Eskom	Standard	Technology

Title: **FIBRE-OPTIC DESIGN STANDARD – PART 2: SUBSTATIONS**

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SCOT Study Committee Number/Name: **Telecommunications Study Committee**

Content

Figures

Tables

1. Introduction

This standard details the designs and applications for fibre-optic cable installations within the Eskom substation environment.

This standard is based on the Eskom Transmission document, TST41-115, 'Substation Fibre-optic cable Installations'.

2. Supporting clauses

2.1 Scope

The purpose of this standard is to provide the required information for fibre-optic system designs for installations within an Eskom substation.

2.1.1 Purpose

There are many types of fibre optic cables installed for various purposes within a substation and this document addressed the correct installation methodology.

2.1.2 Applicability

This document shall apply throughout Eskom Holdings Limited Divisions.

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] TIA/EIA-598-A, Optical fibre cable colour coding

[3] IEC 60793-2-10, Optical fibres – Part 2-10 : Product specifications – sectional specification for A1 multimode fibres

[4] NRS 061-2, Specification for Overhead Ground Wire with Optical. Fibre – Part 2: Installation Guidelines

[5] NRS 088-1, Duct and direct-buried underground fibre-optic cable – Part 1: Product specification

[6] NRS 088-2, Duct and direct-buried underground fibre-optic cable – Part 2: Installation guidelines

[7] EPC 32-245, Waste management procedure

[8] 240-70733995, Optical Distribution Frame / Patch Panel

[9] 240-60725641, Specification for standard (19 inch) equipment cabinets

[10] 240-75975613, Standard for the installation of Power telecommunications equipment cabinet

[11] 240-70732888, Fibre optic cable system acceptance testing procedure

[12] 240-46263618, Labelling of fibre optic cables

[13] 240-110403330, OPGW and hardware requirements for overhead lines

[14] 240-722740830, Multimode Fibre Optic Duct Cable Specification

2.2.2 Informative

[15] 32-9, Definition of Eskom documents

[16] 32-644, Eskom documentation management standard

2.3 Definitions

2.3.1 General

Definition	Description
Dark Fibre	Fibre optic cores that are not managed by a telecommunication's management system and are dedicated for usage on a particular equipment or system.
Fibre optic Cable	This is the complete cable with the optic fibres, and the cable protective coverings and sheaths.
Optic Fibre	The actual optical fibre cores that transmit and receive the data.

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 [cable]
CAP	Committee for Accepted Products
DMK	Diameter Marshalling Kiosk
GM	General Manager
HDD	Heavy-duty Duct
HDPE	High-density Polyethylene
HV	High Voltage
IED	Intelligent Electronic Device
IT	Information Technology
ITU-T	International Telecommunications Union – Telecommunications Sector
LAP	List of Accepted Products
MASS	Metallic Armoured Self-supporting
n/a	not applicable
NRS	New Revised Standard
ODF	Optical Distribution Frame [patch panel]
OPGW	Optical Ground Wire
OPPC	Optical Phase Conductor
OTDR	Optical Time Domain Reflectometer
PTM&C	Protection, Telecoms, Metering and Control

Abbreviation	Description
TCM	Telecommunications Contracts Manager
UV	Ultraviolet [light (wavelength)]

2.5 Roles and responsibilities

It is the responsibility of the Project Engineers to ensure that the SOWs adhere to this document.

2.6 Process for monitoring

The document will be monitored and maintained by the SCOT Fibre Optic Care Group.

2.7 Related/supporting documents

TST 41-115 is superseded by this document.

3. Document content

Fibre optic cables can be permanently damaged if either the minimum bending radius or the maximum tensile rating is exceeded during installation.

The installation and termination of the aerial fibre-optic cables (Optical Ground Wire (OPGW)/All Dielectric Self-supporting (ADSS)/Metallic Armoured Self-supporting (MASS)/Optical Phase Conductor (OPPC)/Lashed all-dielectric cable ('AdLash™')/Helically Wrapped Fibre) or Duct Fibre-optic cable demands adherence to special protection measures to prevent damage to the fibres due to mechanical elongation, bending, twisting and crushing forces.

This part of the standard describes the measures required to correctly terminate the OPGW, ADSS, MASS, OPPC, Lashed all-dielectric cable ('AdLash™') or Helically Wrapped Fibre installed on overhead power lines in such a way that service life is improved and that there will be no danger to either the public or personnel involved in this process. The standard also looks at the installation and termination of fibre optic duct cables. The standard shall be used in conjunction with 240-110403330 and the installation procedures proposed by the fibre-optic cable manufacturers, and shall also comply with the NRS standards.

3.1 Duct fibre optic cable

3.1.1 Structure of duct fibre-optic cable

Two types of optical fibres could be used in the duct fibre cables within substations:

a) 9 µm/125 µm single-mode fibre compliant with ITU-T G652.

b) 50 µm/125 µm multimode fibre of type A1a.2 specified to IEC 60793-2-10.

The underground single mode duct fibre-optic cables are completely non-metallic cables containing optical fibres.

The single mode fibre optic cable is designed according to NRS 088-1, which allows the cable to withstand the mechanical forces during installation as well as pressure from the weight of the ground during its lifespan without any strain affecting the internal fibres. When installed outside the substation, the HDD single mode cable is enclosed within a Class 6 High-density Polyethylene (HDPE) protective tube to prevent rodent attacks. If there are space constraints within the trenches, then the HDD single mode cable which is rodent resistant and designed with a double sheath and a glass yarn/composite in-between layer may be used without HDPE piping.

The multimode fibre optic cable is designed according to 240-722740830, which is a glass reinforced cable that allows water blocking and is able to withstand the mechanical forces during installation. When installed outside the substation, the HDD multimode mode cable is enclosed within a Class 6 High-density Polyethylene (HDPE) protective tube to prevent rodent attacks. If there are space constraints within the trenches, then the HDD multimode mode cable which is rodent resistant and designed with a double sheath and a glass yarn/composite in between may be used without HDPE piping.

For installations within a control room or inside a building that have no rodent resistant requirements, the standard HDD fibre optic duct cable could be installed without the HDPE piping.

3.1.2 Fibre-optic cable criteria

3.1.2.1 Single-mode fibre-optic cable criteria

a) Fibre-optic cables between substations (aerial or duct) shall be single-mode G652D type.

b) If the G652D-type optic fibre cannot provide the required bandwidth, or if there is a requirement for long-haul links, then an improved ITU-T type of single-mode optic fibre can be used.

c) However, the new optic fibre type must be backward compatible with the G652D-type optic fibre and would require approval by the Technology department.

3.1.2.2 Multimode fibre-optic cable criteria

a) Eskom has standardized on the 50 µm/125 µm (type OM2/OM3) multimode fibre-optic cable. The reasons for Eskom not using the 62,5 µm/125 µm (type OM1) multimode fibre are:

   1) The 62,5 µm/125 µm fibre-optic cable is not readily available locally according to manufacturers; if it had to be imported, this would result in increased costs.

   2) Maintenance and repairs could be a problem, as most fibre-optic contractors only have the 50 µm/125 µm multimode fibre-optic cable spares.

   3) Without labels, it would be very difficult to identify which cable is a 50 µm/125 µm or 62,5 µm/125 µm multimode fibre-optic cable.

   4) The growing trend in most industries (telecoms and Information Technology (IT)) is to use the 50 µm/125 µm multimode fibre-optic cables, as these cables allow for more bandwidth and greater distances. The 62,5 µm/125 µm fibre-optic cables are limited to a maximum data rate of 10 Gbps (33m), whereas the 50 µm/125 µm fibre allows for a data rates over 10 Gbps.

b) Depending on the different applications, single-mode or multimode fibre-optic cables may be used. The choice of whether to use single-mode or multimode fibre-optic cables would depend on the following criteria:

   1) If the data rate required is a maximum of 100 Mbps and the distance of the fibre-optic cable is < 2000 m, then the 50 µm/125 µm (OM2/OM3 type) multimode fibre-optic cable can be used.

   2) If the data rate required is a maximum of 1 Gbps and the distance of the fibre-optic cable is < 550 m, then the 50 µm/125 µm (OM2/OM3 type) multimode fibre-optic cable can be used. However, an optical budget calculation is required, which includes all the fibre equipment (fibre drivers, fibre receivers, patch panel, connectors) losses of the system.

   3) For any other application or if the fibre-optic cable needs to be installed between different control rooms within the same substation, single-mode fibre-optic cables shall be used.

Table 1: Relationship between fibre type and bandwidth and distance

Bandwidth		Distance		Fibre-optic cable type
≤ 1 Gbps	+	< 550 m	=	Multimode 50 µm/125 µm (A1a.2 type/OM3)
≤ 100 Mbps	+	< 2000 m	=	Multimode 50 µm/125 µm (A1a.2 type/OM3)
> 100 Mbps	+	> 2000 m	=	Single-mode 9 µm/125 µm (G652D)
> 1 Gbps	+	> 550 m		Single Mode 9 µm/125 µm (G652D)
Between Control Rooms				

c) To differentiate between single-mode and multimode fibre-optic cables, the colours of the HDPE piping and patch leads and cable sheath should be as follows:

1) For single-mode duct fibre cables the above should be a yellow colour, wherever possible.

2) For multimode duct fibre cables, the above should be an orange colour, wherever possible.

3.2 Installation of Fibre-optic cables within substations

The duct cable and installation must comply with national standards NRS 088-1 and NRS 088-2; Eskom specification 240-722740830 and the project Scope of Works document.

The Scope of Works shall ensure that the correct duct fibre cable, which can deliver the requirements from the terminal equipment, is chosen based on the optical budget calculation.

3.2.1 Application

The application of the fibre-optic cable within the substation boundary consists mainly of the following installation types:

a) Duct fibre cables (Heavy-duty Duct (HDD)) between the joint box on the gantry to the Control Room (for a fibre-optic cable originating from a remote substation).

b) Duct fibre cables (HDD) between sites within the High Voltage (HV) Yard (e.g. Diameter Marshalling Kiosk (DMK) on feeder 1 to the DMK on feeder 2).

c) Duct fibre cables (HDD) between the HV Yard sites and the Control Room (e.g. DMK to the control room).

d) Duct fibre cables within the Control Room. The installation of ruggedised patch leads instead of duct cable between cabinets in certain Distribution environments with space constraints is allowed until a specification can address the installation

e) Duct fibre cables (HDD) between the Control Rooms within the same substation.

3.2.2 Substation gantry point requirements with Single mode fibre optic cable

a) The Contractor shall ensure that vibration dampers have been fitted to the cable adjacent to the tension and suspension clamps if required by Eskom or stated in the Scope of Works. Necessary precautions shall be taken to ensure that the minimum bending radius of the cable is not compromised during installation and when the cable is fed down from the structure.

b) The cable must be fixed to the OUTSIDE of the gantry.

c) The OPGW cable must be BONDED to the gantry at all times.

d) At the joint positions, down-lead tails shall be long enough to allow adjacent lengths to be connected using conventional fusion splicing techniques. The down-lead tails shall be neatly fixed to the gantry, tower or pole using suitable down-lead clamps spaced on every lattice crossing or at a maximum of 2 m apart. This shall be done such that the final joint assembly and the aerial fibre-optic cables (OPGW/ADSS/MASS/Lashed all-dielectric cable ('AdLash™')/Helically Wrapped Fibre is secured to the structure, and that the cable does not chafe against the structure at any location.

e) The termination of any OPPC shall be done according to the relevant manufacturer's standards which are approved by Eskom's Lines department, as the OPPC is a 'live' system. Eskom prefers not to utilise OPPC.

f) The aerial fibre-optic cables shall be connected to the gantry such that there is sufficient slack left to allow the splice enclosure to reach ground level. Upon installation, the splice enclosure shall be temporarily assembled on the structure first before cutting the fibre, and not at ground level. This is to ensure that the two cables are of the correct length when permanently assembled again. The splice enclosure shall be mounted approximately ±1.5 m above ground level. The HDPE pipe shall be connected to the galvanized steel or stainless steel pipe, and shall be sealed with UV-resistant silicone sealer or heat shrink tubing at the top end. This steel pipe shall be secured to the gantry leg with a minimum of four stainless steel 'band-it' straps without any insulation in-between. (Refer to 1.)

g) Any strengthening steelwork or attachment shall be fitted with the use of existing bolt-holes or clamping attachments. No extra drilling shall be done on the steelwork and the attachments shall be made of appropriate, hot-dipped galvanized material.

Note 1: In exceptional circumstances, there may be more than one protection panel (two more parallel lines between substations), in which case each one will have its own cable from the main patch panel cabinet to a smaller patch box (or similar).

Note 2: Underground duct cables between substations can be brought directly to the patch panel/ODF.

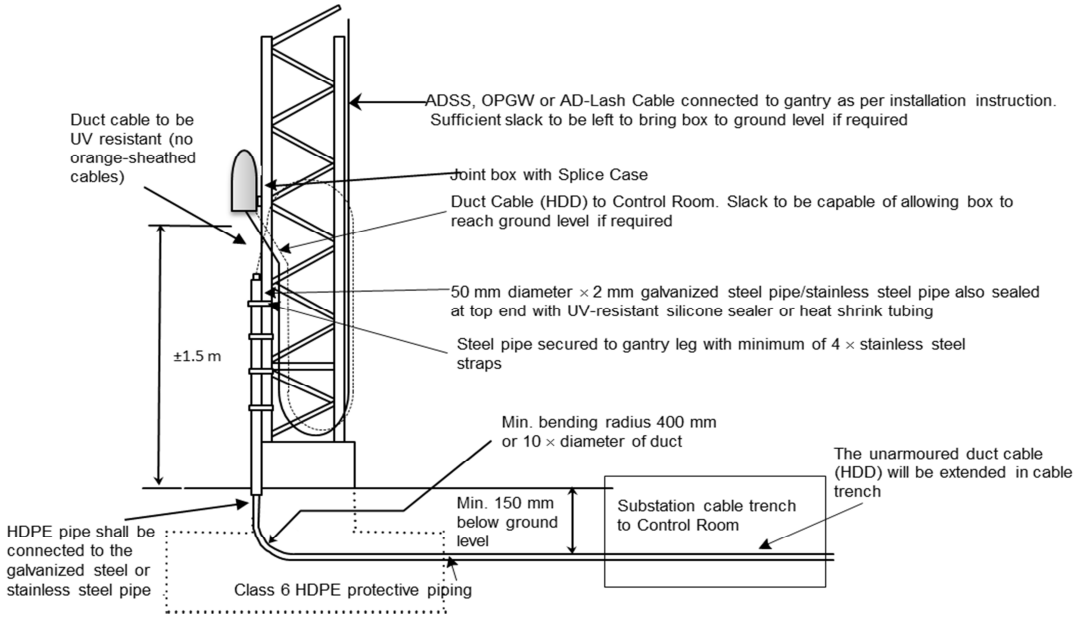

Figure 1: Gantry point fibre connection and termination

3.2.3 Single Mode Duct cabling requirements

a) The single mode fibre-optic duct cable shall be installed in directly buried Class 6 HDPE piping (outside diameter 32 mm) unless there are space restrictions.

b) If there are space constraints, single mode duct cable designed with the glass reinforced layer and a double sheath, may be utilised without HDPE piping.

c) The single mode fibre-optic duct cable with the Class 6 HDPE piping shall be installed within the trench at a minimum depth of 500 mm below ground level.

d) If the substation trenches are available, the single mode duct cable with the Class 6 HDPE piping shall be installed in the trench, the minimum depth of which shall be 150 mm below ground level.

e) A single length of single mode duct cable shall be utilized; no joints will be tolerated.

f) Only unarmoured single mode duct cable shall be used in Eskom's fibre installations.

g) The minimum bending radius specified by the manufacturer shall be maintained when entering the trench (refer to Figure 1). Care shall be taken to maintain the bending radius specification when guiding the single mode duct cable from the substation trench towards the Control Room floor.

h) If the joint box for the single mode duct cable is located on a tower or gantry that is not located in the substation HV Yard, then a 1 m square concrete platform, 10mm thick would be required to be built, to prevent vegetation growth around the foot of the leg of the tower that the duct cable is attached to.

3.2.4 Multimode Duct cabling requirements

a) Due to the quantity of multimode cable required from the HV yard to the control room, the HDPE piping cannot be utilised. Hence the multimode cable shall be a double sheath, rodent resistance with a glass yarn/composite strength member in addition to being a heavy duty duct cable. There shall be an option to utilise the HDD cable (not double sheath) within the control room environment.

b) The multimode fibre-optic duct cable shall be installed within the trench at a minimum depth of 500 mm below ground level.

c) If the substation trenches are available, the multimode duct cable shall be installed in the trench, the minimum depth of which shall be 150 mm below ground level.

d) A single length of multimode duct cable shall be utilized; no joints will be tolerated.

e) Only unarmoured multimode duct cable shall be used in Eskom's fibre installations.

f) The minimum bending radius specified by the manufacturer shall be maintained when entering the trench (refer to Figure 1). Care shall be taken to maintain the bending radius specification when guiding the multimode duct cable from the substation trench towards the Control Room floor.

3.3 Fibre-optic cable installations within control rooms

3.3.1 Control room

a) When entering the Control Room floor, if utilised, the top of the HDPE pipe shall be sealed with UV-resistant silicone sealer or heat-shrink tubing.

b) If separate racking is installed halfway between the Control Room floor and the computer flooring, then the duct cable shall not be protected in an HDPE pipe, this racking is normally 300 mm or 600 mm wide wire mesh fastened with hold down brackets and will be specified in the control building construction drawing.

c) If the cable trench does not extend to just below the cabinet, the fibre cable shall be extended via the overhead racking.

d) If overhead racking is used, the racking must be bonded to the station earth and to the cabinet.

e) The racking and the installation shall be documented in the Scope of Works and approved by the Substations department. The ladder rack on the wall shall be used to anchor cables between the trench and overhead racking.

f) In cases where the trench extends further underneath the cabinets, the duct cable shall be directly glanded onto the fibre cabinet, while maintaining the bending radius requirements.

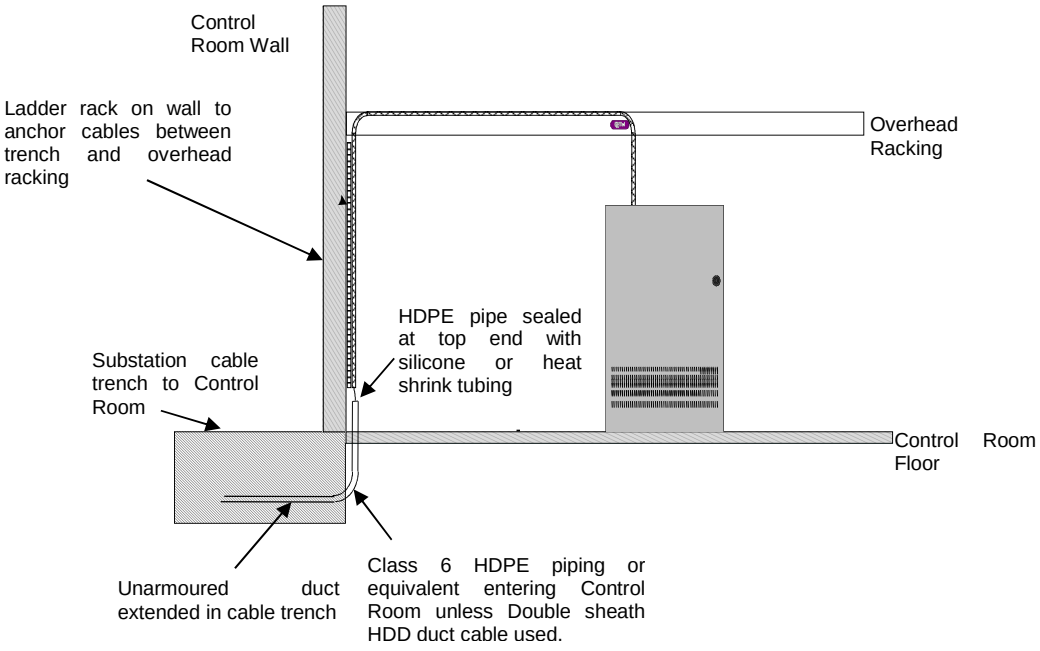

Figure 2: Duct cable arrangements – control room overhead rack termination

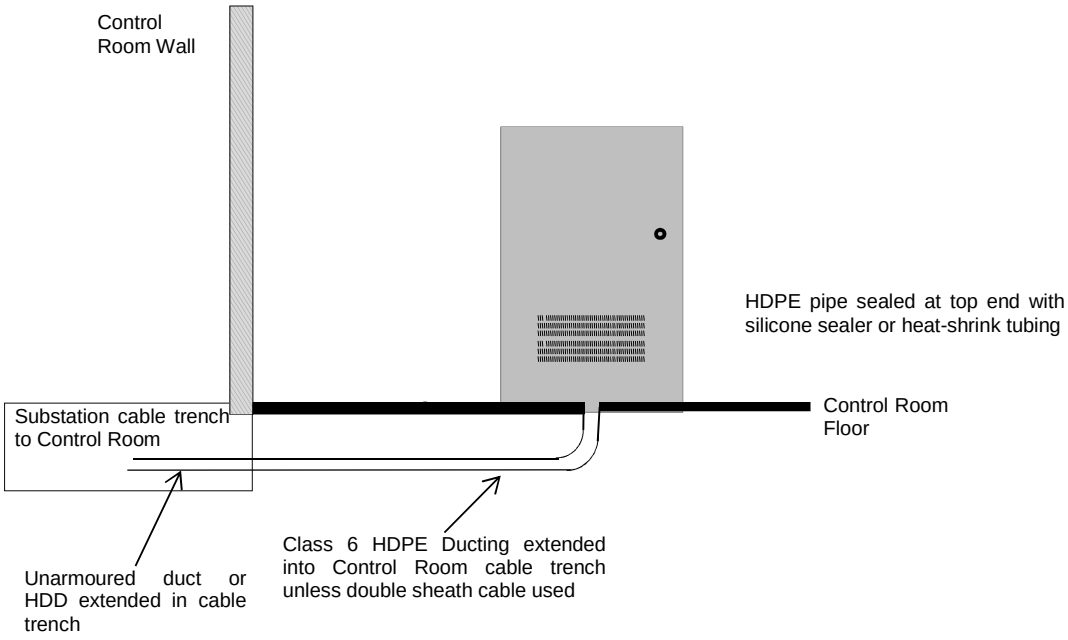

Figure 3: Duct cable arrangements – control room trench termination

3.3.2 Eskom's fibre-optic cabinet philosophy

3.3.2.1 Telecomms fibre-optic cabinet

A fibre-optic cabinet will be installed in the Control Room (Carrier Room, Telecommunications Room, Radio Room) and shall comply with the Eskom specification 240-60725641. This cabinet will be installed in accordance with 240-75975613. The position in the Control Room shall be indicated by Eskom's relevant Applications department. This position shall be marked up on the substation's control room layout drawing.

This cabinet will accommodate fibre-optic patch panels and other related fibre equipment as shown in Figure A.1.

In the case of a third party such as Broadband Infraco requiring connectivity to the fibre cores, all the fibre cores from the joint box at the gantry will terminate in the fibre-optic patch panel in the Eskom control room; A duct cable will then have to be installed from the control room fibre-optic patch panel to the third party kiosk outside of the substation premises.

3.3.2.2 Fibre switching panel

The fibre switching panel will be installed to accommodate the fibre-optic cables for substation automation purposes, which would include ODFs and routers, and/or switches.

The fibre switching panel will be installed in the Control Room (Carrier Room, Telecommunications Room, Radio Room) and shall comply with the same specifications and standards as the fibre-optic cabinet, i.e. 240-60725641 and 240-75975613. The position in the Control Room shall be indicated by the relevant Eskom Applications department and this position shall be marked up on the substation's control room layout drawing.

3.3.3 Preparatory work

Prior to going on site, the installation personnel or approved Contractor shall ensure that the fibre-optic cabinet for terminating the fibre has been installed. In the case where other fibre-optic cables are already installed and active, the cabinet should be regarded as live and should only be worked on under the supervision of relevant Eskom personnel. When terminating the duct cable, the instructions of the cable supplier shall always be adhered to.

3.3.4 Fibre-optic cable terminating in 19″ cabinet

3.3.4.1 Glanding and splicing

The fibre-optic cable shall be glanded on the outer sheath using a compression gland where it enters the 19″ cabinet. At least 5 m of slack shall be left inside the cabinet for splicing.

3.3.4.2 Termination of the optical distribution frame

The optical distribution frame must be mounted as indicated in the Cabinet layout drawing. The slack fibre-optic cable must be routed as shown in 4. This must be done neatly and the minimum bending radius of the cable (typically 10 × cable diameter) must be maintained at the bends. The compression gland sizes shall be as specified by the cable manufacturer. The cable shall be run in such a way that the patch panel/ODF and slack cable can be easily removed from the cabinet.

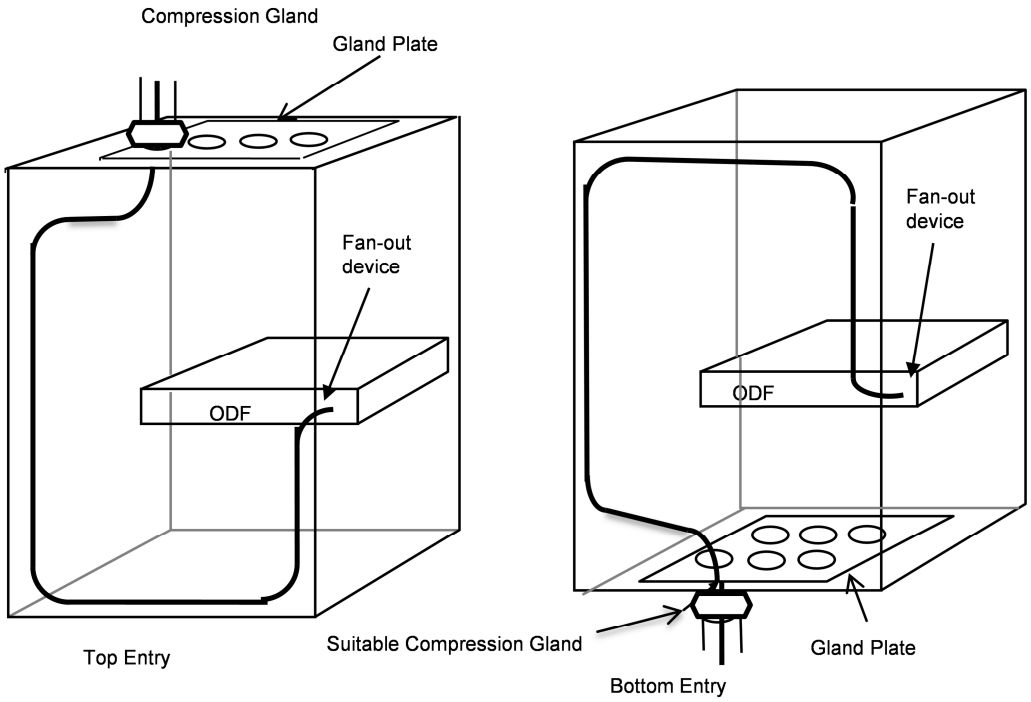

Figure 4: Fibre-optic cable slack routing in cabinet

The inner sheath of the fibre-optic cable shall be clamped at its entry to the ODF, as instructed in 240-70733995, and the central strength member shall be securely fastened. The outer sheath shall be glanded at the gland plate with a suitable compression gland. The fibres shall be neatly organized in the ODF with no twists or sharp bends. Plastic clips with a splice protector comb or splice cassettes must be used to organize the bare fibres. The fibres are to be spliced according to the fibre-optic cable layout drawing for the station.

Each pigtail in the ODF shall be numbered or colour-coded to avoid confusion.

3.3.4.3 Labelling of optical distribution frames/patch panels

a) Labelling requirements

All fibre-optic cables shall be labelled at both ends as indicated in the site drawing, 'Fibre Optic Cable Layout'. The fibre-optic cables and ODF within the cabinet shall be labelled according to 240-46263618.

b) Teleprotection and telecommunications functions

1) The ODFs shall be labelled as indicated in 5, 6 and 7. In the case of 12-way ODF faceplates, the destination name as indicated on the fibre-optic cable layout drawing shall appear on the left side of the faceplate (refer to 5). Link codes shall be used when labelling telecommunications circuits. In cases where the fibre is for protection, the labelling shall indicate the protection function used, as shown in the following figures.

2) The ports shall be labelled below with the corresponding port number and above with the link code indicating the station name and the function. In cases where there is a T-off on the line, the ODF faceplate shall be labelled as shown in 6 for the T-off displayed in 7.

3) For the 24-way ODF faceplates, the destination name, as indicated on the fibre-optic cable layout drawing, shall appear on the left side of the faceplate. The ports shall be labelled below with the corresponding port number (as shown in 8). The fibre circuits shall be clearly identified. In addition, a fibre-optic circuit information sheet shall be secured to the ODF or the panel door.

4) This method of labelling ensures that patching at intermediate sites is from odd port to odd port and even port to even port. Thus there is no cross-patching at the intermediate sites. This simplifies matters in the case of multiple intermediate sites. The mid coupler slots shall always face downward.

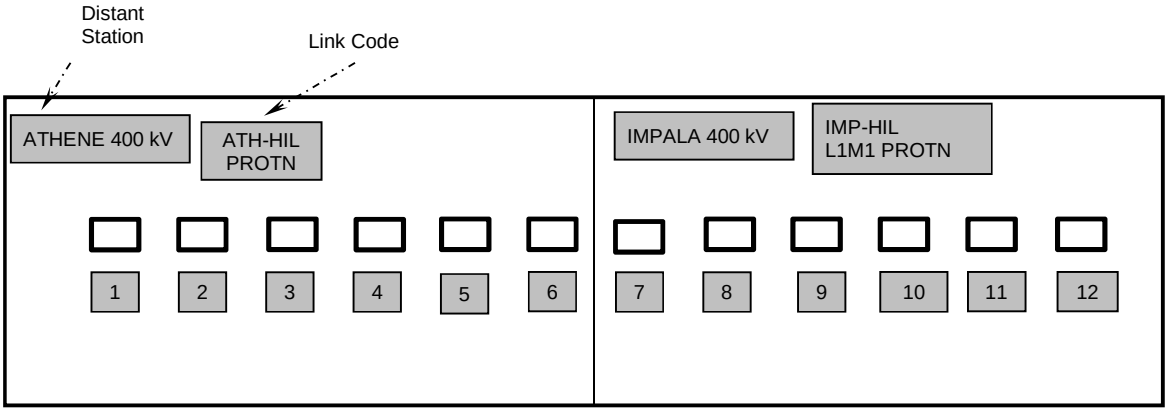

Figure 5: Twelve-way ODF faceplate labelling (1)

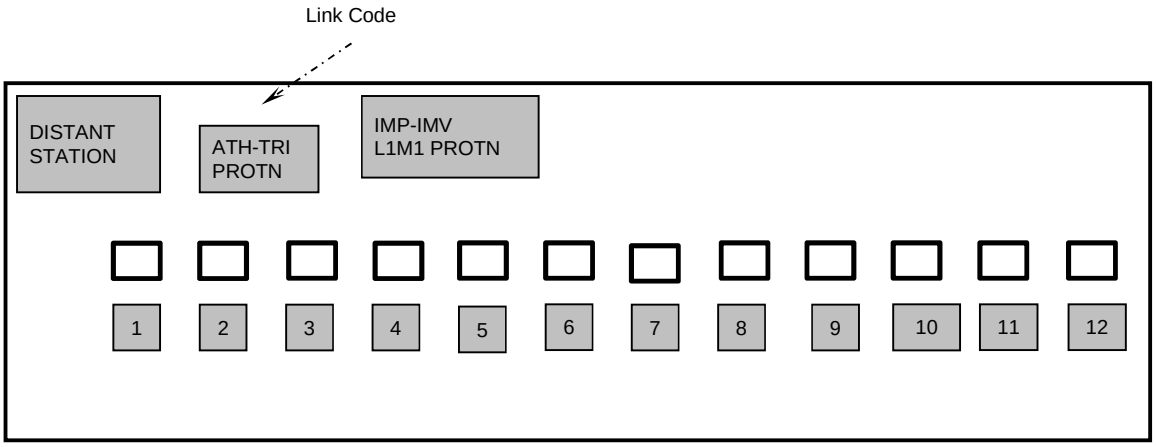

Figure 6: Twelve-way ODF faceplate labelling (2)

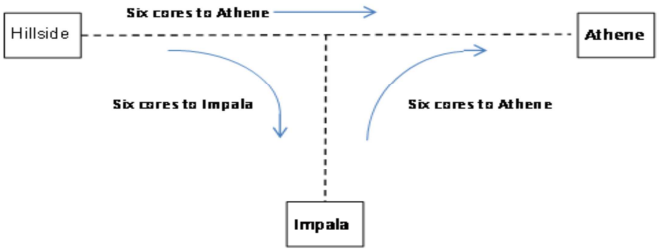

Figure 7: T-off where ODF is located at Hillside

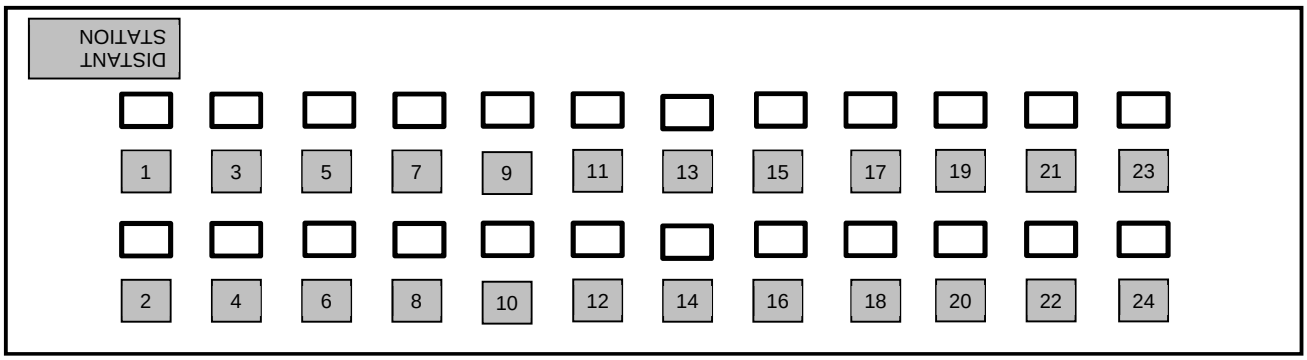

Figure 8: 24-way ODF faceplate labelling

c) Substation automation functions

The ODFs shall be labelled as indicated on the site drawing, 'Fibre Optic Cable Layout', which is labelled according to 240-46263618.

3.3.4.4 Fibre identification

The fibre-optic colour-coding shall be according to TIA/EIA-598-A.

3.3.5 Patch panel to intelligent electronic device panel

For every panel that contains an Intelligent Electronic Device (IED) (protection control), there shall be a separate duct fibre cable between the patch panel in the fibre-optic cabinet or fibre switching panel and the patch panel (termination box) in the IED panel. Refer to the general fibre-optic installation philosophy drawings in Figure A.1.

The ODF/patch panel shall comply with 240-70733995.

a) The duct fibre-optic cable (single mode) for teleprotection shall have a minimum of eight optical cores.

b) The duct fibre-optic cable (multimode) for substation automation shall have a minimum of 12 optical cores.

3.3.6 Patch Box Installation in Junction Box in the HV Yard

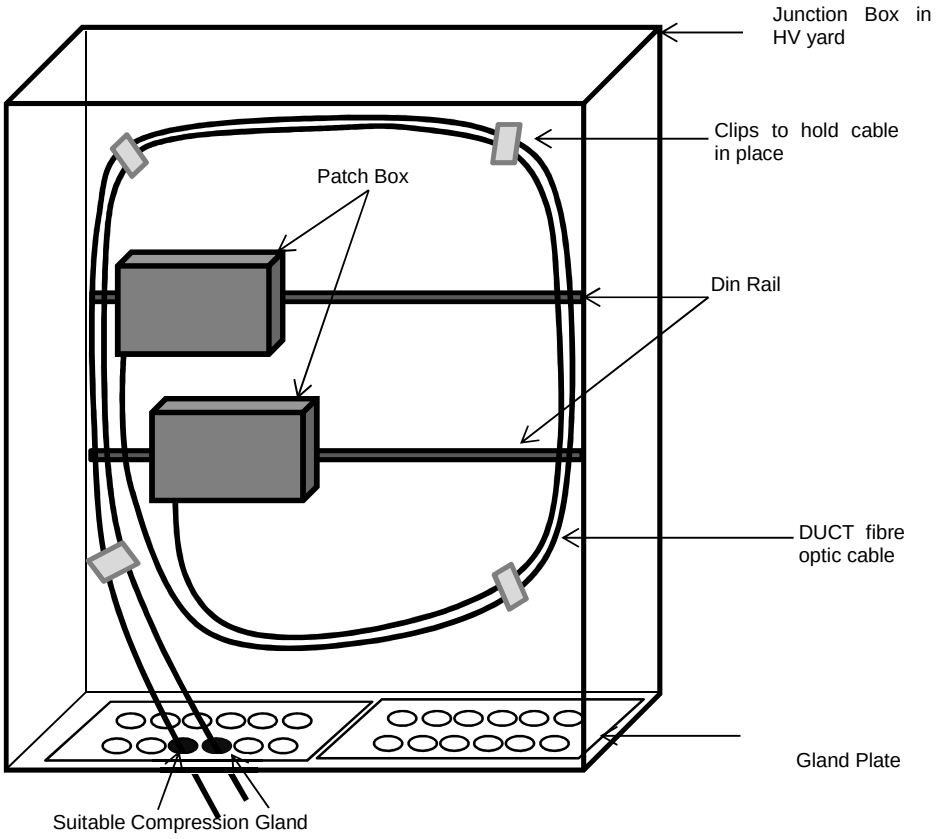

Figure 9: Fibre-optic cable connection to the patch box in the Junction Box

3.3.6.1 Glanding and splicing

The fibre-optic cable shall be glanded on the outer sheath using a compression gland where it enters the Junction box in the HV yard. At least 5 m of slack shall be left inside the cabinet for splicing.

3.3.6.2 Termination of the Patch Box

The Patch Box must be mounted as indicated in the Cabinet layout drawing on the din rails supplied.

The slack fibre-optic cable must be routed as shown in Figure 5 with clamps at the corners of the cabinet to hold the cable in place. This must be done neatly and the minimum bending radius of the cable (typically 10 ×cable diameters) must be maintained at the bends. Note that there may at times be two cables within the junction box.

The compression gland sizes shall be as specified by the cable manufacturer. The cable shall be run in such a way that the Patch box and slack cable can be easily removed from the cabinet.

3.4 Tests

3.4.1 Before installation

Before installation, the fibre-optic cable shall be visually inspected for damage. The fibre optic on the drum shall also be tested using an Optical Time Domain Reflectometer (OTDR) to confirm the fibre condition and overall length.

3.4.2 After installation

After installation is complete, the fibre-optic link shall be tested for continuity, splicing losses, etc. in line with 240-70732888. The test ensures that the fibre-optic cable has been properly terminated before being handed over.

A copy of the commissioning sheets shall be secured to the panel/cabinet door.

3.5 Safety and environment

The safety and environmental aspects of the fibre-optic cables shall be managed in accordance with section 4.5 of NRS 061-2:

a) Eye protection should be worn when cutting off the fibre ends at terminations and also when splicing the fibres.

b) Protective gloves should be worn during installation to prevent fibreglass particles from being embedded under one's skin.

c) Care should be taken not to look directly into the fibre ends as hazardous light levels may be present in fibre systems.

d) There should be proper use of acetone or alcohol, epoxy adhesives and other associated chemicals required for the various processes involved in jointing fibre.

e) Cable and fibre-optic offcuts shall be placed in a container for suitable disposal, in accordance with EPC 32-245.

3.6 Quality control

The Contractor shall have a quality management system as specified by Eskom's Quality department.

3.7 Documentation

3.7.1 Before installation

The Contractor shall provide Eskom with a full technical specification of the duct fibre-optic cable to be installed prior to commencement of the installation.

3.7.2 After installation

The contractor shall submit the following documentation to the Eskom representative for approval on completion of the fibre termination and installation:

a) Test results as per 240-70732888, Fibre optic cable system acceptance testing procedure

b) Line diagram showing the cable routing throughout the substation yard.

4. Authorization

This document has been seen and accepted by:

Name and surname	Designation
Danie Du Plessis	Senior Manager- Grids
Paul Grobler	Chief Engineer-TX
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5. Revisions

Date	Rev	Compiler	Remarks
Oct 2018	2	V. Naidu	Revision required including installation of Multimode duct cable between HV Yard and within control room.
July 2012	1	T. Gosai	New requirement for document. Revision of old TST 41-115.

6. Development team

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

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7. Acknowledgements

Paddy Griffith is recognised for his original input

Annex A – Fibre-optic cable installation diagrams

Figure A.1: Eskom-owned OPGW or ADSS fibre cable into Eskom's substations