

 <b>Eskom</b>	<b>Guideline</b>	<b>Technology</b>
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## **1. Introduction**

It is important that all fibre optic links adhere to the necessary installation standards and specifications. The purpose of this document is to standardise substation fibre optic installation practices and inspection throughout Eskom Transmission and Distribution. This document is intended to assist with substation fibre optic installation inspections by providing all the inspection guidelines and tick sheets needed for such an inspection.

## **2. Supporting clauses**

### **2.1 Scope**

This document shall be used for all substation fibre optic link inspections whether it is a new installation or a repair job on an existing link. It should be used to ensure acceptable installation compliance. A new or repaired fibre optic link shall only be accepted by Eskom if all the schedules and tick sheets in the annexes of this document were completed and approved.

#### **2.1.1 Purpose**

The document covers inspection for the substation fibre optic install. It includes the inspection of the fibre optic duct cable from the gantry to ODF / patch panel as well as their installations. To ensure an acceptable installation, acceptance testing procedures are also included.

#### **2.1.2 Applicability**

This document shall apply to Transmission and Distribution.

### **2.2 Normative/informative references**

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs.

#### **2.2.1 Normative**

- [1] ISO 9001, Quality Management Systems.
- [2] NRS 088-1, Duct and Direct-buried Underground Fibre-Optic Cable. Part 1: Product Specification.
- [3] NRS 081, Single-mode Non-dispersion Shifted Optical Fibres
- [4] 240-43264031, Fibre Optic Design Standard – Part 2: Substations
- [5] 240-70733995, Optical Distribution Frame / Patch Panel Specification.
- [6] 240-70732888, Fibre Optic Cable System Acceptance Testing Procedure
- [7] EIA/TIA 598-A, Optical Fibre Cable Colour Coding
- [8] 240-60725641, Specification for standard (19 inch) equipment cabinets

#### **2.2.2 Informative**

None

## 2.3 Definitions

### 2.3.1 General

Definition	Description
Acceptable	Acceptable to the customer (Eskom)
Armoured cable	Cable that contains metallic armouring elements
Cable	This refers to the physical cable; actual wire while still on the drum
Duct cable	Cable designed to be installed under the surface of the earth in direct contact with the soil
Line	Means the installed cable with all its attachments
Link	The entire fibre optic installation from ODF to ODF
Long span	Span exceeding a length of 250m
Optical ground wire	An earth wire conductor with optical fibres embedded within a steel or aluminium earth wire. It must be able to carry both lightning strikes and fault currents without detrimental effect to the optical fibre telecommunication facilities.
Unarmoured cable	Cable that contains no metallic armouring element

### 2.3.2 Disclosure classification

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

## 2.4 Abbreviations

Abbreviation	Description
ADSS	All-Dielectric Self-Supporting
CST	Corrugated Steel Tape
FOC	Fibre Optic Cable
GPS	Global Positioning System
HDD	Heavy Duty Duct
HDPE	High-density polyethylene
ODF	Optical Distribution Frame / Patch panel
OPGW	Optical Ground Wire
OTDR	Optical Time Domain Reflectometer
PLP	Preformed Line Product
PMD	Polarisation Mode Dispersion
PVC	Polyvinyl Chloride
ROC	Radius of Curvature
SABS	South African Bureau of Standards
SC / APC	Standard Connector / Angled Physical Contact

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Abbreviation	Description
SWA	Steel Wire Armoured
UTS	Ultimate Tensile Strength

## **2.5 Roles and responsibilities**

It is the responsibility of the Grid maintenance teams to ensure that this document is adhered to.

## **2.6 Process for monitoring**

The fibre optic maintenance teams are required to monitor and action the results of this document.

## **2.7 Related/supporting documents**

This document supersedes DGL 34-2098.

# **3. Inspection guidelines**

## **3.1 Fibre optic cable and hardware**

### **3.1.1 Duct Fibre Optic Cable**

The supplier shall provide a Certificate of Conformance to indicate all the technical information of the duct fibre optic cable as required by the Fibre Optic Cable System Acceptance Testing Procedure 240- 70732888. Where possible, the fibre cores used on both types of cable should be from the same manufacturer to ensure splicing compatibility.

### **3.1.2 Patch Panel / Optical Distribution Frame**

The Schedule A/B for ODF Inspection in Annex C shall be completed to ensure that the ODF/patchpanel adheres to 240-70733995, Optical Distribution Frame / Patch Panel Specification. In order for an ODF /patch panel installation to be accepted by Eskom, it shall comply with all the requirements in the schedule. All connectors used shall be SC/APC.

## **3.2 Substation Fibre Installation**

- a) Substation fibre installation starts from the gantry point inside the substation for the Heavy Duty Duct Fibre Optic Cable (HDD) to the patch panel within the Fibre Optic Cabinet. The tick sheet for Substation Fibre installation in Appendix B shall be completed to ensure that the installation adheres to 240-43264031, Fibre Optic Design Standard – Part 2: Substations.
- b) Note, Fibre Optic Cabinet shall be as per 240-60725641 dependent on control room layout. For back and front entry access, the 19" 600 x 600 cabinet shall be utilised. For front access only, the INTERNAL Swing Frame Equipment panel shall be utilised.

## **3.3 Fibre Optic Cable System Acceptance Testing Procedure**

All Fibre Optic cable system acceptance tests that are mentioned in this section shall be done for both 1310nm and 1550nm (above 50km in length – only 1550nm required) operating windows as per procedure 240-70732888, Fibre Optic Cable System Acceptance Testing Procedure, and the test results shall be provided in both hard copy and software format. All the information shall be summarised in table form as shown in the examples in Appendix G of this document.

These tests shall be witnessed by Eskom authorised personnel.

#### **4. Authorization**

This document has been seen and accepted by:

<b>Name and surname</b>	<b>Designation</b>
Lenah Mothata	Senior Manager – Grids
Barry Clayton	Chief Engineer – TX Secondary Plant, Work Planning and Centralised Services
Sikelela Mkhabela	Senior Manager – DX
Prudence Madiba	Senior Manager – GX
Isabel Fick	Senior Manager - Eskom Telecommunications
Maureen Mokone	Senior Manager – GIT
Botse Sikhwitshi	Senior Manager – Group Security (Acting)

#### **5. Revisions**

<b>Date</b>	<b>Rev</b>	<b>Compiler</b>	<b>Remarks</b>
April 2020	2	V Naidu	New format
March 2015	1	V Naidu	Revised into new format Relevant to Tx and Dx Document reference numbers changed Appendix changes

#### **6. Development team**

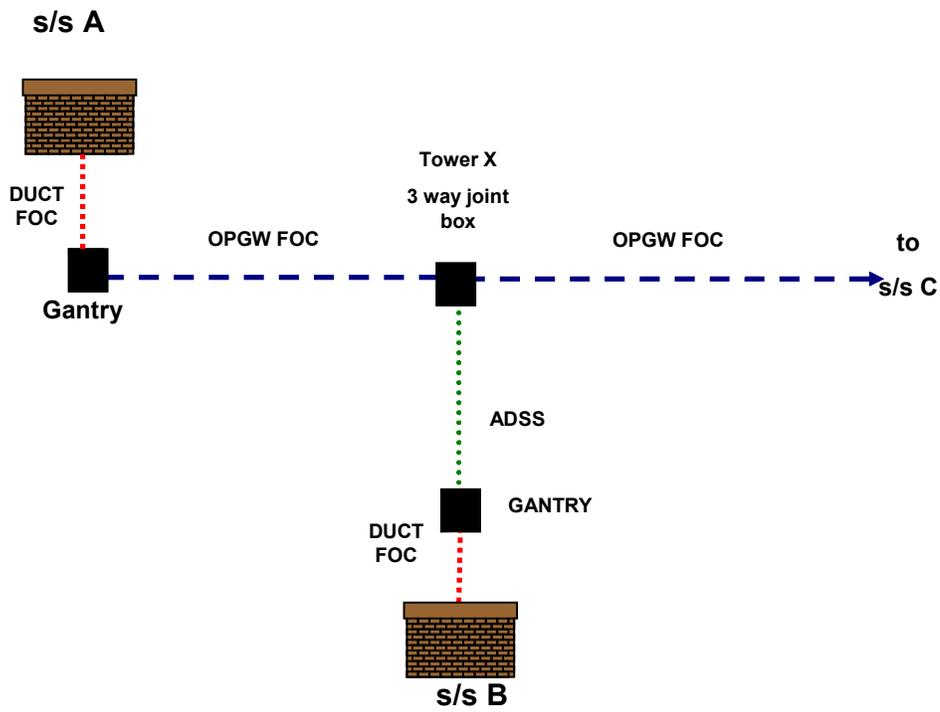
The following people were involved in the development of this document:

- V. Naidu
- Pereira
- R. Westwood

#### **7. Acknowledgements**

MQ Mohamed and E Segers for the original document DGL 34-2098.

**Annex A – Graphical Line Layout example**



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**Annex B – Substation Fibre Optic Installation Tick Sheet**

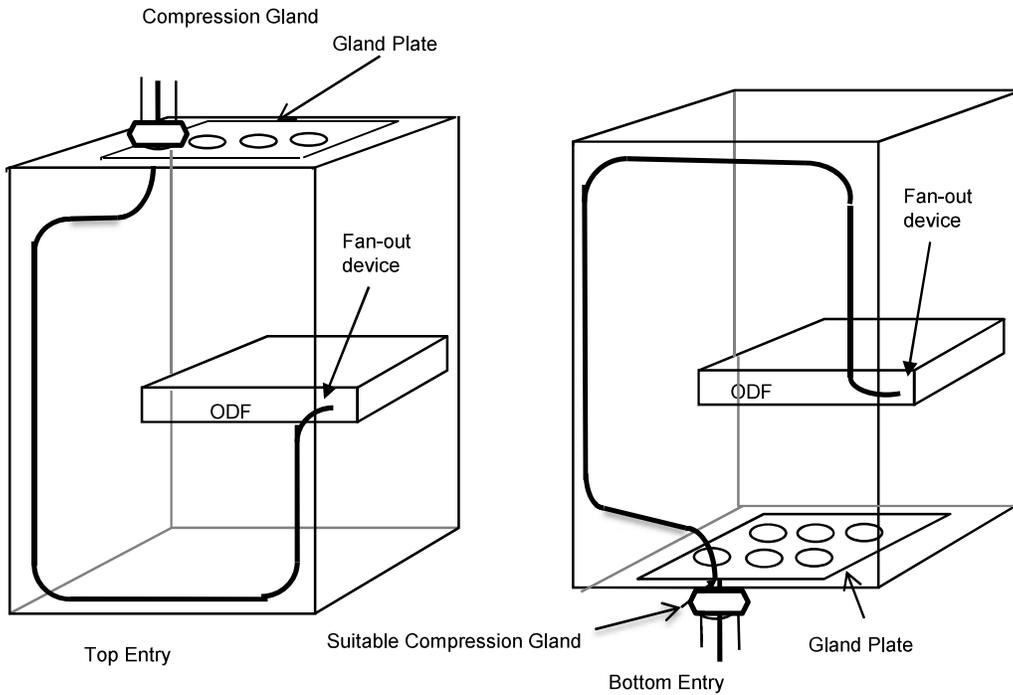
Component	Description	Yes	No
Fibre optic cabinet	Correct cabinet installed as per standard 240-60725641		
	Cabinet was installed in the correct position as indicated on the floor room layouts.		
Substation gantry point	Vibration dampers have been fitted to the cable adjacent to the tension and suspension clamps.		
	Down-lead tails are neatly fixed to the tower or pole with suitable clamps at every tower member.		
	Splice enclosure is mounted between approximately 1.5m above ground level.		
	The HDPE pipe extends through the galvanized or stainless steel pipe and is sealed with a UV-resistant silicone sealer or heat shrink tubing at the top end.		
	The galvanised or stainless steel pipe is secured to the gantry leg with a minimum of four stainless steel "band-it" straps without any insulation in between.		
	No extra drilling was made in the steel works.		
	All attachments were made from hot-dipped galvanized material or stainless steel.		
DUCT cable	High density duct fibre optic cable is installed between the gantry and the Fibre Optic Cabinet.		
	The cable is buried in a Class 6 HDPE.		
	The cable is placed in the cable trench. When buried in the ground, it must be 500mm below ground level.		
	There are no joints in the cable.		
	Un-armoured HDD Fibre Optic Cable was used.		
	The minimum bending radius, as specified by the manufacturer, is not exceeded. (Check trench entry points)		
Control room	The HDPE pipe is sealed where it enters the room floor with UV-resistant silicone sealer or heat-shrink tubing.		
	The cable goes to the cabinet via the trench (which ends just below the cabinet) or the overhead racking.		
	The ladder rack on the wall is used to anchor the cables between the trench and the overhead racking.		
Terminating in 19" Cabinet	At least 5m of slack was left inside the cabinet for splicing.		
Splicing cables in the ODF	The optical distribution frame shall be mounted as indicated in the Cabinet Layout drawing. The slack fibre optic cable shall be routed as shown in 240-4326403.		
	No sharp bends or twists in the fibre inside the ODF.		
Labelling	All fibre optic cables are labelled correctly at both ends with local, remote and fibre distance.		

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Component	Description	Yes	No
	The ODF is correctly labelled with distance to far end.		
Glanding	Outer sheath must protrude through the cabinet gland for approximately 200mm. This prevents breakage.		
	Outer sheath glanded with plastic compression gland where it enters the cabinet.		
Testing	Cable was physically inspected for damage before installation.		
	Testing is completed as per 240-70732888.		
Connectors	Connectors shall be SC/APC.		
Documentation	The contractor provided Eskom with a full technical specification of the DUCT Fibre Optic Cable before installation.		
	The customer received all test results and approved it after the installation was completed. Joint splice summary is provided.		
	The customer received a line diagram showing the cable routing throughout the substation yard after installation was completed.		

<b>Signed on behalf of supplier:</b> Name: _____ Signature: _____ Date: _____
<b>Accepted on behalf of Eskom:</b> Name: _____ Signature: _____ Date: _____

**Annex C – Optical Distribution Frame / PATCH PANEL Configuration**



DISTANT STATION											
1	3	5	7	9	11	13	15	17	19	21	23
2	4	6	8	10	12	14	16	18	20	22	24

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**Annex D – Certificate of Conformance (Duct Fibre Optic cable)**

Date: \_\_\_\_\_

**Order Details:**

Customer: \_\_\_\_\_

Order number: \_\_\_\_\_

Item: \_\_\_\_\_

Order length (m): \_\_\_\_\_

Factory order no: \_\_\_\_\_

**Cable Details:**

Drum no: \_\_\_\_\_

Length: \_\_\_\_\_

Description: \_\_\_\_\_

Embossing: \_\_\_\_\_

Remarks: \_\_\_\_\_

**Test Results:**

Fibre number	Tube		Fibre colour	Attenuation (dB / km)	Dispersion (ps / nm . km)			MFD @ 1310	Cut-off wavelength (nm)	Conc. error (um)
	Position	Colour			@ 1310nm	@ 1551nm	@ 1625nm			
100536	1	red	blue	0.33@1310	-0.60	15.80		9.06	1130	0.2
				0.18@1550	-0.60	15.80		9.06	1130	0.2
100612			orange	0.35@1310	-0.40	16.10		9.30	1197	0.1
				0.21@1550	-0.40	16.10		9.30	1197	0.1
100734			green	0.33@1310	-0.30	16.20		9.23	1170	0.0
				0.19@1550	-0.30	16.20		9.23	1170	0.0

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**Annex E – Sample of Fibre Optic Link Technical Performance Sign-Off**

**FIBRE OPTIC LINK TECHNICAL PERFORMANCE SIGN-OFF**

FIBRE OPTIC CABLE SPECIFICATIONS	
Fibre Size :	9.2/125 µm (SMF ITU-T G.652.B)
Cable Type :	TEC-OPT02-3171D OPGW and Unarmoured DUCT
Cable Length :	22049m

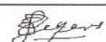
FIBRE OPTIC LINK:	Houhoek s/s	to	Hermanus s/s	Line
A - NEAR END IDENTITY:	Houhoek s/s			B - FAR END IDENTITY: Hermanus s/s
OPTICAL ROUTE/SECTION LENGTH:	22.049	km		TOTAL No OF SPLICES: 11
				(including ODF splices)

CALCULATED ROUTE ATTENUATION	
TOTAL NUMBER OF SPLICES:	= A1 11
LENGTH OF ROUTE:	= A2 22.049
$A(\text{dB}) = (A1 \times 0.1 \text{ dB}) + (A2 \times 0.25 \text{ dB} \{1550\text{nm}\}) + 1.0 \text{ dB} \{ \text{ODF} \}$ $A(\text{dB}) = (A1 \times 0.1 \text{ dB}) + (A2 \times 0.36 \text{ dB} \{1310\text{nm}\}) + 1.0 \text{ dB} \{ \text{ODF} \}$	
A(dB{1550})	7.612 dB
A(dB{1310})	10.038 dB

MEASURED ROUTE ATTENUATION PERFORMANCE CRITERIA CHECKS	
Check 1 :	Average joint loss ≤ 0.1 dB (in both directions)
Check 2 :	Mean joint loss ≤ 0.075 dB (in both directions)
Check 3 :	Measured route attenuation ~ Calculated route at (in one direction only)
Check 4 :	Fibre traces must have NO additional reflective or refractive losses

Wavelength	1550nm				1310nm			
	Check 1	Check 2	Check 3	Check 4	Check 1	Check 2	Check 3	Check 4
Fibre Core #	Ave. joint loss	Mean joint loss	Attenuation	Trace Clear	Ave. joint loss	Mean joint loss	Attenuation	Trace Clear
1	Y	Y	Y	Y	Y	Y	Y	Y
2	Y	Y	Y	Y	Y	Y	Y	Y
3	Y	Y	Y	Y	Y	Y	Y	Y
4	Y	Y	Y	Y	Y	Y	Y	Y
5	Y	Y	Y	Y	Y	Y	Y	Y
6	Y	Y	Y	Y	Y	Y	Y	Y
7	Y	Y	Y	Y	Y	Y	Y	Y
8	Y	Y	Y	Y	Y	Y	Y	Y
9	0.7	Y	Y	Y	0.24	Y	Y	Y
10	0.12	Y	Y	Y	0.18	Y	Y	Y
11	Y	Y	Y	Y	Y	Y	Y	Y
12	Y	Y	Y	Y	Y	Y	Y	Y
13	Y	Y	Y	Y	0.12	Y	Y	Y
14	Y	Y	Y	Y	Y	Y	Y	Y
15	Y	Y	Y	Y	Y	Y	Y	Y
16	0.17	Y	Y	Y	Y	Y	Y	Y
17	Y	Y	Y	Y	Y	Y	Y	Y
18	0.21	Y	Y	Y	0.13	Y	Y	Y
19	0.11	Y	Y	Y	0.14	Y	Y	Y
20	0.11	Y	Y	Y	0.14	Y	Y	Y
21	Y	Y	Y	Y	Y	Y	Y	Y
22	Y	Y	Y	Y	Y	Y	Y	Y
23	Y	Y	Y	Y	Y	Y	Y	Y
24	Y	Y	Y	Y	Y	Y	Y	Y

COMMENTS
FO Splicer indicated that he spliced the affected joints more that 5 times but could not get them within the Eskom Specification of 0.1 dB

COMMISSIONED BY	Optipower	SIGNATURE	
AUDITED BY	Erlind Segers		
DATE	5/04/2006		

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