



## RAIL NETWORK TECHNICAL SPECIFICATION FENCING & STERILE ZONES

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## TABLE OF ABBREVIATIONS AND ACRONYMS

AC	Alternating Current
DC	Direct Current
°C	Degrees Celsius
IEC	International Electrotechnical Commission
SANS	South African National Standards
BS	British Standards
PVC	Polyvinyl Chloride
V	Volt
kV	kiloVolt
HV Yard	High Voltage Yard

### Summary of Revisions

Rev.	Section	Description	Date
00	All	Original Document	23 April 2021
01	4,5,6,7,10,13	Revision of technical elements including: dimensions, construction standards, supplied material/components, earth resistance testing. Clauses have been put in, where applicable, that deviations to specified dimensions, standards, services and supply of material be subject to the approval of the Project Manager.	02 September 2021

## **1.0 SCOPE**

- 1.1 This specification covers Transnet Freight Rail's requirements for both the removal of existing fencing and the supply, installation, testing and commissioning of the novel Fencing and Sterile Zones security approach at all Traction Substations (3kV DC, 25 & 50 kV AC) and Distribution Substations (6.6 & 11 kV AC), High Sites and Relay Rooms in commission under Transnet Freight Rail and Real Estate Management.

## **2.0 SPECIFICATIONS AND STANDARDS**

- 2.1 All material, equipment and work shall be done in accordance with Transnet Freight Rail's specifications, drawings and relevant SANS standards. Any reference made to specifications and standards shall mean the latest publications or edition to these documents which might have superseded earlier standards.
- 2.2 There may be specific requirements in addition to the generic specifications that shall be taken into consideration by the Contractor(s) and/or various equipment designers and manufacturers. It is therefore just as important to read this particular specification, together with the generic specifications listed below.

### **2.2.1 SOUTH AFRICAN NATIONAL STANDARDS:**

SANS 1063	Earth rods, couplers and connections.
SANS 1507-1-3	Electric cables with extruded solid dielectric insulation for fixed installations
SANS 2063	Thermal spraying – Metallic and other inorganic coatings – Zinc, aluminium and their alloys.
SANS 10199	The design and installation of earth electrodes.
SANS 121	Galvanising of steel
SANS 10222-3	Electrical security installations Part3: Electrical security installations and Electric fences (non-lethal) and manufactures requirements
SANS 121	Hot dip galvanized coatings on fabricated iron and steel articles
SANS 3575	Continuous hot-dip zinc-coated carbon steel sheet of commercial and drawing qualities
SANS 4998	Continuous hot-dip zinc-coated and zinc-iron alloy-coated carbon steel sheet of structural quality
SANS 60335-2-76	Particular requirements for electric fence energizers
National Railway Safety Regulator Act 2002	Regulations regarding infrastructure or activity affecting Safe Railway Operations - 2020

### **2.2.2 Transnet Freight Rail:**

Whenever “Transnet”, “Transnet Freight Rail” or “S.A. Transport Services” is used in the generic specifications, it should be read as “the Employer”, and wherever “Engineer” or similar

terminology is used, it should be read as “the Engineering Manager”. The employer here is Transnet. The designs are based on the Transnet specifications. The information and/or requirements as stated in Transnet’s specifications shall be considered as the minimum requirements for equipment to be offered. The Contractor may use the specifications as a guidance and offer material and equipment that comply with the latest technology. The Contractor shall provide details indicating how the equipment offered differs from what was specified and obtain Transnet’s approval. Contractor will be liable for any delays due to approval process.

1	BBB0041	Preparation of drawings for Transnet Freight Rail infrastructure.
2	CEE.0023.2012:	Specification for installation of cables.
3	BBC0198	Requirements for the supply of cables.
4	CEE.0045.2014/1:	Painting of steel components of electrical equipment.
5	CEE.0224.2002:	Drawings, catalogues, instruction manuals and spares lists for electrical equipment supplied under contract.
6	S420	Specification for concrete work.
7	BBF3690	Electrical Safety Instructions
8	BBC1678	Bonding specification for 3kV DC Traction Systems.
9	BBB2007	Environmental guidelines and specifications for electrical construction work.
10	BBF2283	Fall protection and rescue equipment specifications.
11	E7/2	Agreement to work on, over, under or adjacent to railway lines and near high voltage equipment
12	CEE-0059	Earthing and Bonding DC Electrification
13	BBC5989	Steel palisade and Electric fencing
14	BBB3620	3 kV DC earthing arrangement system for high voltage outdoor yards.
15	CEE.0177	Code of practice for Earth systems for electric light and power and traction installations.
16	CEE-TBD-7	Spark gaps and rail earth switch drawing
17	S310	Painting of steel structures
18	BBB3235	Installation of earthing and lightning protection of electronic measurement equipment housing
19	CSE-1154-001-CAT E48	Physical characteristics of the Railway Environment in South Africa

- 2.3 Occupational Health and Safety Act No. 85 of 1993 (Available at for depot for referral)
- 2.4 Any items offered in accordance with other standards will be considered at the sole discretion of Transnet. The contractor shall supply the details stating where the item differs from these specifications as well as supply a copy (in English) of the recognised standard specification(s) with which it complies.

### **3.0 SERVICE CONDITIONS**

#### **3.1.1 ATMOSPHERIC CONDITIONS**

All work relating to the following conditions: Altitude, Ambient temperature, Relative humidity, Lightning Conditions and Pollution shall comply with Transnet's environmental specification *CSE-1154-001-CAT E48*.

### **4.0 FENCING AND GATE DESIGN**

#### **4.1 TECHNICAL REQUIREMENTS**

- 4.1.1 The installation of fencing and sterile zones in all operational assets shall be in accordance with BBC5989.
- 4.1.2 Concrete foundations for the fence and the gate (main entrance and pedestrian) posts shall be 300 x 300 x 600 mm. Any deviation from these dimensions will only be allowed subject to approval from the Project Manager.
- 4.1.3 The concrete base at main entrance gates shall have a width of 500 mm a foundation depth of 250 mm.
- 4.1.4 The concrete base at the pedestrian entrance shall be suitable for safe and unobstructive passage of staff and hand drawn maintenance equipment.
- 4.1.5 The foundations at all points of fencing shall not protrude above ground level to prevent damming – in addition the foundation level should be in line or below yard level of the substations, relay rooms and high sites.
- 4.1.6 The strength of all concrete used shall not be less than 21 MPa after 28 days of casting.
- 4.1.7 The contractor shall arrange for sampling and testing of all concrete used and shall submit all records to a Transnet representative. The method of sampling used shall comply with specification S420. If ready mix concrete is used, the contractor shall submit certificates confirming the strength of the concrete to the Transnet supervisor for approval.
- 4.1.8 The fence shall be intrusion resistant by means of intrusion detection sensors as per BBH4464 - *CCTV and Intrusion Detection* specification with an overlaid double mesh design.
- 4.1.9 The double mesh design of the fence shall be of aperture size small enough to exhibit both anti-cut and anti-climb characteristics i.e. aperture size should not be used/leveraged to aid in climbing the fence.
- 4.1.10 The contractor shall ensure the fence is corrosion resistant with Zinc-Aluminium alloy and PVC powder coating to prevent electrolysis from stray currents.
- 4.1.11 A double fence is required for sites specified by the Project Manager. Both the outer and inner fence posts shall have a height of 3400 mm. The aforementioned posts these shall be hot dipped galvanised with the galvanising thickness adhering to SANS121 and/or SANS3575, 4998 respectively - depending on the process of galvanising chosen. Any deviation of post dimensions or galvanising approaches will only be allowed subject to approval from the Project Manager.
- 4.1.12 None of the main posts may be joined by welding in order to comply with the specified height.
- 4.1.13 The corner posts shall have a 12 mm diameter hole drilled in the centre of the section 300 mm above ground level for earthing purposes. The hole shall be drilled before galvanising. Any deviation from these dimensions will only be allowed subject to approval from the Project Manager.
- 4.1.14 The fence shall have good see-through visibility - so that all equipment within the operational asset is clearly visible.

- 4.1.15 The welding at each intersection of the fence where required shall not increase the chance of penetrability i.e. fence strength must not be compromised and be as secure as at the continuous mesh panels.
- 4.1.16 The contractor shall ensure that the fence is surface finished after welding at all points where required.
- 4.1.17 The fence posts shall be fully integrated with anti-tamper fixings.
- 4.1.18 To prevent anyone from climbing on top of the fence only two types of fence tops shall be used:
  - Flat razor wire coil with barbed wire
  - Concertina barbed wire

Substations will, unless otherwise stated by the Project Manager, include the double fencing security approach, with Sterile Zone. Relay Rooms and High sites, unless otherwise stated, will employ the single fence approach.

  - The outer fence shall be continuous from the top to the bottom of the panel mesh to prevent any chance of climbing on it with intrusion detection sensors mounted on the inner side of the fence.
  - The inner fence shall be electrified without intrusion detection sensors.
  - In the case of single fencing, the fence will not be electrified but have intrusion detection sensors.
- 4.1.19 The contractor shall supply and install 4.6 m wide x 3.4 m height lockable (mechanical lock with digital unlock code) gates in the perimeter fence to allow for:
  - Entrance to operational asset building and/or yard.
  - Entrance to the high voltage outdoor yard adjacent to the main transformer(s).
  - In the case of a double unit substation - six gates shall be installed.
  - In the case of a single unit substation - four gates shall be installed.
  - In the case of a relay room and high site - one gate shall be installed.

Any deviation from these dimensions will only be allowed subject to approval from the Project Manager.
- 4.1.20 Where access to the HV outdoor yard is possible between the substation building and perimeter fence, a fence the same height as the perimeter fence shall be installed. A 1000 mm wide lockable gate (mechanical lock with digital unlock code) shall form part of the fence.
- 4.1.21 Provision shall be made for, with installation of, spark gaps and rail earth switches on the HV yard gate. Refer to drawings *CEE-TBD-7* and *BBB3620*.
- 4.1.22 Warning notices and danger signs shall be in accordance with *BBD5450* and be fitted to the perimeter fencing and gates.

## **5.0 STERILE ZONE**

In order to provide an effective and clear line of sight for surveillance of the perimeter of the operational asset it is important to keep the area as sterile as possible, and for the sterile zone to be effective it is necessary for it to be connected to the earth mat. The width of the sterile zone will be 1 m spaced between the outer and inner fence with length specific to the dimension of the specific operational asset on all four sides.

### **5.1 STERILE ZONE PREPARATION**

- 5.1.1 Clearing of 250 mm depth of soil.
- 5.1.2 Carting away of all debris and waste.
- 5.1.3 Spray the prepared soil with appropriate chemical (this chemical must be harmful to the environment and must be approved by Transnet Horticulture specialists) to prevent any future debris and vegetation growth in accordance with Transnet environmental pollution specification.
- 5.1.4 Placing of geotextile on the soil - the geotextile shall be able to sufficiently drain water so that no pond forms when it rains.
- 5.1.5 Spreading of the appropriate industrial grade carbon compound to a thickness of 120 mm across the placed geotextile – this is to create lower resistance paths for earth fault currents.

#### 5.1.6 Crowfoot Earth with Theft Deterrent Rail:

- 25 mm x 3 mm copper bar
- 5 m long jointed to a 2m tail of 25 mm x 3 mm copper plus 2 m of 50 mm<sup>2</sup> clear insulated composite cable with stainless steel termination lug.
- All joints are to be exothermically welded. Where welding is carried out on galvanised surfaces of the support steel structures, the galvanising shall be removed and the surface cleaned. After completion of the exothermic weld, the surface area on the support steel structure where the galvanising was removed shall be treated in accordance with the requirements of SANS 2063.
- Exothermic joints shall be hammer tested on recommendation of the manufacturer to ensure that the mechanical strength of the joints are adequate. The exothermic weld is to be tapped by a hammer depending on the sound it will be determined whether the joints are solid or if there are voids in the joint.
- Where two earthing conductors run parallel to each other, exothermic parallel joints shall be installed every 1.5 metres on all straight sections between these conductors.

Any deviation from these dimensions will only be allowed subject to approval from the Project Manager.

## 5.2 SOIL CONDITION

Desired lower earth resistance enhancement methods shall be used by the contractor where necessary to obtain the desired value of 5 Ohms or less as specified in BBF8190 section 14.6.1, the contractor shall measure the earth resistance before and after completion of the specified work. The report with test results will require approval by the designated Senior Engineer from Technology Management.

## 6.0 EARTHING

### 6.1 TECHNICAL EARTHING REQUIREMENTS

- 6.1.1 Before any work commences at any site, an earth resistance test shall be carried out. If the test reveals that the earthing is compliant as per Transnet earthing requirements, the Contractor is to ensure that the site is still earthing compliant after work is completed, this may involve the Contractor having to perform additional earthing works at their own cost. If the earth resistance test before work commences reveals that the site is not earthing compliant as per Transnet earthing standard, the Contractor is to include earthing works as part of their billable scope of work.
- 6.1.2 The design and installation of Transnet Freight Rail's earth mat system shall be in accordance with Transnet Freight Rail's drawings *CEE-TBD-7* and *BBB3620* Sheet 1 for areas that is susceptible to theft.
- 6.1.3 A 5-second fault current duration shall be used for the rating of the earth mat system. The earth down conductors and earth tails shall be able to withstand 6.2 kA for 5 seconds when exothermically welded. The rated AC fault level for 3 kV DC traction substations shall be taken to be 16 kA.
- 6.1.4 Deviation of the design shall be submitted to the project manager for approval before commencing with work.

### 6.2 EARTHING MATERIALS TO BE USED

- 6.2.1 Copper rods of 70 mm<sup>2</sup> shall be used for earth electrodes in accordance to SANS 1063. For areas susceptible to theft (as identified by Transnet Freight Rail, alternate electrodes shall be considered for approval by Technology Management responsible Senior Engineer) a copper equivalent rod of at least 70 mm<sup>2</sup> can be used.

The length of the rods will be dependent on the application:

- Earth electrodes (earth spikes). Minimum length of 1.5 meters shall be used.



- Down conductors, earth tails and interconnecting conductors. Rods of varying lengths may be used.
- 6.2.2 The minimum size of conductor used for the earthing system shall be 95 mm<sup>2</sup> copper. For areas susceptible to theft a copper equivalent rod of 95 mm<sup>2</sup> can be used.
- 6.2.3 For the installation or replacement of the main earth mat/earth electrode a copper conductor of at 16 mm diameter shall be used and shall be buried at 1.5 m below the ground. The earth mat shall cover an area of at least 1.5 m<sup>2</sup>.
- 6.2.4 The earth mat shall be provided with a test point connection for test purposes. This test point shall protrude 100 mm above ground level and shall be protected by means of a metal pipe or metal housing.
- 6.2.5 The location of the earth mat/earth spike shall be as close as possible to the main surge arresters support structures.

Any deviation from these dimensions will only be allowed subject to approval from the Project Manager.

### **6.3 INSTALLATION OF EARTHING SYSTEM**

- 6.3.1 Before any trenching commences the contractor shall consult with Transnet Freight Rail (Depot Engineering Manager) for approval with regard to the routing of the trenches in the outdoor yard.
- 6.3.2 Trenching done shall include all trenches required for the installation of the earthing system according to *BBD3620*.
- 6.3.3 The perimeter fence trenching shall be as close as possible to the perimeter fence on the inside of the HV yard.
- 6.3.4 The depth of trenches shall be 600 mm. Care shall be taken not to damage existing cables in the high voltage outdoor yard during trenching operations, any damage shall be repaired and/or replaced, where applicable, at the expense of the contractor. Any deviation from these dimensions will only be allowed subject to approval from the Project Manager.
- 6.3.5 Before the trenches are closed a representative from Transnet Freight Rail (Technical office and Technology Management) shall inspect the earthing system for correct installation procedure.

### **6.4 EARTHING INSTALLATION PROCEDURE**

- 6.4.1 Earth electrodes shall be driven into the ground in the perimeter fence trench at the corners of the outdoor yard and in between the corners.
- 6.4.2 In the case of double unit substations, the number of earth electrodes between the corner electrodes shall be determined in consultation with Transnet Freight Rail (Technology Management).
- 6.4.3 The depth of the earth electrodes driven into the ground shall be such that the top of the earth electrode shall be at least 700 mm below the surface of the ground.
- 6.4.4 The earthing of the support steel structures for the surge arresters, AC disconnects, voltage transformers (where installed) and current transformers shall be in accordance with Transnet Freight Rail's drawing BBB 3620.
- 6.4.5 The surge arresters base shall be connected directly to earth mat/spike.
- 6.4.6 Where surge arresters are fitted on the main transformer provision shall be made to install an earth electrode in close proximity to the transformer. The earth electrode shall be connected directly to the earth system as shown in drawing BBB3620.
- 6.4.7 All underground connections which include connections to the earth electrodes, the joints in the copper plated steel rods, connections to the perimeter fence posts, support steel structures and the connection to the new or existing earth mat shall be exothermically welded or crimped by means of tinned lugs or by means of brass clamping system.
- 6.4.8 Where exothermic welding cannot be carried out, galvanised or stainless steel grade S304 studs, nuts, tinned cable lugs and any other approved means may be used for the termination of the earthing conductors to the fence posts, surge arresters down leads, metal structure and other electrical equipment.

- 6.4.9 Exothermically welded joints and steel components exposed to corrosion shall be sealed with a durable waterproofing compound i.e. Bitumen, Denso tape or Noxide.
- 6.4.10 All crimped connections that are above ground level shall be filled with an anti-corrosive compound.
- 6.4.11 Where the exothermic welding is carried out on galvanised surfaces of the support steel structures, the galvanising shall be removed and the surface cleaned. After completion of the exothermic weld, the surface area on the support steel structure where the galvanising was removed shall be treated in accordance with the requirements of SANS 2063.
- 6.4.12 Exothermic joints shall be hammer tested on recommendation of the manufacturer to ensure that the mechanical strength of the joints are adequate. The exothermic weld is to be tapped by a hammer depending on the sound it will be determined whether the joints are solid or if there are voids in the joint.
- 6.4.13 Where two earthing conductors run parallel to each other, exothermic parallel joints shall be installed every 1.5 m on all straight sections between these conductors.
- 6.4.14 The contractor shall remove the necessary crusher stone before any excavation commences.
- 6.4.15 The contractor shall restore the crusher stone of size 25 mm to its original condition once the installation work has been completed.
- 6.4.16 The contractor shall supply any additional crusher stone required to restore the trenched areas to a depth of 150 mm.

Any deviation from these dimensions will only be allowed subject to approval from the Project Manager.

## **7.0 INSTALLATION OF ELECTRIC FENCE**

All material the supplier will use for erecting the electric fence must comply with SANS 10222-3.

### **7.1 ELECTRICAL FENCE WIRE**

- 7.1.1 A solid wire must be used in order to ensure no additional conducting filament is required for increasing current carrying capacity.
- 7.1.2 When joining wire ends crimp ferrules of the same material composition as the wire must be used to eliminate any electrolytic effect which can lead to corrosion and eventually breaking the wire, this will also ensure there is no communication interference.
- 7.1.3 The maximum distance between wires on the bracket must be 100 mm.
- 7.1.4 Strain brackets must be adequately stayed.
- 7.1.5 Barbed or razor wire may not be electrified either with an energizer or any other power source.

Any deviation from these dimensions will only be allowed subject to approval from the Project Manager.

### **7.2 ENERGIZER**

- 7.2.1 The energizer shall be installed in a dry, dust free environment.
- 7.2.2 As required by the Act, the energizer must comply with SANS 603335-2-76 and the supplier of the product must be able to produce a certificate issued by an internationally recognized laboratory to verify this.
- 7.2.3 The energizer shall be powered by 220 V – 240 V mains.
- 7.2.4 The energizer shall have a minimum energy output of 500 Ohms with a load of 7 Joule.
- 7.2.5 The minimum open circuit voltage shall be 9 kV.
- 7.2.6 A lightning arrestor shall be attached as close to the connection from the energizer and the electric fence as possible, two arrestors shall be used one on the out-put wire and one on the return wire.

Any deviation from these power ratings will only be allowed subject to approval from the Project Manager.

## **8 MATERIAL AND EQUIPMENT**

- 8.1 The Contractor shall supply all the material and equipment necessary to complete the work subject to Transnet approval.
- 8.2 All material and equipment supplied and utilized during the installation, testing and commissioning shall comply with the Occupational Health and Safety Act with its regulations (Act 85 of 1993).
- 8.3 All material specifications are covered in the assembly drawings, component drawings and generic specifications as well as the layout designs.
- 8.4 All material shall be inspected and certified by Transnet before it can be shipped to site and shall be later inspected and accepted or rejected by the Project Manager or designated Technical Officer(s) of the project.
- 8.5 The contractor shall inspect all material before it can be sent out for installation. No defective material shall be installed.
- 8.6 All bonding shall comply with Transnet specification CEE 0059 and BBC1845.
- 8.7 The bonding layout shall be provided by Transnet.

## **9 CERTIFICATION OF CONTRACTORS**

- 9.1 Only Contractors who are certified and accredited by the exothermic welding industry shall be used for the installation.
- 9.2 Only Contractors who are certified according to the Electrical Safety Instructions are permitted to work at Transnet's site.

## **10 WARRANTY AND DEFECTS**

- 10.1.1 The Contractor shall guarantee the satisfactory operation and lifespan of all works completed and accept liability for defects that may potentially appear in design, materials and workmanship.
- 10.1.2 The Contractor shall be issued with a completion certificate with the list of all defects to be repaired within 14 working days after commissioning.
- 10.1.3 The guarantee period for all works shall expire after a period of 36 months commencing on the date of completion of the contract or the date the work was handed over to Transnet Freight Rail.
- 10.1.4 Any defects that may become apparent during the guarantee period shall be rectified to the satisfaction of Transnet Freight Rail, and to the account of the Contractor.
- 10.1.5 The Contractor shall undertake work on the rectification of any defects that may arise during the guarantee period within 7 days of being notified by Transnet Freight Rail of such defects.
- 10.1.6 Should the Contractor fail to comply with the requirements stipulated above, Transnet Freight Rail shall be entitled to undertake the necessary repair work or effect replacement of defective apparatus or materials, and the Contractor shall reimburse Transnet Freight Rail the total cost of such repair or replacements, including the labour costs incurred in replacing defective material.
- 10.1.7 Any specific type of fault occurring three times within the guarantee period and which cannot be proven to be due to other faulty equipment not forming part of this contract e.g., faulty locomotive or overhead track equipment, etc. shall automatically be deemed an inherent defect. Such inherent defect shall be fully rectified to the satisfaction of the Project Manager or Supervisor and at the cost of the Contractor.
- 10.1.8 If urgent repairs have to be carried out by Transnet Freight Rail staff to maintain supply during the guarantee period, the Contractor shall inspect such repairs to ensure that the guarantee period is not affected and should they be covered by the guarantee, reimburse Transnet Freight Rail the cost of material and labour.

## **11 COMMISSIONING**

- 11.1.1 Commissioning will only take place after all defects have been rectified to the satisfaction of the Senior Responsible Engineer (Technology Management/Technical Office).

- 11.1.2 On completion of commissioning, the Contractor will hand the equipment over to the relevant Transnet Manager.
- 11.1.3 The commissioning of protection equipment by Transnet Freight Rail will in no way absolve the Contractor from any responsibilities during the guarantee period.
- 11.1.4 It is the Contractor's responsibility to satisfy themselves that the commissioning of the protection equipment has been carried out in a satisfactory manner, and in no way compromises the proper operation of the equipment supplied in terms of the contract.
- 11.1.5 The Contractor shall be present during the testing and setting of the protection to rectify any faults found.

## 12 GENERAL REQUIREMENTS

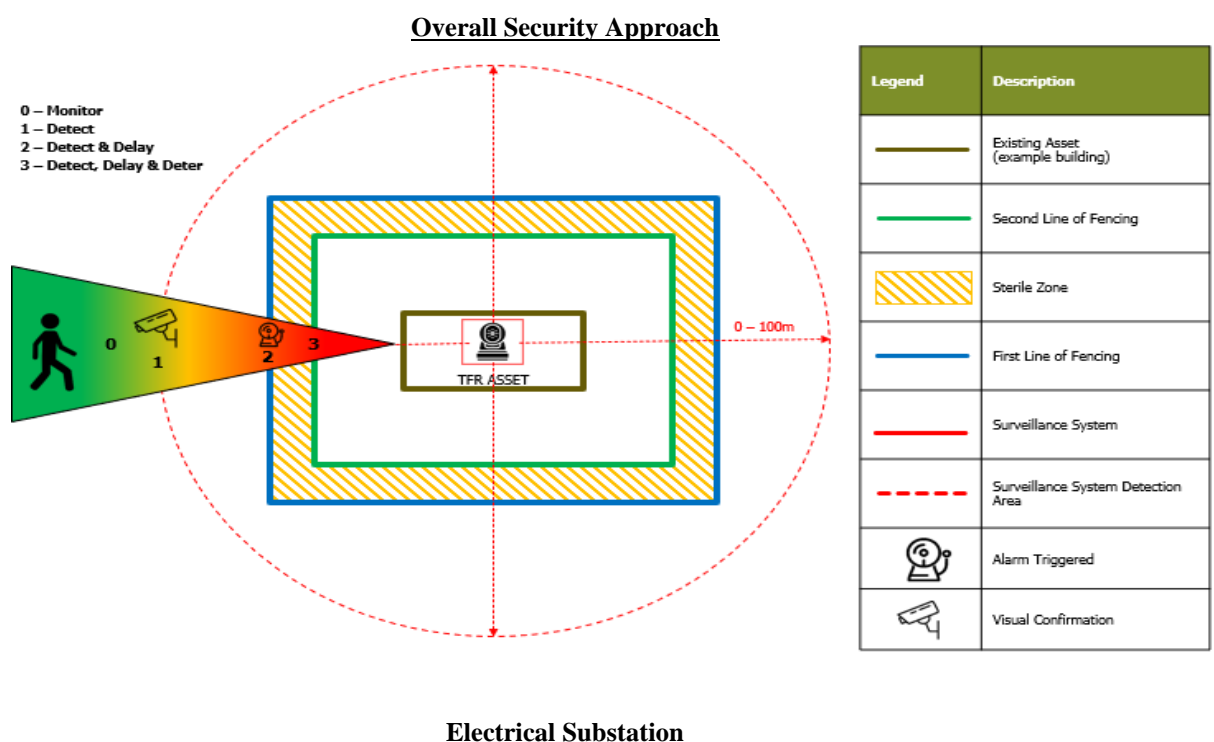
- 12.1.1 The Contractor shall provide the suppliers and/or manufacturers of their material and equipment with a copy of the equipment specification to ensure compliance.
- 12.1.2 The Contractor may offer quality product from any manufacturer based in any Country of the world, as long as the product complies with the requirements of the relevant equipment specification. The product will have to be approved by Transnet before it can be purchased and used in Transnet property. Contractor will be liable for any delays due to approval process.
- 12.1.3 The Contractor shall supply and install all material needed to complete the work, which shall be according to Transnet drawings, specifications, SABS and SANS.

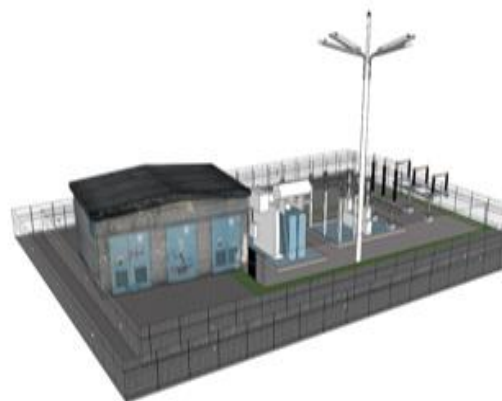
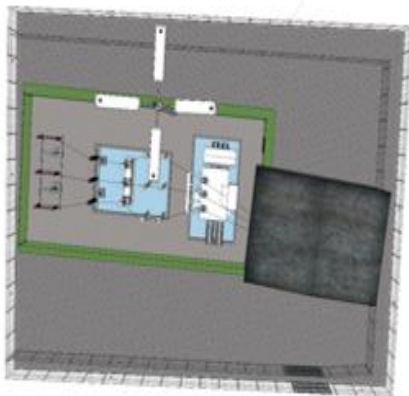
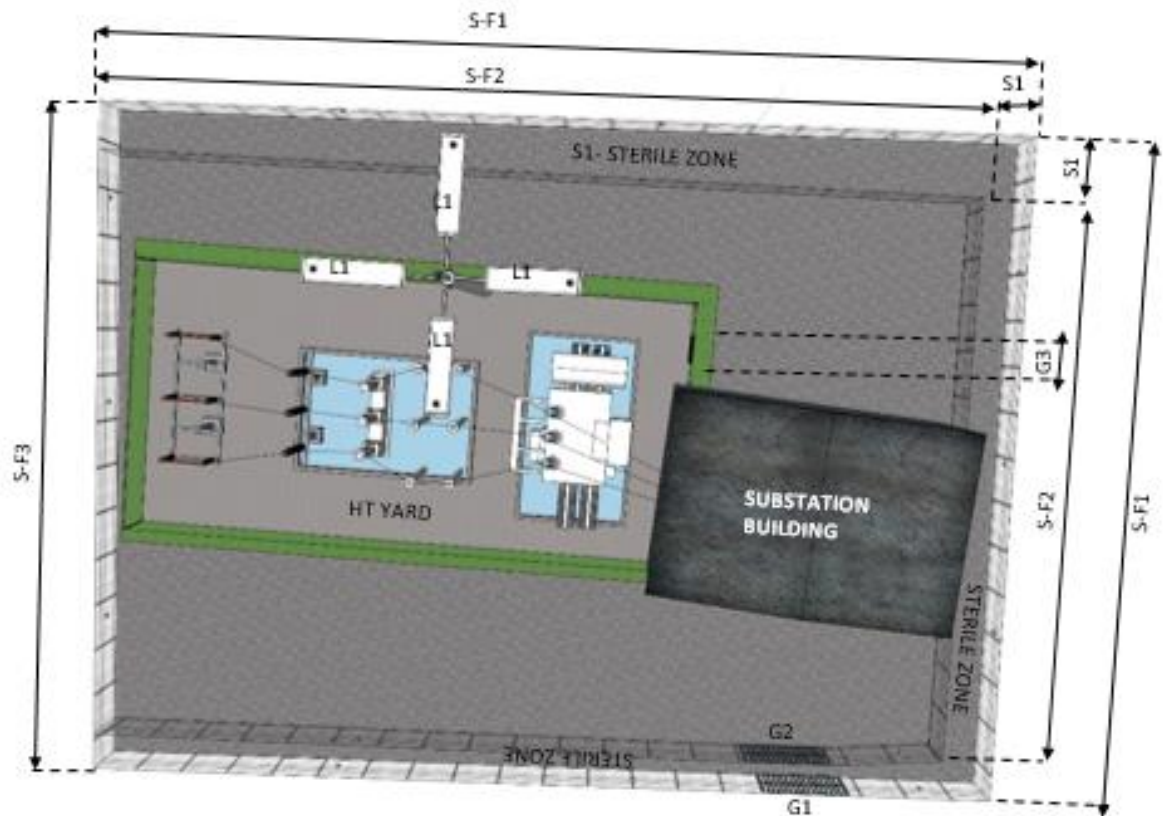
## 13 DEMOLITION AND TRANSPORT OF MATERIAL

- 13.1.1 The contractor shall dismantle and stock pile all old fencing equipment at the identified areas. The areas will be identified and indicated to the contractor by Transnet's Environmental Officer or Technical Officer for the project.
- 13.2 The stock piling area shall be within Transnet reserved land.
- 13.2.1 The Contractor shall demolish and dispose of the existing fencing and equipment, where applicable.

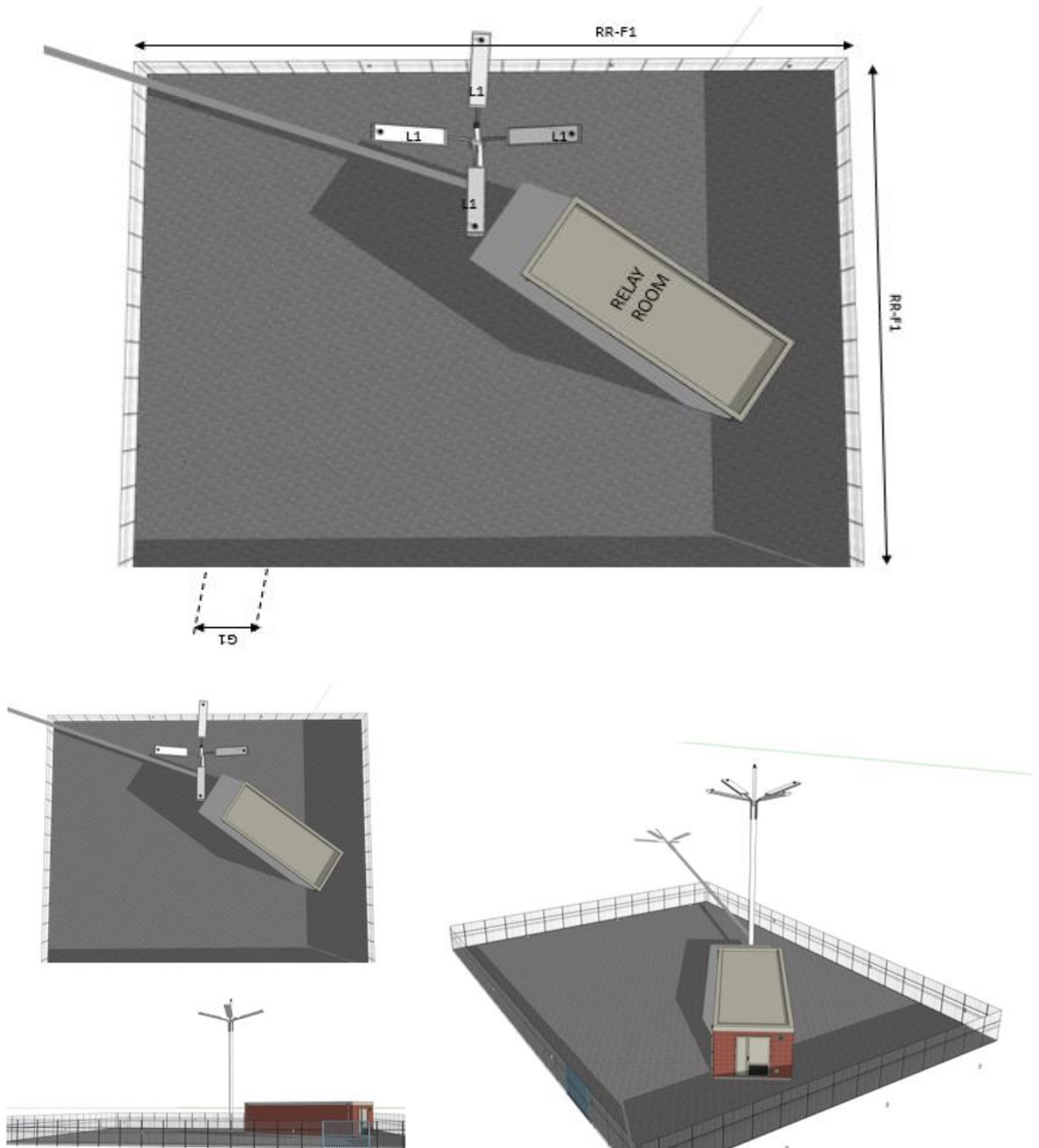
## 14 APPENDIX

### ANNEXURE 1





### Signalling Relay Room



### Telecommunication High Site

