kN
Coupling method	In-line tongue and clevis caps in accordance with IEC 60471 size 16L
Arcing horn shape	“Jacob’s Ladder” with minimum strait horn lengths of 50mm and an angle of 60±5 degrees between them
Arcing horn bending radius	≥2 times the arcing horn rod/bar diameter at base
Arcing horn material	Hot dipped galvanized forged steel
Arcing horn cross sectional area	> 18 mm^2 each
Arcing horn gap size	8 (± 2) mm fixed

3.6. Guywire Insulation Design

Minimum insulation distance:	3.2 m
Basic insulation level (BIL):	1425 kV
Basic insulation switching level (BISL)	1050 kV
Mechanical strength:	210 kN
End fitting sizes:	Clevis-Clevis 20 mm

The insulator and earthwire hardware drawings are shown in APPENDIX C and D.

3.7. Hardware Design

The supplier to design hardware assemblies for the phase conductor and earthwire that is applicable to the structure using ESKOM standard 240-60777474, “Specification for Suspension and Strain assemblies and for Hardware for Transmission Lines”. The hardware will be accepted by the client prior to ordering of the ERS.

The supplier will design all the hardware assemblies based on the tower needs and orientation using the same ESKOM standard.

All hardware including insulator end fittings shall be galvanised to a minimum of 105 µm.

All components are to have a minimum breaking strength of 120 kN.

All hardware to be done according to the latest version of SANS10280 and TRMSCAAC.6 (240-47172520).

All Tower shackles should be supplied as part of the hardware.

Minimum breaking load for all the phase conductor Strain Assembly to be 300 kN.

Minimum breaking load for all the phase conductor Suspension Assembly to be 210 kN.

End fitting for post insulators – (See Appendix D – Post Insulator drawing)

3.8. Structure Loads

ESKOM will perform the necessary tests to verify the design of ERS. If it’s a new design and development of the ERS, ESKOM will keep full copyright of the design and drawings. Failure to meet all criteria design after testing, the supplier will have to modify the system accordingly. The loading must be designed and tested according to SANS10280.

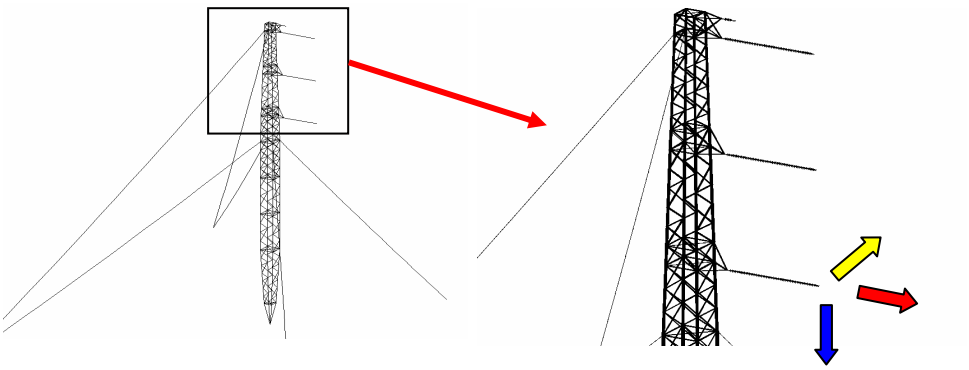


Figure 4: Insulator tip loads (schematic arrangement)

3.9. FOUNDATION DESIGN LOAD FACTORS

Foundation Loads are to be determined from the most severe load cases described above: The foundation reactions obtained from this analysis must be increased by the following additional load factors:

Foundation Loads: Additional Load Factor:

Anchors: 1.3

Centre plinth / pad & column: 1.1

Foundation drawings for each soil type on the anchor and on the centre plinth shall be provided.

3.10. ERGONOMICS AND SAFETY

The tower must be safely and fairly assembled and dissemble without too much strain on the line workers. The following should be considered in the design of the ERS and the ergonomic requirements for the workers.

- System must be light weight.
- Sections easily movable (Modular sections should not be longer than 4 m)
- Easily transportable to mountainous areas when taken section by section.
- Be symmetrical as far as possible
- Easy to climb safely (practical hook up points)
- Corrosion and rust protection
- Easy access to conductors during tower dressing and stringing without damaging the insulators
- Insulator protective covers (for auditing, storage, transportation, and installation)

3.11. TRAINING (CLASSROOM AND PRACTICAL)

The supplier to provide Eskom personnel with adequate training on how to use the set system (design, installation, decommissioning and auditing of components). The training will both be theoretical and practical application which shall be done over a period of at least 5 days. Site of training will be mutually decided upon award of the contract. At the end of the training, the supplier is expected to accredit (certificate of completion on both classroom and practical) the attendees in accordance with their knowledge and use of the set ERS system.

4. ALTERNATIVE TENDERS

For tenders to be considered compliant, at least one main offer must be submitted which complies fully with the specification.

Alternative tenders, in which, for example, unconventional materials are suggested, should be clearly marked as: “Alternative Tender No. ….,” and should be accompanied by concise descriptions detailing the primary distinguishing features of the alternative, as well as the relative advantages associated with the system.

5. MAINTAINABILITY

Due to the number of emergencies that ESKOM undertakes yearly, the copyright would be handed to ESKOM for spares maintenance. Detailed drawings of all consumables and connectors to be shared with ESKOM.

Detailed service and maintenance schedule for all the machinery and tools (including all load bearing equipment) involved in the construction of the ERS.

- service – maintenance plan for all the components in the container
- calibration certification requirements
- local available tools/spares
- fabrication of spares locally
- scrap and recycling requirements locally
- auditing of components
- certificate of life

APPENDIX A – SCHEDULE A – STATEMENT OF TECHNICAL CONFORMANCE

DESCRIPTION	PARTICULARS OF ESKOMS REQUIREMENTS	GUARANTEED TECHNICAL PARTICULARS OFFERED		REMARKS
1. Design voltage	400 kV	Yes or No		
2. Mast / Tower Design	IEEE 1070-2006 - IEEE Guide for the Design and Testing of Transmission Modular Restoration Structure Components	Yes	No	
3. Main Structure material (Steel, Aluminium, composite, other)	Specify with class/ grade (For Steel and Wood comply to 240-47172520 TRMSCAAC Standard for the Construction of Overhead Powerlines 6.0)			
4. Section length(s)	Specify (in meters)			
5. Mass per section (long)	Specify (in meters)			
6. Mass per section (short)	Specify (in meters)			
7. Minimum Conductor Attachment Height -CAH (lowest conductor)	Specify (in meters)			
8. Maximum Conductor Attachment Height -CAH (lowest conductor)	Specify (in meters)			
9. Maximum wind span (based on Quad Zebra + 2 x 19/2.7)	Specify (in meters)			
10. Maximum weight span (based on Quad Zebra + 2 x 19/2.7)	Specify (in meters)			
11. Conductor bundle and size	Quad Zebra			
12. EW size	2 x 19/2.7 Steelwire			
13. Moderate wind	125 Pa	Yes or No		
14. Maximum wind	555 Pa	Yes or No		

15. Minimum Dry Arcing distance	3.2 m	Yes or No	
16. Creepage distance	31mm/ kV	Yes or No	
17. Minimum Insulation strength Vertical tip load	40 kN	Yes or No	
18. Minimum Insulation strength tension load	210 kN	Yes or No	
19. Suspension Assembly configuration (I, V , Strapped post, other)	Specify each assembly type		
20. Hardware assembly drawings (both suspension and strain) to be supplied	Supply conceptual drawings		
21. Suspension Hardware Assembly weight	Specify (in kg)		
22. Strain Assembly configuration (single, double, other)	Specify		
23. Strain Hardware Assembly weight	Specify (in kg)		
24. Stay wire size and type	Specify (in mm & Mpa)		
25. Insulator type: Conductors	Specify (glass, composite or other)		
26. Insulator type: Earthwires and OPGW	Specify (Only composite / Polymer)		
27. Insulator type: Stay wires	Specify (Only composite / Polymer)		
28. Foundation system	Specify the system type		
29. Foundation system: Competent soil Type 1 soil	Submit (Foundation design drawing)		
30. Foundation type: Intermediate Type 2 soil	Submit (Foundation design drawing)		
31. Foundation type: Soft/loose Type 3 soil	Submit (Foundation design drawing)		
32. Method of tower erection	Specify and include method statement		
33. Foundation system for lifting the hoisting/erection equipment.	Specify the design loads and installation requirements for the foundation system.		
34. Erection equipment equipped with locks for severe weather and overnight disturbances	Specify the function and its safe deployment process.		

35. Tower storage type	Specify storage properties and dimensions		
36. Tower storage corrosion protection mitigation	Specify corrosion levels and mitigations (C4 level with air circulation measures)		
37. Component storage inside the container can be done without requiring lifting equipment.	Specify if any lifting equipment is required to pack and unpack the containers during deployment.	Yes or No. If yes, supplier to specify.	
38. Design check Software OS	Must be compatible with Windows OS AND either Android OS or IOS		
39. Wind Return Period	1 in 50 years		
40. Mast / Tower Configurations: Tapered / Parallel	Specify		
41. Tower steel work Grade of Bolts and Nuts Used:	Grade 8.8		
42. Foundation Anchor Bolts	Grade 4.8		
43. Structure Design and Testing max angle of deviation.	State the min and max angle the tower has been designed and tested for.		

APPENDIX B: SCHEDULE B: RESPONSE TO SPECIFICATION

Clause	Compliance/Non-Compliance/Information
2	**SUPPLY OF RESTORATION SYSTEM**
2.1	
2.2	
2.3	
2.4	
2.5	
2.6	
3	**EMERGENCY STRUCTURE REQUIREMENTS**
3.1	
3.2	
3.3	
3.4	
3.5	
3.6	
3.7	
3.8	
3.9	
3.10	
3.11	
4	**Alternative tender**
5	**Maintainability**

APPENDIX C – SCHEDULES FOR INSULATORS

Table 1: SCHEDULE C: Post INSULATOR REQUIREMENTS

Item No	Description	Eskom's minimum requirements	Equipment guarantees and particular
2.0	Manufacturer/ Supplier	xxxxxxx	
2.1	Drawing No.	xxxxxxx	
2.2	Maximum System Voltage (U_m)	420 kV	
2.4	Phase Conductor	e.g. 4 x Zebra	
2.6	Span Length: Wind Weight	450 m 450 m	
2.7	Altitude	1800m	
2.8	Required Life Expectancy	≥30 years	
3.0	Technical Details		
3.2	Core material Cover Thickness	≥3mm	
3.3	Shed material	Silicone based	
3.4	Shed profile	Flat Shed preferred	
3.6	Operating Temperature		
(a)	- Minimum	-5°C	
(b)	- Maximum	50°C	
(c)	- Maximum Diurnal Variation	30°C	
3.10	Combined Load Curves offered	Y/N	
3.11	Strength Requirements		
	- CBL	kN	
	- SCL	kN	
	- MDCL	kN	
3.12	Maximum Connecting Length of Insulator	3800 mm	
	Horizontal Inclination for Installation	5 Deg.	
3.13	Live End Fitting	Drop Eye	
	Dead End Fitting	Gain base	
3.15	Minimum Specific Creepage Distance	31 mm/kV	
3.16	Shed Spacing to Projection Ratio	≥ 1	
3.17	LIWV (at specified altitude)	1425 kV	
3.18	SIWV (at specified altitude)	1050 kV	

Item No	Description	Eskom's minimum requirements	Equipment guarantees and particular
3.19	60 sec Power Frequency Withstand (at specified altitude)	N/A	
3.18	Corona Rings		
(a)	Corona ring arc rating	50kA @ 100ms	
(b)	Live End Corona Ring Diameter	m	
(c)	Dead End Corona Ring Diameter	m	
3.19	FRP Rod Diameter	mm	
3.20	Diameter over sheath	mm	
3.21	Dry Arcing Distance (between rings as applicable)	3200 mm	
3.22	Hot dip galvanizing of ferrous fittings	Y/N	
3.23	Live and dead end electric field limits	≤0.42kV/mm	

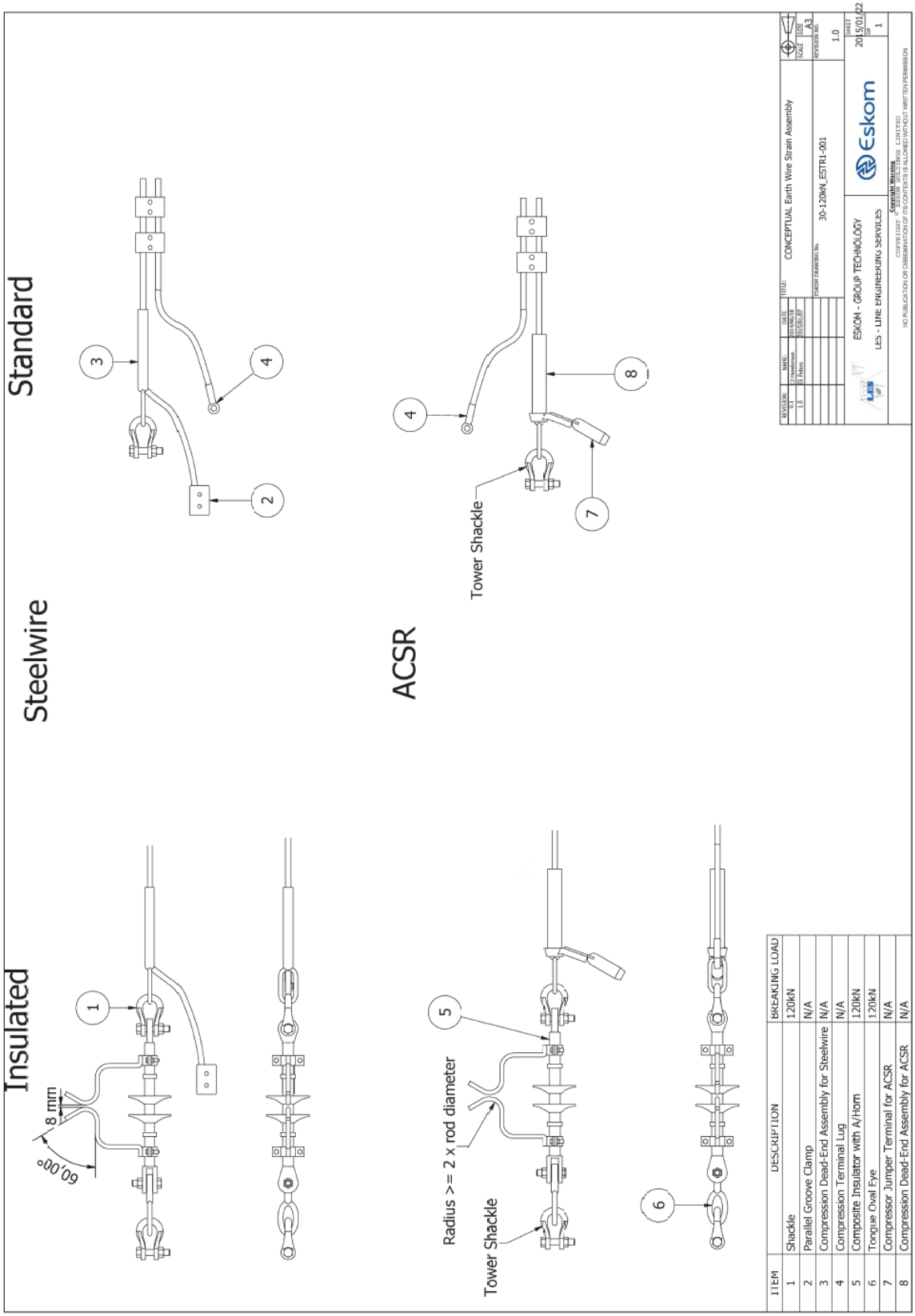
Table 2: SCHEDULE D: Phase Tension INSULATOR REQUIREMENTS

INSULATOR TYPE	210 KN INSULATORS				
Conceptual Design Drawing No.	Based on the design of the structure and insulators used.				
PARAMETER	**CLIENT REQUIREMENTS**	**Points**	**Comply (Y/N)**	**Comments**	**Supplier Points**
MODEL Number					
Shed Material	Silicone-based	1			
Open Profile	Preferred	1			
Alternating Sheds	Preferred	1			
Core cover Thickness	≥ 3 mm	1			
Life Expectancy	50 years	1			
Altitude of Application	1500 m	1			
Temperatures: • Minimum • Maximum • Average	 -5 ^{0}C 50 ^{0}C 30 ^{0}C	 1 1 1			
Specific Creepage	31 mm/kV	2			
S/P Ratio	≥ 1.0	2			
BIL (+) – (@altitude)	1425 kV	1			
SIL (+) – (@altitude)	1050 kV	1			
Dry-arcing distance (DAD)	≥ 3.2 mm	2			
Connecting Length	Shortest Possible Considering DAD limit	2			
Corona Rings: • Dimensions • Ratings (kA/s)	Live/dead/both Live end Dead end Live end Dead end	1			
SML	210 kN	2			
End fittings: • Type • Size • IEC60120	 Ball-Socket 20 mm (Y/N)	 1 1 1			
TOTAL SCHEDULE C POINTS		**25**			
Deviations:					

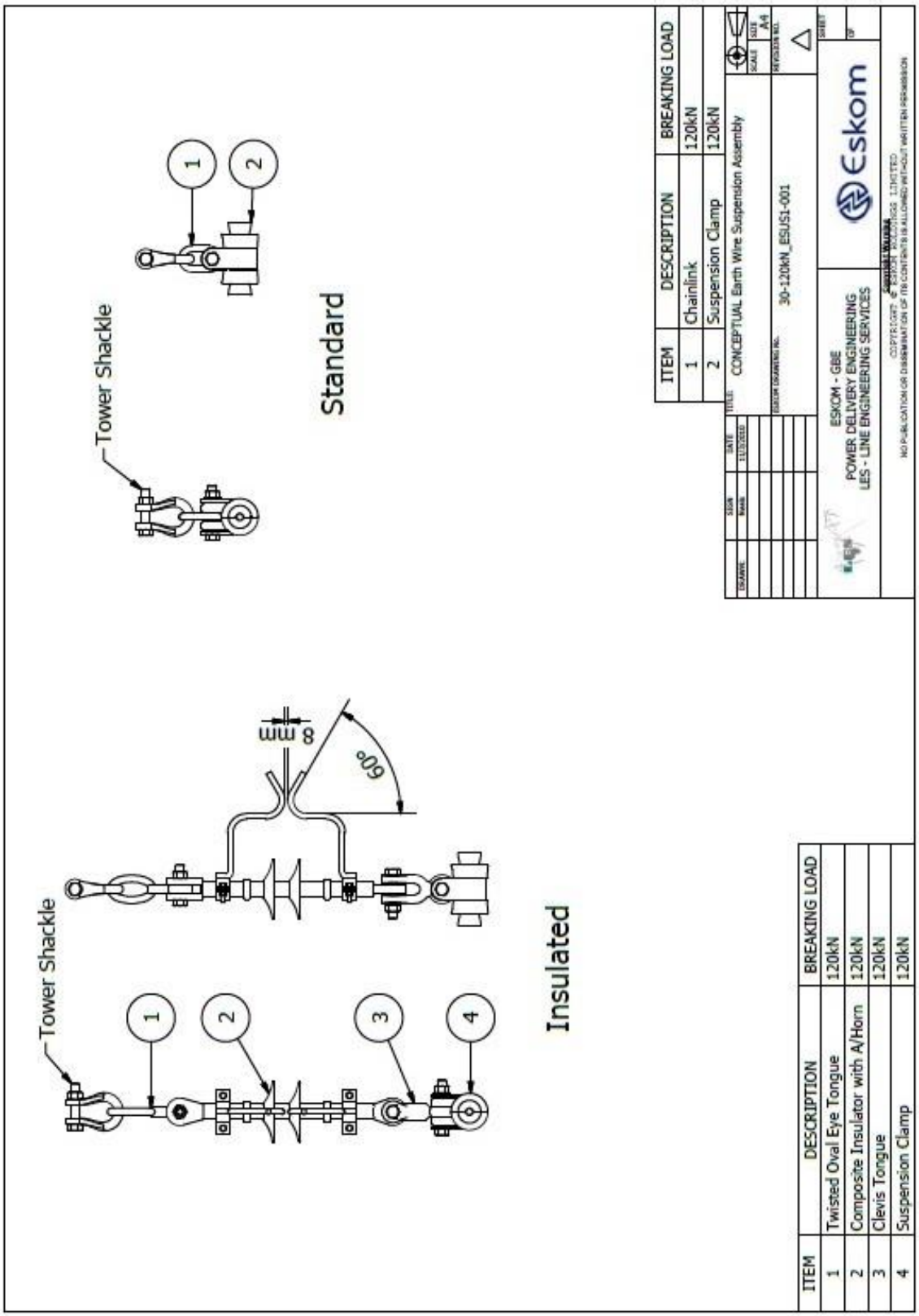
Table 3: SCHEDULE E: EARTHWIRE INSULATOR

INSULATOR TYPE	EARTHWIRE INSULATOR				
Conceptual Design Drawing No.	Check conceptual drawing attached				
PARAMETER	**USER REQUIREMENTS**	**Points**	**Comply (Y/N)**	**Comments**	**Supplier Points**
MODEL Number					
Shed Material	Silicone-based	2			
Standards	Comply with IEC60815, IEC61109	3			
Core cover Thickness	≥ 3 mm	1			
Insulator Class	Class A	1			
Connecting Length	375 (±12) mm	1			
Creepage length	≥ 174 mm	1			
Pf. Dry, one minute withstand	50 kV (without arcing horns)	1			
Pf. Wet, one minute withstand	25 kV (without arcing horns)	1			
Lightning positive impulse withstand	80 kV (without arcing horns)	1			
Minimum mechanical strength	120 kN	1			
Coupling method	In-line tongue and clevis caps in accordance with IEC 60471 size 16L	1			
Arcing horn shape	“Jacob’s Ladder” with minimum strait horn lengths of 50mm and an angle of 60±5 degrees between them	3			
Arcing horn bending radius	≥2 times the arcing horn rod/bar diameter at base	2			
Arcing horn material	Hot dipped galvanized forged steel	2			
Arcing horn cross sectional area	> 18 mm^2 each	2			
Arcing horn gap size	8 (± 2) mm fixed	2			
TOTAL SCHEDULE C POINTS		**25**			
Deviations:					

EARTHWIRE ASSEMBLY DRAWINGS



ITEM	DESCRIPTION	BREAKING LOAD
1	Shackle	120kN
2	Parallel Groove Clamp	N/A
3	Compression Dead-End Assembly for Steelwire	N/A
4	Compression Terminal Lug	N/A
5	Composite Insulator with A/Horn	120kN
6	Tongue Oval Eye	120kN
7	Compressor Jumper Terminal for ACSR	N/A
8	Compression Dead-End Assembly for ACSR	N/A


Standard
Tower Shackle
1
2
ITEM
DESCRIPTION
BREAKING LOAD
1
Chainlink
120kN
2
Suspension Clamp
120kN
CONCEPTUAL Earth Wire Suspension Assembly
30-120kN_ESUS1-001
ESKOM - GBE
POWER DELIVERY ENGINEERING
LES - LINE ENGINEERING SERVICES
Eskom
Insulated
Tower Shackle
8 mm
60°
1
2
3
4
ITEM
DESCRIPTION
BREAKING LOAD
1
Twisted Oval Eye Tongue
120kN
2
Composite Insulator with A/Horn
120kN
3
Clevis Tongue
120kN
4
Suspension Clamp
120kN

APPENDIX D – POST INSULATOR DRAWING