

Title: **ANTI – VANDAL MEASURES
GUIDELINE FOR OVERHEAD
POWER LINES**

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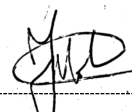


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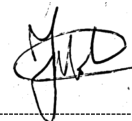


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1. Introduction

The vandalism and theft of steel members from Eskom's overhead power line lattice structures has become a key priority as these activities have increased drastically over the last decade. Not only does it cause unwanted maintenance at a huge cost, but in worst cases, the collapse of the entire lattice structure(s) and massive power interruptions to Eskom's customers.

This document is a guideline that provides anti - vandal measures in an attempt to minimise the risk of vandalism and theft of steel members on these structures.

2. Supporting clauses

2.1 Scope

This guideline details the anti-vandal measures that can be implemented on new build and existing power lines. The document details the following:

- The current anti-vandal fastener measures (swage bolt and weld) for structures.
- The anti-vandal measure of raised tower foundation columns.
- The marking of steel members to be able to trace ownership to Eskom. Compulsory for new tower members.
- The compulsory anti-climb devices (ACD), either palisade type or razor flat wrap.
- The complimentary measure of razor flap wrap around tower members.
- An overview of the complimentary measure of the vibration sensor and alarm system.
- Alternate and eliminated anti-vandal systems/measures.

2.1.1 Purpose

The purpose of the document is to provide anti - vandal measures in an attempt to minimise the risk of vandalism and theft of steel members on structures used within Eskom.

2.1.2 Applicability

To be used on Eskom Transmission and Distribution overhead power lines. All the guidelines outlined here should be implemented where practically possible and not only single solution guidelines.

2.1.3 Normative

- [1] NRS 108:2018, Guide for prevention of theft of overhead line steel tower components.
- [2] ISO 9001, Quality Management Systems.
- [3] 240-47172520 TRMSCAAC 6 – The Standard for the Construction of Overhead Power Lines
- [4] SANS 10280 (NRS 041) - Overhead Power Lines for Conditions Prevailing in South Africa

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- [5] Occupational Health and Safety Act 85 of 1993, incorporating the Construction Regulations, and Electrical Machinery Regulations. Published by South African Government Press, under auspices of the Department of Labour.

2.1.4 Informative

Not applicable

2.2 Definitions

2.2.1 General

Items	Definition
Anti-climb device	A part of the structure that aims to prevent unauthorized access to the upper part of the tower.
Break-away nut	A special type of nut consisting of two parts namely tapered part and hexagon part. The hexagon part can shear off at a pre-determined torque load whilst the joint is being tightened leaving the tapered part.
Swage bolt	A fastener, alternative to a bolt-nut pair, where the joint strength is obtained by applying an axial force to the bolt and which is maintained by deforming a metal collar in contact with the bolt shaft and one of the components of the joint.
Vulnerable overhead power line towers	Overhead power line towers that are not protected in any way against vandalism and member theft and are at risk.

2.2.2 Disclosure classification

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

2.3 Abbreviations

Abbreviation	Description
ACD	Anti – Climb Device
HDGASA	Hot Dip Galvanising Association of South Africa
OHS	Occupation Health and Safety

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LES	Line Engineering Services
SAIW	Southern African Institute of Welding
CAH	Conductor Attachment Height

2.4 Roles and responsibilities

n/a

2.5 Process for monitoring

n/a

2.6 Related/supporting documents

[1] 240-170000156 – Anti-theft Vibration Sensor and Alarm System

[2] 240-166854454 – Raised Column Foundations (Draft)

3. Anti – vandal Fastener Measures

There are two anti-vandal fastener measures currently used in Eskom. The preferred measure is the swage bolt system, which is detailed in Section 3.1. Alternatively, the welding of the nut-to-bolt measure, detailed in Section 3.2, can be used. Alternative anti-vandal systems/measures may be considered subject to Eskom's approval and is discussed in Section 9 of this document.

Location on the structure:

- *Member-to-member connection:* The measure must be installed on at least one hole/bolt per member connection at each end, up to and including anti-climb level. The measure must secure each member to each other. Refer to Figure 3.1 and 3.3.
- *Plate connection:* The measure must be installed on at least 60% of holes/bolts on a plate connection, up to and including anti-climb level. The measure must be distributed evenly to secure each member to the plate and the plate to the tower. Refer to Figure 3.1, 3.2 and 3.3.
- *Guy anchor connection:* The shackles and U-bolts of guys on ground level must be fitted with an anti-vandal measure. The current options for this connection is the use of anti-vandal cups for the U-bolt and the welding of nut-to-bolt measure for the shackles. Refer to Figure 3.4 and 3.5.

Figures 3.1 - 3.5 are a guide on the installation layout of the anti-vandal fastener measure that meets the criteria for the above connections. The red circles indicate where the anti-vandal fastener measure should be installed for the different examples.

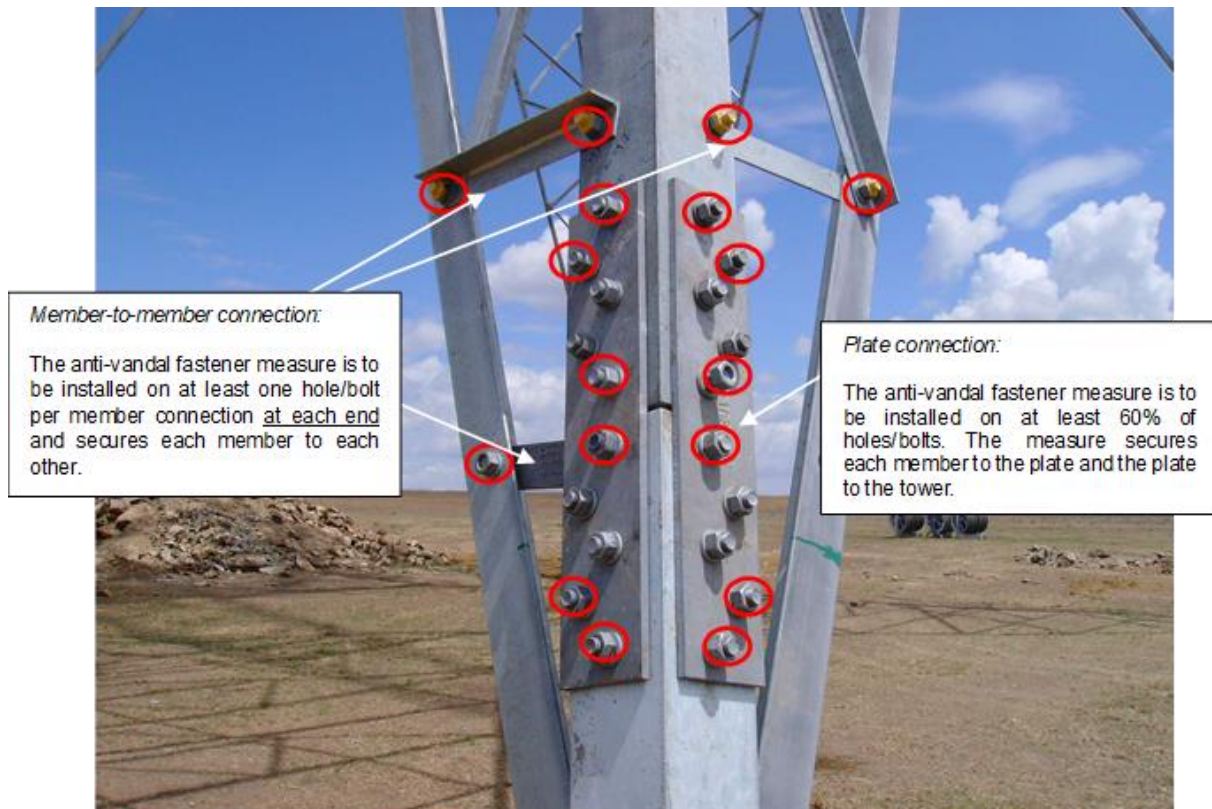


Figure 3.1: Stub and member-to-member connection example

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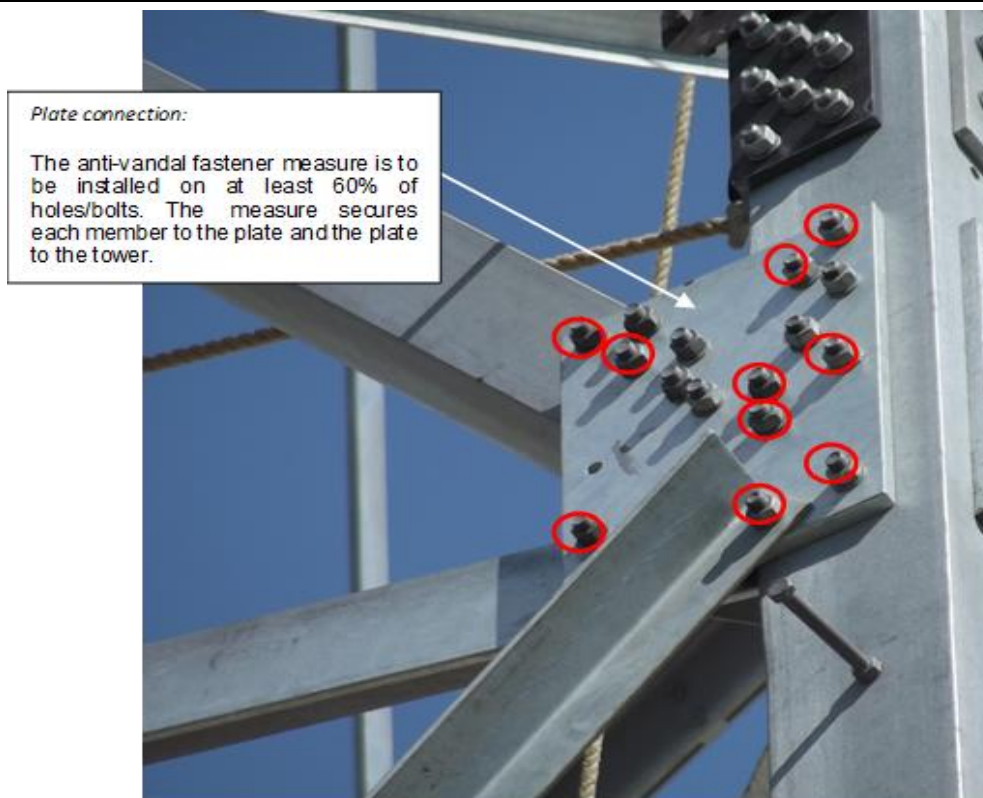


Figure 3.2: Gusset plate connection example

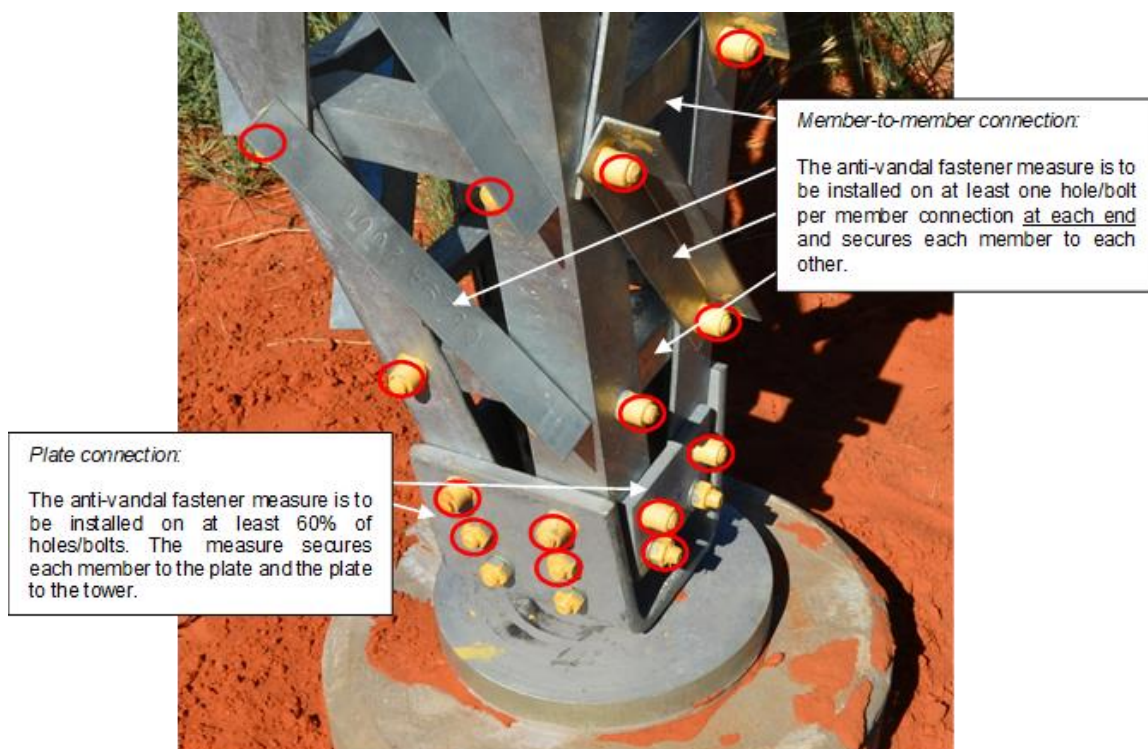


Figure 3.3: Guyed tower mast connection example

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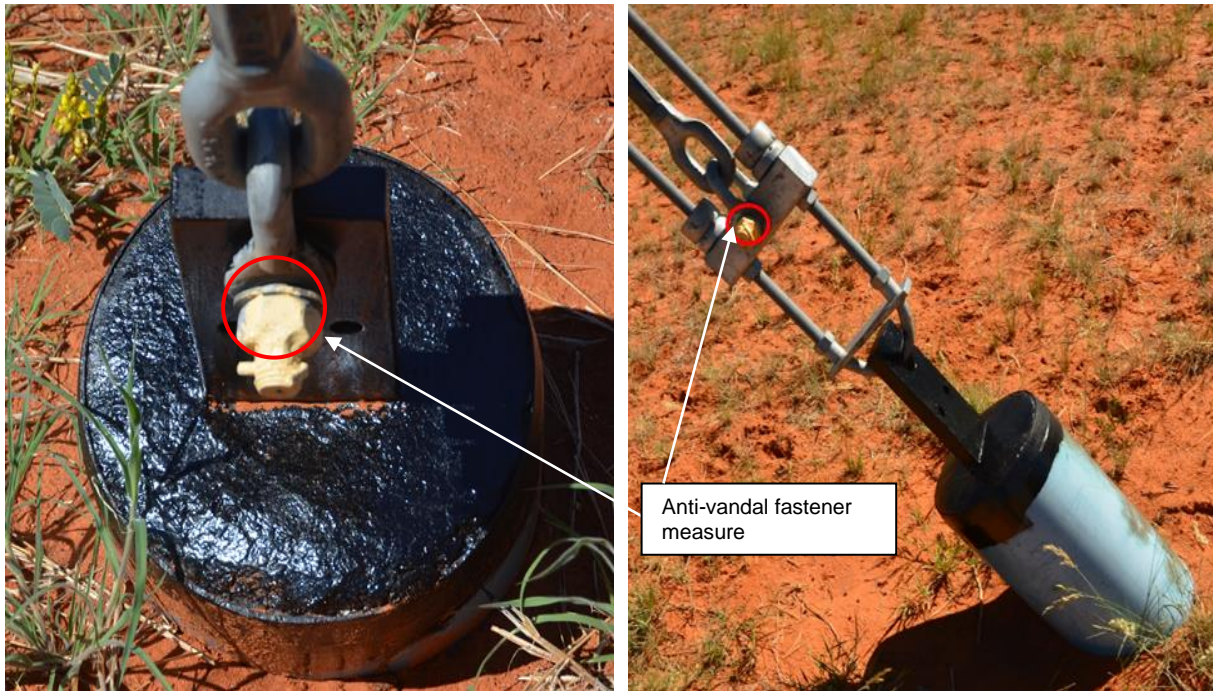


Figure 3.4: Guy anchor connection example – welded nut-to-bolt

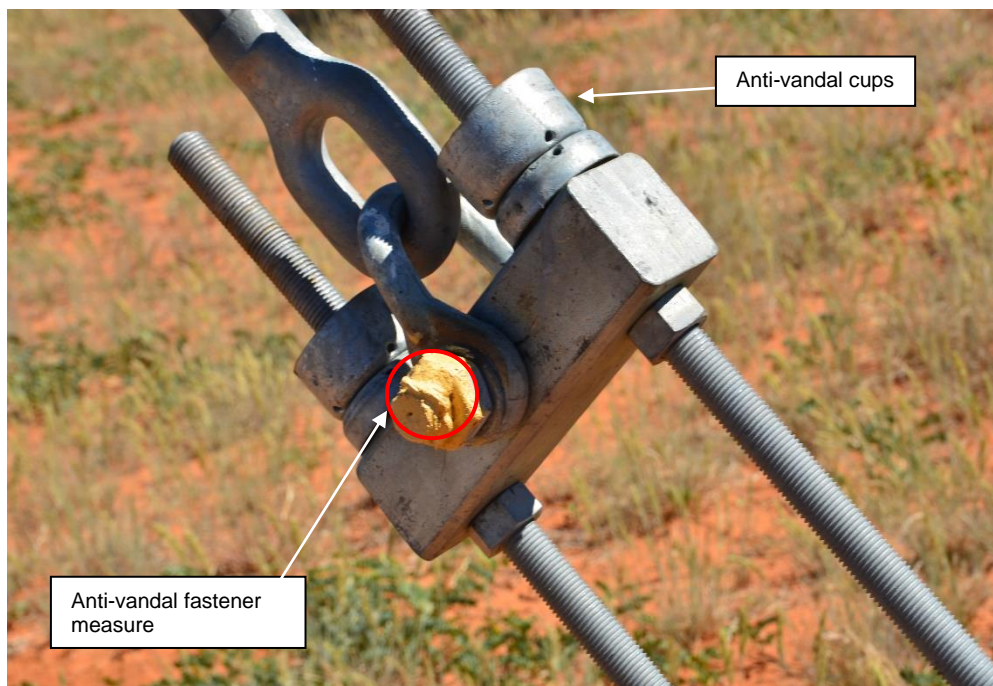


Figure 3.5: Guy anchor connection example - U-bolt anti-vandal cups and welded nut-to-bolt

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3.1 Swage bolt

This measure requires metal deformation during installation. The system requires a collar being swaged onto the bolt after the required clamping force has been reached. Due to the high metal deformation that is involved, hydraulic equipment is normally used to perform the installation.

- **SPECIFICATION**

- The grade of bolt to be used should be Grade 8.8 or higher and must be hot dip galvanized. No electroplated coating will be acceptable.
- The nut must have a flange (collar), see **Appendix A, Figure A2**.
- For the installation of swaged bolts on smaller members, it may be necessary to flatten one side of the hydraulic crimper in order to reach all places, see **Appendix A, Figure A3**.

New power lines:

The swage bolt must be installed on the structure only during construction:

- *Guyed structures:* the system must be installed before structure erection.
- *Self-supporting lattice structures:* the system must be installed before stringing of the conductors commences.

Existing power lines:

- Extreme caution must be taken when installing the swage bolts that must be done in accordance with the preparation and installation procedure below.

- **PREPARATION AND INSTALLATION**

- Where swage bolts cannot be installed during the assembly of certain structures (eg. self-supporting) and standard bolts are used for erection, then **loosen and remove only one bolt at a time** and replace the removed bolt with the swaged type before removal of the next bolt. This should be done not to affect the tower strength by having any members not connected to the tower, at any given time.
- Removal of existing bolts and nuts can be done using a using a hydraulic nut splitter or other suitable means.
- Refer to **Appendix A** for a typical installation process for a swage bolt.
- After installation of the swage bolt, all bare metal and exposed parts must be protected against corrosion with a suitable coating. **Refer to Appendix G** for coating requirements.

- **PRECAUTIONS AND SAFETY**

- The necessary inspections on hydraulic equipment should be conducted on a daily basis such as inspection of the hydraulic hoses and oil tank for leaks or any signs of damage.
- The equipment works under pressure therefore precautions should be taken not to kink or bend the hoses sharply.
- Where work will be conducted at heights, the necessary precautions and measures should be taken to ensure the installation is done in a safe manner. This may include, but is not limited to, hook up at heights

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by means of a suitable safety belt and/or harness, temporary platforms and/or scaffolding or any other acceptable or suitable way must be employed.

3.2 Welding of the nut-to-bolt

This measure involves the welding of the nut-to-bolt thread interface. The structure's bolts and nuts that are used to keep the members connected to the main members or onto each other can be welded using commonly available welding equipment. Welding onto tower members is not permitted. This measure can be used on both new and existing power lines.

- **SPECIFICATION (refer to Appendix B)**

- Type of weld: Seam weld
- The weld length should be more than half the bolt circumference. No tack or spot welding is allowed.
- Qualified welder of level 1 (SAIW)

- **PREPARATION, INSTALLATION AND POST WELD**

- Prior to welding the nut-to-bolt thread, the galvanizing, anti - corrosion products and/or slight corrosion should be removed from the area that will be welded. This can be done by brushing the area with a steel wire brush or any other suitable means.
- Some sort of protection is required around the proposed weld area to protect the tower steelwork.
- After welding, any welding slag must be removed, and the weld brushed clean with a steel wire brush.
- Any visible damage to the galvanizing of the bolt and/or nut must be fixed with a suitable coating. Refer to **Appendix G** for coating requirements.
- Any visible damage to the galvanizing of the tower steelwork should also be fixed with a HDGASA approved zinc-rich epoxy coating (of at least 100 µm or more than the specified galvanising thickness) with at least 82% zinc in the dry film.

- **PRECAUTIONS AND SAFETY**

- Veld fires can easily occur during the welding process therefore mitigation measures should be in place. Measures like fire extinguishers, buckets with sand/water and fire brigade etc should be utilised to kill a fire if required.
- Toxic fumes can be generated during the welding process therefore the welder should be wearing the compulsory respiratory mask to mitigate against inhalation of any toxic fumes.
- The correct safety gear and clothing required for performing welding should be worn such as welding gloves, safety boots, welding helmet, respiratory mask etc.
- When work is conducted at heights, the necessary precautions and measures should be taken to ensure the welding is done in a safe manner. This may include, but is not limited to, hook up at heights by means of a suitable safety belt and/or harness, temporary platforms and/or scaffolding or any other acceptable or suitable way must be employed.

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4. Raised Foundation Columns

This anti-vandal measure entails the raising of the tower foundation column to a height that is deemed sufficient to aid in the prevention of tower vandalism and member theft. Refer to **Appendix C** for illustrations.

New Power Lines:

- **GENERAL SPECIFICATIONS**

- Height of the concrete columns at minimum 3m above ground.
- Applicable to self-supporting lattice structures and guyed lattice structures (not guy anchor foundations).
- The stub is extended so that the leg starts at the top of the foundation column for self-supporting lattice structures
- The column for the mast foundation is extended so that the structure's mast sits at the required height above ground.
- Dimensions of the columns are tower loading dependent.

- **DESIGN AND CONSTRUCTION CONSIDERATIONS**

- The increased foundation size.
- The original CAH must be maintained by decreasing the structures height proportionally to the additional height of the foundation columns. Where the lowest CAH is required for the self-supporting lattice structures the stubs shall be attached directly to the body of the structure. Where the lowest CAH is required for the guyed lattice structures a body section shall be removed. When determining the guy rope length, the additional foundation column height plus the structure height must be considered.
- The practicality of construction at the increased height must be considered.
- The anti-climb device attachment height must be considered.

- **PRECAUTIONS AND SAFETY**

- When working at heights, the necessary precautions and measures should be taken to ensure the construction of the columns are done in a safe manner. This may include but is not limited to; hook up at heights by means of a suitable safety belt and/or harness, temporary platforms and/or scaffolding or any other acceptable or suitable way must be employed.

Existing Power Lines:

- This shall be investigated on a case-by-case basis.
- Refer to the guideline *240-166854454 – Raised Foundation Columns (Draft)*

5. Marking of Members

The marking of members is compulsory on new power lines, in order for members to be easily identified as Eskom material to aid in reducing the selling and buying of steel members. All members up to anti-climb device level must be stamped with the words “ESKOM” at 300 to 500 mm intervals. The Eskom logo may not be used, and no abbreviation of the word ESKOM is allowed.

On existing towers, a battery-operated compression tool, with modified jaws to accommodate a single piece stamp with the word ESKOM, can be used to perform the marking. The compression tool must have a crimping capacity of at least 10 ton. Refer to **Appendix D** for an example of the tool (unmodified) and die.

• PREPARATION

New power lines:

- Markings must be done at the factory before galvanizing.

Existing power lines:

- The area on the tower members to be marked must be cleaned and clear of all foreign material.
- Ensure that the compression tool is in good working order and that the die (with the word ESKOM) is clean and clear of all foreign material and is securely fixed into the moveable part of the compression tool.
- The operator should stand in a comfortable position near the member.
- Press the fixed head of the die against one flange of the member to be marked. Apply power and ensure the moving head makes good contact with the flange. The marking process is done correctly if the indentation with the word ESKOM is clearly visible on the member.
- Repeat this operation every 300 to 500 mm along the whole length of the member.
- Damaged to the galvanizing must be repaired with a HDGASA approved zinc-rich epoxy coating (of at least 100 µm or more than the specified galvanising thickness) with at least 82% zinc in the dry film.
- When the depth of the impression becomes inadequate (not easily readable) the operator must check the battery of the compression tool and replace if necessary. If the die becomes worn or blunt it has to be replaced.

• PRECAUTIONS AND SAFETY

- When working at heights, the necessary precautions and measures should be taken to ensure the marking of members is done in a safe manner. This may include but is not limited to; hook up at heights by means of a suitable safety belt and/or harness, temporary platforms and/or scaffolding or any other acceptable or suitable way must be employed.
- The compression tool is generally fairly heavy therefore, it is advisable to have an additional safety rope that will support the tool and prevent it from falling.
- Since high forces will be exerted by the compression tool, precautions should be taken that no parts of the body or clothing be trapped in between the jaws of the tool and/or tower member as serious injury may be incurred.

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6. Anti-climb Devices

In compliance with the OHS Act, it is a requirement that all towers be fitted with an effective anti-climb device (ACD). There are three types of anti-climb devices currently used within Eskom; barbed wire, razor flat wrap and the palisade type.

The barbed wire type is installed on old existing lines, however this ACD type is not satisfactory anymore as it is easily stolen within a short period of time after being installed (in high vandalism areas) and deteriorates in corrosive areas. Not all towers have been modified to accommodate the palisade type ACD yet.

The razor wire flat wrap ACD type is recommended where the palisade type cannot be used. This design can be implemented on the tower's barbed wire existing brackets with minimal or no additional intervention. The razor wire flat wrap is easy to install, cost effective and lasts longer than the previous barbed wire type. It has been used in the Distribution division and on some transmission lines and was found to be very effective.

The razor flat wrap for use on existing towers should be as per the specifications on the generic drawings for inland applications and for coastal applications. However, each tower leg has its own drawing. Refer to **Appendix E** for the generic drawings.

• PREPARATION

Razor flat wrap:

- Where applicable, remove all existing barbed wire type anti-climb devices and scrap as per Eskom commercial asset disposal process.
- Install the razor flat wrap. Refer to **Appendix E – Distribution Technical bulletin 05TB – 028** for an installation guideline.
- Ensure that the correct PPE is used when working with razor flat wrap. Care must be exercised during the installation process.

Palisade type:

- Refer to the palisade drawings for the respective towers.

• PRECAUTIONS AND SAFETY

- When working at heights, the necessary precautions and measures should be taken to ensure the anti-climb devices are installed in a safe manner. This may include but is not limited to; hook up at heights by means of a suitable safety belt and/or harness, temporary platforms and/or scaffolding or any other acceptable or suitable way must be employed.
- The assembly is subjected to tension therefore precautions should be taken to ensure that no parts of body and clothing be ensnared in the razor flat wrap.
- When working on the ACD ensure not to stand on it without being hooked up at heights.

7. Razor Flat Wrap around Tower Members

Complementary to the installation of anti-vandal fastener measures, ACD and the marking of members, protection of the members from vandalism may still be required. Tower bracings can be sawn off either by hand or using portable tools and this additional installation of razor flat wrap around the legs with anti-vandal clips can offer additional protection. Refer to **Appendix F** for the wrapping concept.

- **PREPARATION**

- Ensure that the correct PPE is used when working with razor flap wrap. Care must be exercised during the installation process.

- **PRECAUTIONS AND SAFETY**

- When working at heights, the necessary precautions and measures should be taken to ensure the anti-climb devices are installed in a safe manner. This may include but is not limited to; hook up at heights by means of a suitable safety belt and/or harness, temporary platforms and/or scaffolding or any other acceptable or suitable way must be employed.
- The assembly is subjected to tension therefore precautions should be taken to ensure that no parts of body and clothing be ensnared in the razor flat wrap.

8. Vibration Sensor and Alarm System

Complementary to the installation of anti-vandal fastener measures, ACD and the marking of members, protection of the members from vandalism may still be required. Thieves are forced to cut the members using grinders, cutting torches, hacksaws, etc. in an attempt to steal the steel members. This cutting action (except cutting torches) produces a vibration frequency within an identifiable band.

This vibration device can be installed onto the structure and will detect that the structure is experiencing vibration within a specified frequency band, it will send out an alert to a central control system to dispatch armed response to the affected site. This alert will be accompanied by either a still image from a camera or a short audio recording (depending on the system selection) in an attempt to take care of false alerts and to positively confirm theft activity at the site. This activity can then be communicated to the relevant Grids to ensure the maintenance of the structures takes place timeously.

- **SPECIFICATION**

- Refer to the specification 240-170000156 – *Anti-theft Vibration Sensor and Alarm System*.

9. Alternative anti-vandal systems/measures

If an alternative system or measure is considered, it must be presented to LES for approval. Testing of the alternatives may be required and shall be witnessed by an Eskom representative.

The alternative for an anti-vandal fastener measure must offer protection (similar to swaged bolts) against loosening of the nuts using normal spanners and hand tools (including other types of vandalism tools) as well as hammer blows. Alternative systems/measures with written approval by LES will be considered for implementation on power lines.

9.1 Eliminated alternatives

The following options have been tested and should not be considered as alternatives:

Anti-vandal fastener measures:

- **Standard bolt and nut without any mitigation measures**

This is easily removed by readily available hand tools.

- **Bolt punched only**

This is done to prevent loosening of the nut and indicate that the nut has been tightened when inspected. The nut can be easily removed by readily available hand tools.

- **Nut tack welded to the bolt**

The tack weld can be easily broken, after which the nut is loosened with some difficulty as the tack weld damaged the thread. This loosening can be done with readily available hand tools and hence at least half or more of the circumference of the bolt needs to be welded.

- **Break away nut system**

This system can be loosened using standard hand tools like a hammer and a punch or monkey wrench. By knocking the rounded nut at the bottom with the punch, it becomes loose after a few blows, after which it is easily removed by hand.

- **Loctite/lock bolt**

The types that were previously proposed were only effective for smaller bolts up to approximately 10mm in diameter.

- **Round head bolt with special nuts**

Nuts that require special spanners to tighten and loosen them, with or without cups to offer better protection is not an effective solution. Using hand tools to cut slots whereby standard screwdrivers can be used or by flattening the cup against the nut and then using monkey wrench type spanners to undo them, are examples of measures used to bypass these systems. Any standard threaded system does not offer a solution to undo a bolt and nut type connection.

- **Bituminous coating products**

Two bituminous coating products were tested, namely Flexigum (a water based bituminous product by a company called Bitumproof) and BlackSeal-Lastic (a liquid paint by a company called Sika). These products were tested in an attempt to hinder an angle grinder from cutting through a member as well as an anti-vandal fastener measure. However, both products failed the test, as the results were similar to not having any product applied. The angle grinder could easily cut through the member for both products. As an anti-vandal fastener measure, the Flexigum did not bond with the steel member (could be easily removed) and the applied BlackSeal-Lastic had no difference to the effort required to remove a nut.

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10. Authorization

This document has been seen and accepted by:

Name and surname	Designation
Sibonelo Nzama	Middle Manager SCH Cluster (Structures, Civil and Hardware)
Bertie Jacobs	Chief Technologist - Mechanical
Lebo Maphumulo	Corporate Line Specialist
SCH Cluster team	
Line Managers Forum (LMF)	
Line Technical Forum (LTF)	
Line Engineering Services team	

11. Revisions

Date	Rev.	Compiler	Remarks/changes
September 2012	1	Bertie Jacobs	First issue
August 2022	2	Shaina Grant	Update on technologies, document template and content.

12. Development team

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

Bertie Jacobs	Transmission – Line Engineering Services (LES)
Shaina Grant	Transmission – Line Engineering Services (LES)
Ockert Fourie	Transmission – Line Engineering Services (LES)
Faith Mokhonoana	Transmission – Line Engineering Services (LES)
Jacque Calitz	RT & D Department
Dan Dukhan	Transmission – Line Engineering Services (LES)

13. Acknowledgements

Not applicable

Appendix A: SWAGED BOLT

The installation of the swage bolts must be done according to the supplier's method. However below is a typical installation process (refer to Figure A1).

1. The pin (1) is pushed through the prepared hole as far as possible. The collar (2) is then placed over the pin and located as close to the joint as possible.
2. The installation tool is placed over the assembly holding the pin head close to the joint face and also pushing the collar as close as possible.
3. On installation, the collet (3) moves backwards allowing the jaws (4) to grip the pintail. As the collet (3) continues to move backwards, the anvil (5) is forced forward firmly closing any gap condition and then swaging the collar into the grooves, developing the specified clamp and tensile properties.
4. On completion of the swaging cycle, the collet (3) continues to move backwards causing the pintail to break off. In the return mode of the tool, the assemble joint is first ejected from the anvil (5) and then the jaws (4) are opened freeing the spent pintail which is then removed from the tool.

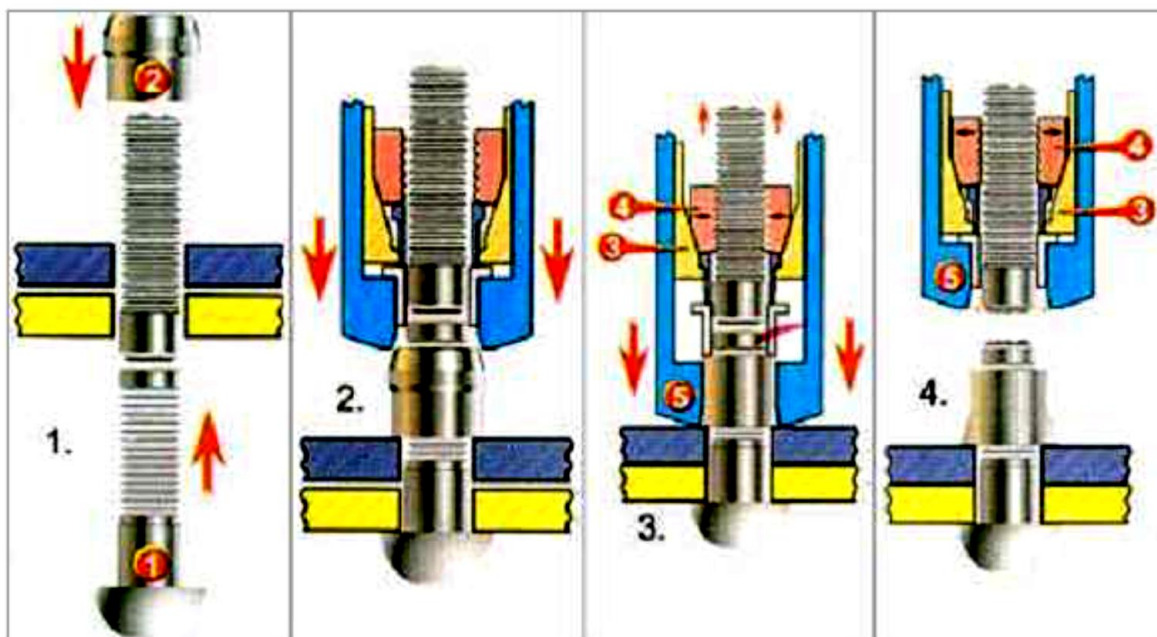


Figure A1: Typical swage bolt installation

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Figure A2: Swage bolt nut with a collar (flange)



Figure A3: Hydraulic crimper with one side flatten

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Appendix B: WELD OF THE NUT TO BOLT**WELDING PROCEDURE SPECIFICATION (WPS)**
for manual Metal Arc Welding (MMAW) ("Stick welding")Company _____ Approved by _____
(Signature Required)

WPS No _____ Date _____

WPS Revision No. _____ Rev. Date _____

Welding Process(es) Arc welding Type(s) Manual**Joints**

Joint Type	<u>Seam weld</u>		
Backing	<u>N/A</u>	Backing Material (Type)	<u>N/A</u>
Groove Angle	<u>N/A</u>		
Back gouging:	<u>No</u>	Back gouging Method	<u>N/A</u>

Base MetalsSpecification Type M16 and M20 tower fasteners Grade 8.8**Positions**

No welding and/or weld strikes will be allowed on any other tower member except at the nut-thread interface of the fastener as revealing Photograph1.

Weld length to be approximately half of the bolt circumference.

**Photograph 1:** Reveals the position of the weld**ESKOM COPYRIGHT PROTECTED**

Electrical Characteristics

Current Type/Polarity	DC
Current (Range)	120 A = 2.5 mm electrode and 140 A 3.15 mm electrode
Cleaning Method	Wire brush and degrease
Voltage (Range)	Determined by power source
Technique	Stringer bead
Electrode Size/Type	2.5 or 3.15 mm Vitamax (type ER 6013)
Pulsing Parameters	N/A
Transfer Mode	N/A (Only applicable to MIG/MAG welding)
Contact Tip to Work Distance	N/A

Addition requirementsHealth and safety

As the welding method requires the welding of galvanised fasteners it is recommend that the requirements as specified by **SANS 10238:2009 Welding and thermal cutting processes — Health and safety** be adhere to.

Fire / burn hazard

The welding of the galvanized fasteners resulted in a significant amount of spatter to occur, hence the need to use non-flammable blankets or alternative products around the base of the tower, as welding will be conducted on site and the spatter could result in the vegetation to ignite. On completion of the welding activity on a structure (tower), proper inspection of the surrounding vegetation need to be conducted in order to ensure that no fires could occur due to hot melt (spatter) falling outside the cover area of the non-flammable blanket.

Corrosion protection

As the welding is conducted on galvanised fasteners, the heat from the welding process vaporizes the protective zinc coating near the weld. Paints which are high in elemental zinc (i.e., "Zinc-rich"), properly applied, will effectively restore full corrosion protection to the weld areas. This paint can be applied to the weld after sand blasting or wire brushing to remove all welding slag followed by wiping the weld clean with a rag.

Eskom will specify the paint to be used for restoring the corrosion protective coating of the welded fasteners.

Manufacturer or Contractor _____

Date _____ By _____
(Please Print) (Signature Required)

Appendix C: RAISED TOWER FOUNDATION COLUMNS



Figure C1: Example of a raised foundation column



Figure C2: Example of a raised foundation columns on a tower

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Appendix D: MARKING OF MEMBERS

On existing towers, a battery operated compression tool (used to apply compression fittings to copper, aluminium and ACSR conductor), with modified jaws to accommodate a single piece stamp with the word ESKOM, can be used to perform the marking. The compression tool must have a crimping capacity of at least 10 ton. **Figure D1** shows an example of a compression tool and **Figure D2**, an example of the ESKOM stamp.



Figure D1: Example of a compression tool (unmodified jaws).



Figure D2: Example of a single piece ESKOM stamp

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Appendix E: ANTI-CLIMB DEVICE

Figure E1 and E2 are generic drawings of the razor flat wrap ACD for inland and coastal applications respectively. It must be noted that for transmission towers there are usually six or ten rows of steel wire.

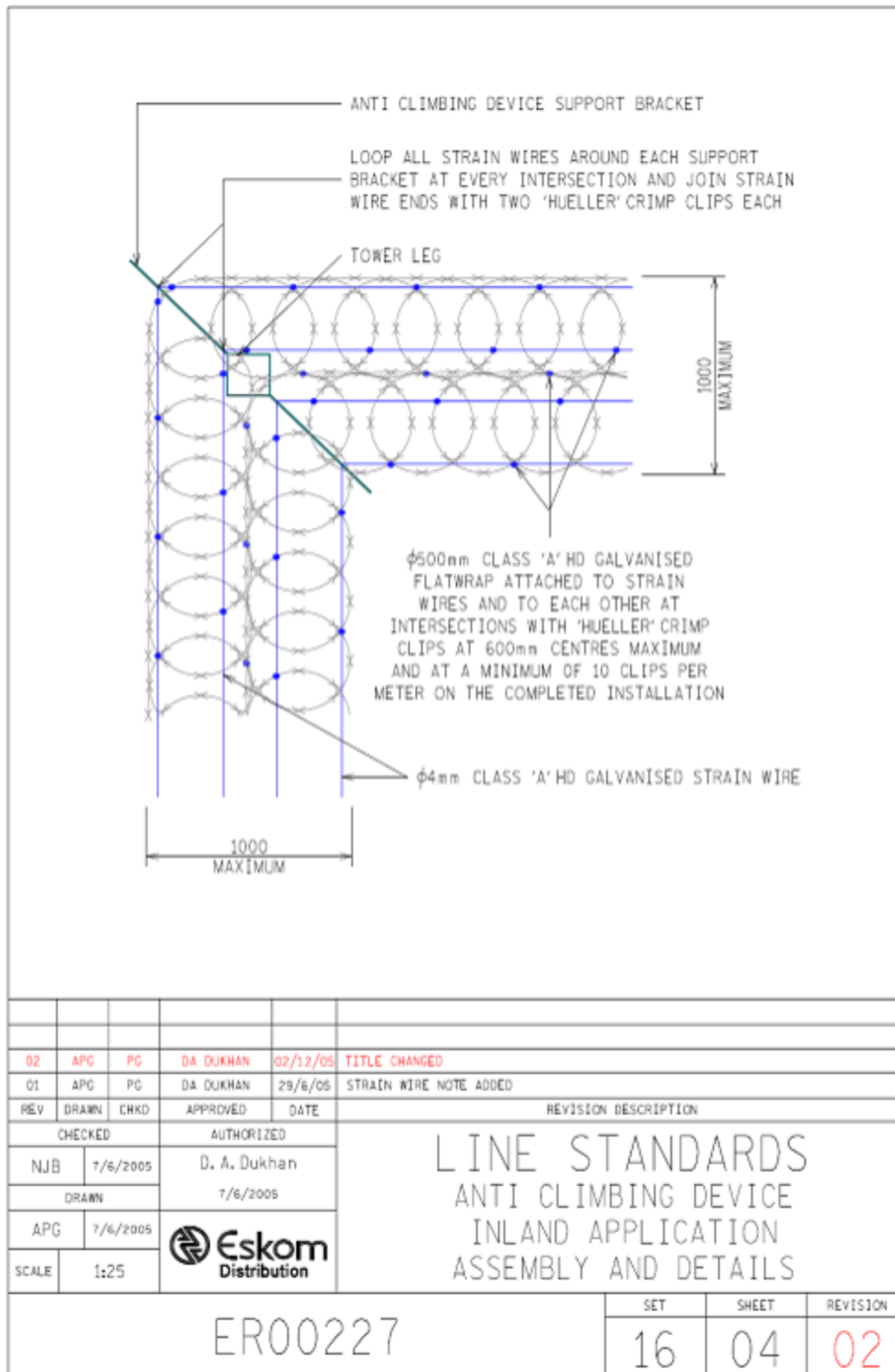


Figure E1: Razor flat wrap ACD drawing for inland applications

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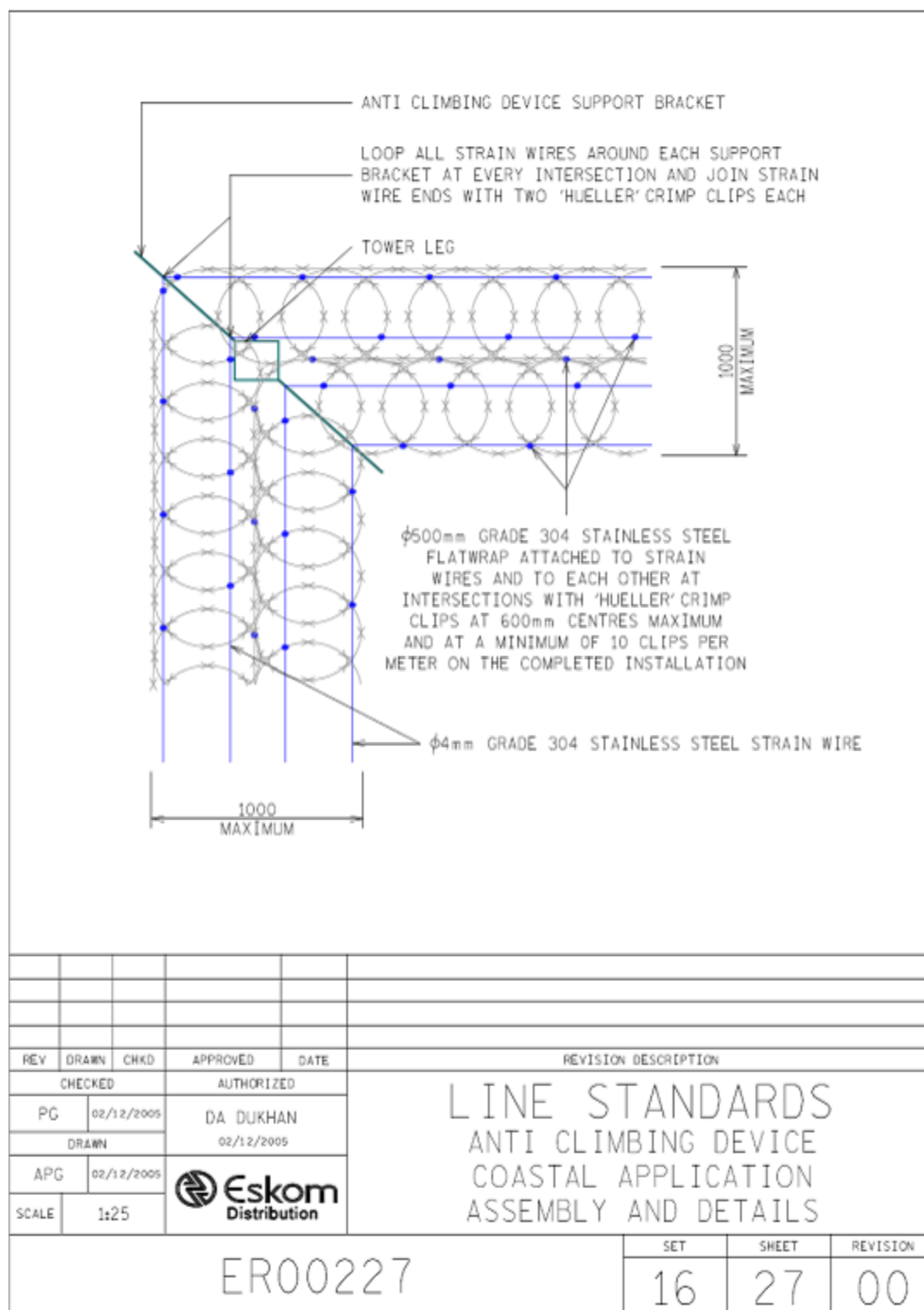


Figure E2: Razor flat wrap ACD drawing for coastal applications

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TECHNICAL BULLETIN: 05TB-028

Part 6: HV lines

TITLE: ANTI-CLIMBING DEVICES FOR LATTICE TOWERS

Background

Some existing anti-climbing devices have been installed in a manner such that persons are able to lift the barbed wire and gain access to the lattice tower legs. This bulletin addresses methods in which to modify the existing anti-climbing devices (ACD's) to prevent unauthorized access to the tower.

Lattice towers are supplied with an anti-climbing device. In some cases the bracket may vary but the concept is similar. *Insert 1* below shows the conventional device with brackets clamping onto the legs of a lattice tower. The barbed wire forms the horizontal "table" to severely inhibit any person from climbing past the device.

THE PHOTOGRAPHS BELOW ARE INDICATIVE ONLY AND MAY NOT REPRESENT THE ACTUAL SCENARIO ON SITE.

Insert 1: Conventional anti-climbing device



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The brackets are fabricated from steel with a slot provided for the connection of the wires. The slots can be seen on "Insert 2" below. The device relies on tension in the barbed wire to prevent it from being lifted vertically. Once the barbed wire is lifted out of one slot, the wire whole system becomes slack and is easily removed. Theft of the barbed wire is common in some densely populated areas.

Insert 2: Barbed wire captured by vertical slots



ESKOM, KZN have modified the ACD device to consist of flat razor wire and plain steel wire as shown in "Insert 3". They have found it both effective as an ACD and have experienced less theft of the wire.

Insert 3: Modification as installed by KZN



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Method of installation

ACD Brackets:

The ACD brackets shall be securely bolted onto the legs of the lattice towers. They shall not move vertically or horizontally when a force is applied to them.

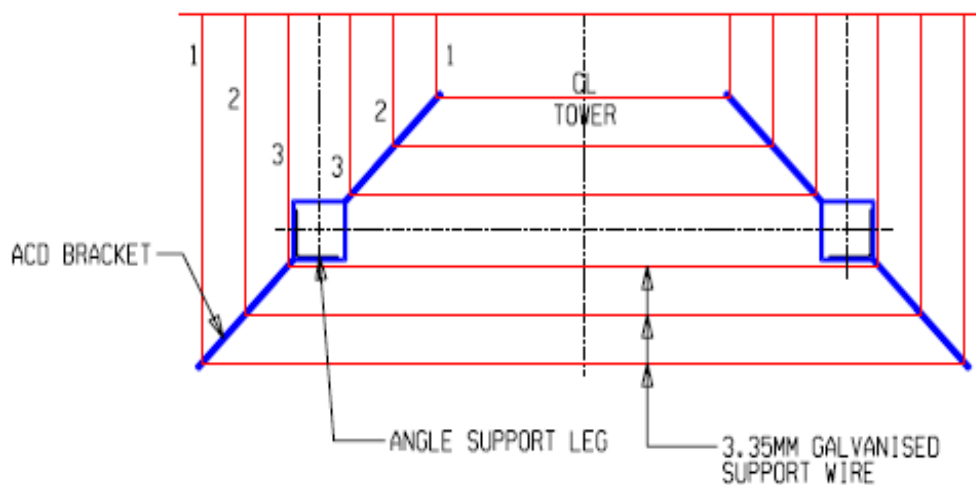


Figure 1. Half-section through tower

Placement and fitting of support wires

Numbers 1, 2 and 3 in Figure 1 above represent the layout of the 3.35mm heavily galvanized steel wires to achieve support for the razor wire ie. one outer support, one inner support and one center support per side.

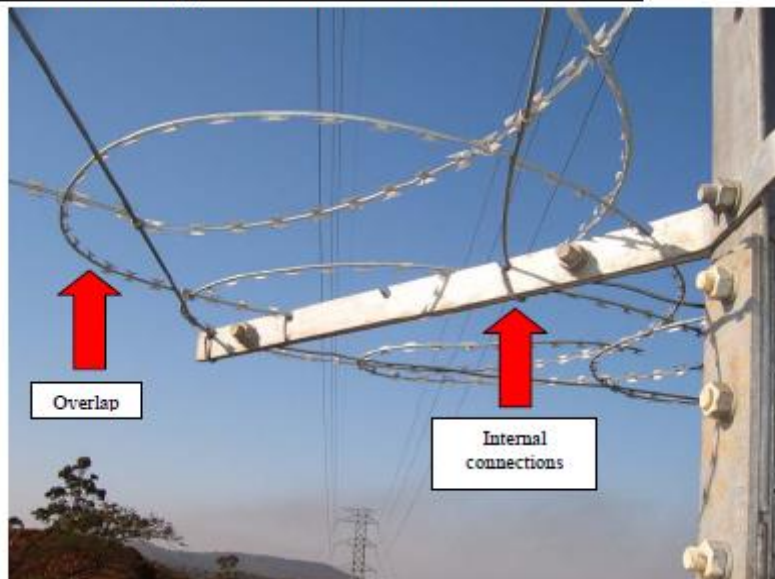
A 3.35mm heavily galvanized wire shall be connected to the brackets at positions 1, 2 and 3. The start of the wires forming the horizontal support shall be securely connected to the brackets by wrapping them around the steel brackets at least once and securing them by binding the wire back over itself. Where a wire join is required the join shall occur on an ACD bracket and the wire shall be wrapped around the steel brackets at least once and secured by binding the wire back over itself as for a start joint.

Internal connections shall be wrapped around the depth of the bracket to ensure that they are secure as shown in "Insert 4";

The wires shall be pulled up as tight as possible.

NOTE: FOR COASTAL APPLICATIONS THE USE OF STAINLESS STEEL MAY BE CONSIDERED.

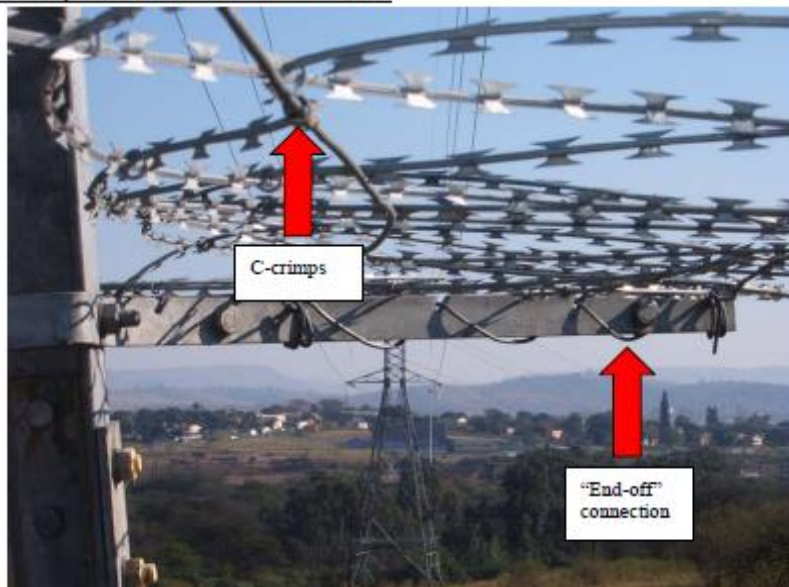
Insert 4: Connection of support wire onto ACD arm and razor wire overlap



Placement and fitting of flat wrap razor wire

The flat wrap razor wire shall be laid on top of the galvanized support wire. The radius of the razor wire shall extend over the inner and outer support wires to allow an overlap. This is depicted on the above photograph. Attention shall be paid to the inner corner where the wires numbered 5 meet at the leg of the tower. The razor wire shall extend over this area sufficiently to prevent any person from passing through it. At the intersection points of the support wire and the flat wrap razor wire a C-cripp shall be applied to connect the two together. There shall be no loose connections at any point where the razor wire overlaps the galvanized wire. All critical points shall be connected with a maximum distance between C-cripps of 500mm.

Insert 5: Crips and method of end connection



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All ACD's installed shall severely inhibit any persons from climbing the structures.

Required modifications to existing ACD's on lattice towers and required action

	Description	Action
1	The brackets and wire are in good condition. The wire is secured onto the brackets preventing vertical lifting of the wire out of the bracket.	No action required.
2	The brackets and barbed wire are in good condition but the barbed wire is not tied onto the ACD brackets. The tension in the barbed wire is taught.	The barbed wire shall be bound onto the ACD brackets using 3.35 galvanised binding wires to ensure that the barbed wire cannot be lifted from the bracket. This shall be done even if the tension of the barbed wire restricts the vertical movement of the barbed wire from the ACD bracket.
3	The bracket is loose at the structure but is in good condition. The tension in the wires is loose due to the bracket being loose.	Loose bolts shall be re-tightened and loose wires shall be re-tensioned. The wires shall be bound onto the ACD as for point 2 above.
4	The bracket is in good condition but the tension in the wires is loose.	The wires shall be re-tensioned and the tie wires shall be bound onto the ACD as for point 2 above.
5	The bracket is in good condition but the barbed wire/razor wire is rusted.	The barbed/razor wire shall be removed. New 3.35mm heavily galvanized steel wire and flat wrap razor wire shall be installed as explained in "Method of Installation".
6	The bracket and the barbed/razor wire are not in good condition.	The brackets shall be replaced and new 3.35mm galvanized steel wire and flat wrap razor wire installed as explained in "Method of Installation".
7	New installations	New 3.35mm heavily galvanized steel wire and flat wrap razor wire shall be installed as explained in "Method of installation".

ALL TRANSMISSION LATTICE TOWERS SHALL BE FITTED WITH ANTI-CLIMBING DEVICES WHICH ARE INSTALLED IN ACCORDANCE WITH THIS TECHNICAL BULLETIN.

The following drawings, from Eskom Eastern region (KZN), are attached as a guideline for new installations for ACD's for coastal and inland applications.

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Appendix F: RAZOR FLAT WRAP AROUND TOWER MEMBERS



Figure F1: Example of a razor flap wrap around the tower members

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Appendix G: ADDITIONAL COATING REQUIREMENTS

1. Corrosion System Selection

Currently the primary protection system and the first line of defence against corrosion is galvanizing of tower steel members, fasteners and hardware components. When the galvanizing was damaged due to punching of bolts, welding, etc. the protection system needs to be repaired to offer the same level of protection against corrosion. This can be achieved through applying an additional coating to the component to restore the protection against corrosion to a desired level.

The selection of a corrosion protective systems is based on the atmospheric environmental conditions and the estimated corrosion category (C1 to CX) specified (ISO 14713-1; ISO 12944-2) and should be reflected in the requirements sent to the supplier.

- C1 very low corrosivity
- C2 low corrosivity
- C3 medium corrosivity
- C4 high corrosivity
- C5 very high corrosivity
- CX extreme corrosivity

The corrosion category for new build lines should be found in the line specification. Line Engineering services may be contacted to assist with determining the corrosion category for existing lines.

2. Additional Coating Systems

This section deals with the performance requirements for the additional corrosion protection coatings to be used as well as requirements from the contractor for equipment exposed to outdoor environments and covers coatings on hot dip galvanised mild steel.

2.1 MATERIAL SELECTION

2.1.1 System

Requirements for an additional coating system will be specified for each component application.

2.1.2 Material Supply

- a) All materials, i.e. paint, solvents and cleaning agents for a specific paint system shall be supplied by the same manufacturer.
- b) All coatings, solvents and cleaning materials shall be supplied in sealed, sturdy containers which have been labelled with all the information necessary to ensure proper storage, mixing, application and traceability. The coating containers shall be of a size large enough to allow mixing in the containers themselves.

2.1.3 Material Storage

Storage instructions received from the supplier should be followed at all times.

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- a) All containers (i.e. coatings, solvents and cleaning materials) shall be kept in a storage area that is completely dry, enclosed, well ventilated, covered and maintained at a temperature compatible with good preservation of the materials.
- b) Should any of the coating containers show traces of leakage prior to use, the contents of that container shall not be used.
- c) Similar to the coatings, all abrasive media shall be stored in an area that is completely dry and covered to allow for good preservation of the materials.

2.2 SURFACE PREPARATION

It is extremely important that the Contractor endeavour to achieve the best surface preparation, as described in the manufacturer instruction sheet, possible to ensure proper adhesion. All harmful contaminants such as scale, grease, oil, soil, salt residues, corrosion product and any foreign matter or residues that may affect the performance of the coating system shall be removed, prior to application of the protective system.

2.3 GUARANTEES

Since the Contractor is obliged to submit signed product data sheets at the time of the Contract Order Acceptance, in doing so, and by supplying materials to the Contractor, both the Contractor and his paint supplier bind themselves to a minimum guarantee period of 36 months in terms of the performance of the corrosion protection system.

As a minimum, the guarantee regarding the performance of the corrosion protection system is stipulated as follows:

The coating will be considered defective should rusting of the coated surfaces develop within 36 months where it is rated more than Ri 1 or 0.05% (in accordance with ISO 4628-3)

and/or

Blistering, flaking, delamination, cracking, alligatoring, or any other defects not specifically listed, are present that in the opinion of the Project Manager or his coating specialist, reduces the aesthetic appearance or compromises the integrity of the coating system.

2.4 RESPONSIBILITIES

- a) The contractor is responsible to use the requirements provided in the relevant line specification and submit it to a paint supplier to be used for each activity specified.
- b) The contractor will ensure that all the necessary product documentation requested in the requirements section in the relevant design documentation is sufficient. The contractor will submit these documents to Eskom for review and record-keeping purposes.
- c) The contractor should follow the supplier application instructions on the system to ensure the best possible outcome. Coating thickness will be measured after application following supplier instructions.
- d) Eskom will require the contractor to supply a guarantee certificate at the end of a project for the paint supplier, for each specific system supplied, including the product name, transmission line name, contractor name and guarantee period.
- e) If the contractor cannot provide Eskom with a certificate with the initial durability requirements with stated reason. The contractor should be held liable for maintenance on the system.
- f) It is preferred that the paint system should be applied at the galvanising yard, alternatively it can be applied on site with a clear indication from the supplier how it would affect the guarantee.

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2.5 ADDITIONAL COATING SYSTEM PERFORMANCE REQUIREMENTS

2.5.1 Fastener requirements outline

The below paint system requirements should be sent to the supplier.

1) Surface

Indicate what type of surface:

- Newly or slightly Weathered HDG surface / Welded area

2) Coating type

- Single stage application
- Solvent or water-borne base coating

3) Application method

- Brush (on site application)

4) Environment

Indicate the category and estimated surface temperature:

- C2-C5 Environment
- Surface temperature range of 0 to 50°C (estimated, should be verified with conditions)

5) Durability

Based on the category, state the minimum durability:

- C2-C3 Environment Medium (7-10 years)
- C4-C5 Environment High (15 years)

6) Guarantee

- Minimum 3 years

7) Colour Requirements

- Should stand out for easy inspection e.g. yellow, orange (to be confirmed as it might be chosen to match the tower e.g. battleship grey)

8) Supporting Documents Required

- Safety Data sheet
- Signed Technical data sheet
- Salt spray Test reports (2000h for C4-C5; 1000h for C2-C3)
- UV Test reports
- Adhesion testing

9) Material Supply

- All material shall be supplied by the same manufacturer
- All material shall be properly sealed and stored as per the manufacturer requirements

Preference will be given to products that minimize the impact on the environment and health, which includes:

- Toxic or carcinogenic substances;

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- Emissions of volatile organic compounds (VOCs);
- Harmful effects of fumes, dust, vapours, as well as fire hazards;
- Protection of water and soil during corrosion protection work;
- Recycling of materials and waste disposal.