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Title: **STANDARD FOR FENCES IN ESKOM TRANSMISSION SUBSTATIONS**

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Content

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1. Introduction

This document prescribes the minimum requirements for substation HV yard fences which Eskom shall comply with. Every substation is to have a fence around which defines its boundary, and a security fence to prevent public access into the substation and a safety fence around HV yards to prevent unauthorised persons and accident contact with the live equipment.

2. Supporting Clauses

2.1 Scope

The scope of this document pertains to the boundary, security and safety fencing.

The contents of this document does not deal with High Security Mesh Fence (refer to document 240-76368574) and Non-lethal electric fence (refer to document 240-78980848).

2.1.1 Purpose

The purpose of this document is to provide and to comply with the minimum requirements for fences surrounding the HV yard as used in Eskom Transmission Substations.

2.1.2 Applicability

This document shall apply to Substation Engineering Department within Group Technology in Eskom.

2.2 Normative/Informative References

2.2.1 Normative

[1] ISO 9001 Quality Management Systems.

[2] SANS 121 Hot-dip galvanized coatings on fabricated iron and steel articles – Specifications and test methods

[3] SANS 675 Zinc-coated fencing wire

[4] SANS 927 Precast concrete kerbs, edgings and channels

[5] SANS 929 Plywood and composite board

[6] SANS 1200 D Standardized specification for civil engineering construction Section D: Earthworks

[7] SANS 1200 DA Standardized specification for civil engineering construction Section DA: Earthworks (small works)

[8] SANS 1200 G Standardized specification for civil engineering construction Section G: Concrete (structural)

[9] SANS 1373 Chain-link fencing and wire accessories

[10] SANS 1700-5-8 Fasteners Part 5: General requirements and mechanical properties Section 8: Mechanical properties of corrosion- resistant stainless-steel fasteners – Bolts, screws and studs

2.2.2 Informative

None

2.3 Definitions

2.3.1 General

Definition	Description
Hot-dip galvanising	Formation of a coating of zinc and/or zinc iron alloys on iron and steel products by dipping prepared steel or cast iron in a zinc melt.

2.3.2 Disclosure Classification

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

2.4 Abbreviations

Abbreviation	Description
HT	High Tensile
HV	High Voltage
IP	Intermediate Post
kN	KiloNewton
m	Metre
mm	Millimetre
SANS	South African National Standard

2.5 Roles and Responsibilities

Substation designers involved in the designing, refurbishment and installation of fences shall adhere to this standard.

The contractor shall be responsible for the provision of all services associated with the concept and implementation of the quality assurance control.

2.6 Process for monitoring

Not applicable.

2.7 Related/Supporting Documents

Not Applicable

3. Requirements

3.1 Contractors Equipment

The contractor shall ensure the provision of suitable construction equipment for the erection of the fencing, gates and concrete kerb in compliance with the requirements of this specification.

3.2 Fencing types

In the substation designing environment, the following fencing types are available:

- Boundary fence (animal fence),
- Security fence,
- High security mesh fence,
- Safety fence,
- Concrete wall and
- Non-lethal electric fence.

An assessment shall be done on each substation by Eskom Group Security to determine the level of security required based on potential security hazards. This assessment shall influence the fence type that is to be used. Either a high security mesh fence or a standard outer security fence shall be used. The inner security fence shall always be used.

3.2.1 Boundary Fence

The boundary fence is used to mark the extent of the Eskom property. If the substation area falls within the power line servitude, then the boundary fence shall be common to both.

The height of the boundary fence shall 1.2m high, but there may be instances where 1.5m height is specified to meet the local requirements.

3.2.2 Security Fence

The security fence shall be 2.4m high galvanised fence to the specification below. It shall be made up of welded mesh to limit the risk of unauthorised persons gaining entry over the fence with the aid of climbing. There are two types of security fences with overhangs, an outer security fence with a V-overhang and an inner security fence with single V-overhang (single angle veranda). The V-overhang shall have a razor wire coil installed for anti-climbing measures.

3.2.3 Safety Fence

A safety fence shall comprise of 1.8m high diamond mesh with no overhangs. It is used to restrict unauthorised access of persons into the live enclosures inside the substations.

3.3 Specification for fencing

3.3.1 General

All steel shall be S275JR or S355JR grade hot-dip galvanized to SANS 121.

3.3.2 Wire

Wire for fencing shall comply with the requirements of SANS 675 and SANS 1373.

3.3.2.1 Welded Mesh Fence

Welded mesh fence shall be 3.15mm diameter HT mesh 50 x 50mm openings for security fences with stainless steel jointing clips.

3.3.2.2 Diamond Mesh Fence

Diamond mesh fence shall be 2.50mm x 64 galvanized mild steel.

3.3.2.3 Straining Wire

Straining wire shall be 4.0mm diameter galvanized mild steel.

3.3.2.4 Barbed Wire

Barbed wire for boundary fence and security fence overhangs shall be 2.24mm diameter galvanised HT campion class A.

3.3.2.5 Barbed Tape Wire

Barbed tape wire shall be 750mm diameter coils of 2.5mm galvanized wire with long blade profile galvanized barbs at 37.5mm spacing.

3.3.3 Posts, stays and extension arms

All posts shall include footplates as indicated in the relevant drawings. Where large plant items such as power transformers or shunt reactors are installed, removable fence posts shall be provided to aid installation and removal of the plant. Posts, stays and extension arms shall be of the dimensions summarised below for security and safety fences:

Table 1: Security and safety fences and posts

Fence	Fence Type	IP spacing	Strain Posts Spacing
Security	2.4m high, welded mesh fence	4.0m maximum	40m maximum where distance between corner posts exceed 90m
Safety	1.8m high, diamond mesh	4.5m minimum	60m maximum where distance between corner posts exceed 90m

3.3.4 Standards and droppers

Requirements for both the boundary fence of 1.2m high and 1.5m high are summarised below:

3.3.4.1 1.2m Boundary fence

- Tying wire shall be 2.0mm diameter mild steel lightly galvanised wire for tying fencing wire to standards and droppers.
- Intermediate strain posts shall be spaced at a maximum distance of 400m.
- Gate corners and strain posts shall be painted tubular sections having a nominal bore of 101 outside diameter x 2.5mm thickness and stays shall have a nominal bore of 48x2.5mm.
- All tubular sections shall be provided with a 200x200mm footplate and a pressed steel or cast iron cap.
- Intermediate standards shall be 2.0kg/m ‘Y’ section provided with a protective coating of tar or other approved material spaced at a maximum of 3.5m.
- Droppers shall be 0.56kg/m ridgeback pattern provided with a protective coating of tar or other approved material, spaced at a maximum of 3.5m.
- Boundary fence shall consist of 6 runs of single HT steel strand campion 2.24mm thick, galvanised class A barbed wire.

3.3.4.2 1.5m Boundary fence

- Tying wire shall be 2.5mm diameter mild steel lightly galvanised wire for tying fencing wire to standards and droppers.
- Intermediate strain posts shall be spaced at a maximum distance of 37.5m.
- Gate corners and strain posts shall be painted tubular sections having a nominal bore of 76mm and stays shall have a nominal bore of 60mm with a wall thickness of at least 2.9mm.
- All tubular sections shall be provided with a 200x200mm footplate and a pressed steel or cast iron cap.
- Intermediate standards shall be 2.5kg/m 'Y' section provided with a protective coating of tar or other approved material spaced at a maximum of 6.25m.
- Droppers shall be 0.56kg/m ridgeback pattern provided with a protective coating of tar or other approved material, spaced at a maximum of 1.25m.
- Boundary fence shall consist of 10 or 15 runs of single HT steel strand campion 2.24mm thick, galvanized class A barbed wire.

3.3.5 Gates and removable panels

- The substation safety fence shall have pedestrian and removable panels or double gates big enough to allow crane mounted truck and/or manlift to enter and reach all sections of substation yard. Boundary and security fence shall have the main access sliding gates.
- Removable panels shall be installed where large plant such as power transformers and shunt reactors are installed.
- Gates and removable panels shall have a galvanized steel tube frame as indicated in the relevant drawings.
- All openings that shall result in water entrapment shall be closed.
- The layout plan shall indicate the position of the gates.
- 6mm diameter drain holes at 300mm centres shall be drilled at the bottom of all gates before galvanizing.

3.3.6 Metal Fittings

Bolts, nuts washers, turnbuckles, hinges and similar fittings shall be of galvanized mild steel complying where relevant with the requirements of SANS 1700-5-8.

3.3.7 Concrete

Post length foundations below ground shall be as shown on drawing 0.54/398 for boundary fence, drawing 0.54/5633 for security fence and drawing 0.54/4963 for safety fence. Typical foundation size of the removable post foundation size shall be 450mmx450mmx500mm deep.

Concrete for all post and strut foundations shall be grade 15 MPa/26 mm and for kerbs, grade 20 MPa/19 mm.

Where scheduled a concrete kerb of nominal dimensions 75 mm wide x 300 mm deep of Grade 20 MPa concrete (or precast concrete kerb Figure 5 to SANS 927) shall be constructed along the security fence line, as detailed on the relevant drawings.

3.3.8 Galvanizing

Posts, strays and extension arms shall be galvanized hot-rolled mild steel sections and galvanized mild steel tubular sections for boundary fences.

Galvanizing of steel members and metal fittings, mild steel and high tensile wire, and barbs on barbed tape shall comply with the requirements of SANS 675 for general applications. Galvanised hot-rolled mild steel sections shall be used for security and safety fences and galvanised mild steel tubular sections are to be used for boundary fences.

No cutting or drilling of any galvanized component shall be permitted. Any damage to the galvanising surfaces shall be prepared with an approved galvpack containing an organic epoxy (Application to supplier's specifications). Alternatively damaged components shall be sent for stripping and re-galvanizing.

3.3.9 Holes

Holes in the steel members for fences shall not be punched or flame cut but shall be drilled (and burs removed) before the member is galvanized.

3.4 Construction

3.4.1 General

Construction of the fence, gates and concrete kerb shall comply with the details given in the relevant drawings and with the requirements of this specification.

3.4.2 Clearing Fence Line

Where the fence line has not already been cleared, it shall be cleared over a width of at least 1m on each side of the centre line of the fence and surface irregularities shall be graded so that the fence will follow the general contour of the ground. The bottom of the fence shall be located a uniform distance above the ground line in accordance with the requirements shown on the relevant drawings. All material removed shall be disposed of as specified in SANS 1200D Section 5.2.2.3.

3.4.3 Installation of Posts and Standards

The length of all posts above ground shall be such that the correct clearance between the lowest wire and the ground can be maintained.

Straining posts shall be erected at all ends and corners or bends in the line of the fence and at all junctions with other fences, provided that straining posts shall not be spaced further apart than the minimum distances shown on the drawings.

Spacing of intermediate posts, standards and droppers shall not be more than it is indicated, provided that the spacing of the standards and intermediate posts between any two straining posts is uniform.

All posts and stays shall be set in dug holes to the dimensions shown in the relevant drawings and provided with concrete bases. Holes shall be dug to the full specified depth, even in rock where blasting may be necessary to obtain the required depth.

Corner, Tee-off, gate and straining posts shall be braced by stays bolted to the posts.

All posts shall be accurately aligned and set plumb. After posts have been set in concrete, the concrete shall be cured for at least 7 days before the fence wire is attached to the posts at the spacing indicated in this specification.

3.4.4 Installation of Fencing and Straining Wire

All fencing wire shall be attached to the posts as detailed on the drawings. The wire shall be carefully stretched and hung without sag, and with true alignment, care being exercised not to stretch the wire so tightly that it will break or that the posts will be pulled up or destroyed.

The maximum force in fencing wire after it has been stretched between straining posts shall be 0.9kN.

Splices in the straining wire shall be permitted if made using a splice tool. The wire ends shall be carried past the splice tool for at least 75mm and wrapped snugly around the other wire for at least 6 complete turns, the two separate wire ends being turned in opposite directions. The unused wire ends shall be cut close to leave a neat splice.

3.4.5 Installation of Welded Mesh Sheets

Welded mesh sheets shall be stretched against the fence posts and properly tied to the straining wire by means of 2.5mm nominal diameter binding wire or stainless steel clips at 250mm centres, or close to remove bulges in the mesh. The mesh shall be taken continuously past the face of all intermediate posts, intermediate straining posts and corner posts. At the straining posts and corner posts the mesh shall be clamped on either side of the post using 20mm wide galvanized flat bars, bolted together with galvanized bolts and nuts and fastened to the post by means of a hook bolt, as detailed in the relevant drawings. Small bulges formed in the mesh between these clamps shall be acceptable. Mesh which has been distorted prior to erection e.g. egg shaped instead of circular coils shall not be accepted.

Welded mesh shall be 2.7m high, the bottom 400mm shall be dipped in a bitumen solution, and when erected the bottom 300mm (minimum 250mm) shall be buried in an excavated trench and backfilled with a granular material and neatly levelled off to the supervisor's satisfaction. The joining of the welded mesh sheets shall be as shown in the relevant drawing. The screw threads on the stand-outs of all bolts, hook bolts and eye bolts shall be turned over after erection to prevent the possible removal of the nuts.

3.4.6 Installation of Diamond Mesh or Wire Netting

Diamond mesh shall be stretched against the fence posts and properly tied to the fencing wire as detailed in the relevant drawings. The diamond mesh shall be secured by tying wire at every third aperture along the straining wires and at every aperture at end and gate posts.

3.4.7 Installation of Barbed Wire (Only if specified)

Single strand barbed wire that shall be fitted to the top of the posts shall be installed along the upper face of the single overhang of the fence. The barbed wire shall be stretched as described in Section 3.4.4 of this specification and fixed to the immediate posts using 2.5mm diameter binding wire.

3.4.8 Installation of Gates and removable panels

Gates and removable panels shall be installed at the places indicated in the relevant drawings. The gates shall be hung on the gate fittings in accordance with the details shown in the relevant drawings. Gates shall be so erected as to swing in a horizontal plane at the right angles to the gate posts, clear of the ground in all positions. Gates shall not be further than 40mm from the gate post when closed, or as otherwise shown in the relevant drawings.

3.4.9 Transport and Storage

The transporting, off-loading and storage on site of all materials shall be carried out with care so that no damage to steel, mesh, paint or galvanizing shall occur.

3.4.10 Earthing

The installation shall be earthed in accordance with the requirements of SANS 10142-1. The fence shall be earthed across gate openings and removable panels by means of a 40mm wide x 3mm thick copper earthing strap as shown on drawing No. 0.54/4963 sheet 5 or as otherwise detailed in the drawings 0.54/393.

3.5 Tolerances

The completed fences shall be plumb, taut, true to line and ground contour, with all the posts and stays firmly set.

Permissible deviations shall be as follows:

- The height of the lower fencing wire above the ground at posts and standards shall not vary from that shown on the drawings by more than 25mm. Other fencing wires shall not vary by more than 10mm from their prescribed relative positions.
- The maximum acceptable out of alignment of fence posts in any direction shall be 25mm. The maximum acceptable out of plumb of fence in any direction shall be 20 mm.
- The maximum acceptable distortion of mesh already erected shall not exceed plus/minus 25mm on each 4m length.
- Gates shall swing in a horizontal plane at right angles to the gate posts clear of the ground in all positions within maximum ground clearance of 80mm. Double leaf gates shall not have a gap of more than 40mm between the two leaves when closed and all gates shall not be further from the gate posts when closed than the dimensions shown on the drawings.

3.6 Testing

Testing shall be as specified in SANS 1200 G clause 7 and variations and additions or as called for by the supervisor.

3.7 Maintenance

All fences shall be maintained to ensure that the level of security is kept. Maintenance procedures shall ensure this by renewing any:

- Corroded sections;
- Damaged sections of fence and of concrete and kerbs;
- Signage;
- Ground subsidence or disturbances and
- Holes or penetrations.

All fences shall be maintained so that its appearance and integrity is not compromised.

3.8 Drawings

Drawings can be found in Eskom transmission drawing off archive system.

The following drawings shall be used:

3.8.1 Boundary fence

- 0.54/398 Sheet 1 - Boundary Fence 1200 High Layout and Details
- 0.54/398 Sheet 2 - Boundary Fence 1500 High Layout and Details

3.8.2 Security fence

- 0.54/5633 Sheet 1 - 2,4m High Security Fence with Overhang Access Gate Plan, Elevations and Details
- 0.54/5633 Sheet 2 - 2,4m High Security Fence with Overhang Access Gate Posts Plan, Elevations and Details

- 0.54/5633 Sheet 3 - 2,4m High Security Fence with Overhang Posts and Struts Detail
- 0.54/5633 Sheet 4 - 2,4m High Security Fence with Overhang Posts Concrete Bases and Gate Keep Detail
- 0.54/5633 Sheet 5 - 2,4m High Security Fence with Overhang Weldmesh Termination and Fixing Detail
- 0.54/5633 Sheet 6 - 2,4m High Security Fence with Overhang Access Gate Post, Wiring Protection Detail
- 0.54/5633 Sheet 7 - 2,4m High Security Fence with Overhang Brackets Layout and Details

3.8.3 Security Sliding Gates

- 0.54/7470 Sheet 1 - Security Fence Three Types of Security Sliding Gates General Arrangement
- 0.54/7470 Sheet 2 - 7m Security Sliding Gate with Removable Post and Concrete Wall – Outside Steelwork Arrangements
- 0.54/7470 Sheet 3 - 7m Security Sliding Gate with Removable Post and Concrete Wall - Outside Steelwork Details
- 0.54/7470 Sheet 4 - 7m Security Sliding Gate with Removable Post and Concrete Wall - Outside Steelwork Details
- 0.54/7470 Sheet 5 - 7,8m Non-Lethal Sliding Gate – Middle Steelwork Arrangements
- 0.54/7470 Sheet 6 - 7,8m Non-Lethal Sliding Gate – Middle Steelwork Details
- 0.54/7470 Sheet 7 - 7,8m Non-Lethal Sliding Gate – Middle Steelwork Details
- 0.54/7470 Sheet 8 - 7m Security Sliding Gate with Removable Post Steelwork Arrangements – Inside
- 0.54/7470 Sheet 9 - 7m Security Sliding Gate with Removable Post Steelwork Details – Inside
- 0.54/7470 Sheet 10 - 7m Security Sliding Gate with Removable Post Steelwork Details – Inside
- 0.54/7470 Sheet 11 - 3,3m Security Gate Steelwork arrangements and Details

3.8.4 Safety fence

- 0.54/4963 Sheet 1 - HV Yard Safety Fence with Steel Posts Arrangement Foundation Details
- 0.54/4963 Sheet 2 - HV Yard Safety Fence with Steel Posts Arrangement Gate Details
- 0.54/4963 Sheet 3 - HV Yard Safety Fence with Steel Posts Arrangement Posts Details
- 0.54/4963 Sheet 4 - HV Yard Safety Fence with Steel Posts Arrangement Gate Hinges Details
- 0.54/4963 Sheet 5 - HV Yard Safety Fence Earthing Clamp for Substation Gates

4. Authorisation

This document has been seen and accepted by:

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5. Revisions

Date	Rev	Compiler	Remarks
April 2016	1	TL Seatlholo	New document required

6. Development team

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

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7. Acknowledgements

Not applicable.