



Eskom

Standard

Technology

Title: **MULTIMODE FIBRE OPTIC DUCT CABLE STANDARD** Unique Identifier: **240-72274830**

Alternative Reference Number: **N/A**

Area of Applicability: **Engineering**

Documentation Type: **Standard**

Revision: **3**

Total Pages: **16**

Next Review Date: **October 2025**

Disclosure Classification: **Controlled Disclosure**

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1. Introduction

This document is required to specify Eskom's requirements for all applications where multimode fibre optic duct cables need to be installed.

2. Supporting clauses

2.1 Scope

This specification provides for the manufacture, testing at works, delivery to site, off-loading and, when called for, installation of multimode fibre optic duct cable.

The following schedules are attached to, and form part of the specification:

- Schedule A/B : Schedule of Technical Details
- Schedule A.5 : Statement of Compliance

Note: This specification overrides any other Recommendation or Specification. In cases of conflicting requirements, Schedule B to the Tender or Contract Documents only overrides this Specification and Schedule A/B.

2.1.1 Purpose

The purpose of this document is to ensure that all multimode fibre optic duct cables used by Eskom are of the required standard.

2.1.2 Applicability

This document shall apply throughout Eskom Holding Limited, its divisions, subsidiaries and entities wherein Eskom has a controlling interest where multimode fibre optic duct cable is required.

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] IEC 60794-1-2: Optical fibre cables - Part 1-2: Generic Basic optical cable test procedures
- [2] IEC 60793-2-10 Optical Fibres Part 2-10: Product Specification (2004) – Sectional specification for category A1 multimode fibres
- [3] Guide 104: The preparation of safety publications and the use of basic safety publications and group safety publications (IEC Standard)
- [4] ISO 9001 2000 Quality Management Systems (IEC Standard)
- [5] 598-A Colour Coding of Fibre Optic Cables (TIA/EIA Standard)
- [6] TST41-168: Quality assurance requirements for the procurement of assets, goods and services

2.2.2 Informative

- [7] 32-9: Definition of Eskom documents
- [8] 32-644: Eskom documentation management standard
- [9] 474-65: Operating manual of the Steering Committee of Technologies (SCOT)

2.3 Definitions

2.3.1 General

None

2.3.2 Disclosure classification

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

2.4 Abbreviations

Abbreviation	Description
µm	micrometre
ASL	Above Sea Level
dB	decibel
h	hours
Hz	Hertz
IEC	International Electro technical Commission
kg	kilogram
km	kilometre
kPa	Kilopascal
m	metre
M	Mega
mm	millimetre
N	Newton
N/A	Not Applicable
nm	nanometre
TIA/EIA	Telecommunications Industry Association/Electronic Industry Association

2.5 Roles and responsibilities

Not applicable.

2.6 Process for monitoring

Not applicable.

2.7 Related/supporting documents

This document cancels and replaces revision number 0 of document number TSP 41-665

3. Requirements

3.1 Fibres

- a) All fibres shall have a cladding diameter of 125 micrometres and shall comply with IEC Recommendation 60793-2-10 for either Type OM2/OM3 (50 µm core diameter) for multimode graded index fibres. The fibre shall be capable of operating in both the 850 nm and 1310 nm wavelength regions. The attenuation and dispersion characteristic requirements of the fibre to be provided are detailed in the A/B schedule attached to this specification.
- b) The type of fibre required (OM2/OM3) shall be specified in Schedule A of the contract document.
- c) Full details of primary, secondary and tertiary coatings (if used) shall be supplied. If chemical stripping of the coatings is recommended then the chemical composition of the coatings and of the recommended solvents shall be supplied.
- d) If mechanical stripping is recommended then a suitable stripping device shall be specified.
- e) No fibre shall be under strain in an installed cable under any normal operating condition.
- f) The fibres shall be marked by a coloured coating with 12 different colours according to TIA/EIA 598. The optical fibre colours shall be stable during temperature cycling and not subject to fading or smearing onto each other or into the gel filling material. Colours shall not cause fibres to stick together.
- g) All optical fibres shall be sufficiently free of surface imperfections and inclusions to meet the optical, mechanical, and environmental requirements of this specification. Optical fibre splices within individual cable lengths shall not be permitted.

3.2 Cable Configuration

- a) The required number of loose buffered multimode graded index fibres to be incorporated in the cable is specified in Schedules A and A/B. Each fibre shall be uniquely identified in an approved manner. Details are to be provided.
- b) Cables shall be resistant against ultra violet radiation from the sun and details shall be provided as to the measures taken to attain the necessary immunity to ensure a service life of a minimum of 25 years.
- c) All the interstices of the cable shall be completely filled with a suitable compound to prevent water penetration of the cable. Details are to be provided.
- d) Full details of the cable construction shall be provided, as shall the measures taken to minimise hydrogen absorption in the fibres.
- e) As the cable is intended to be drawn into ducts or pipes, it shall have a tensile strength in excess of a load value given by $0.6 \times 9.81 \times M \times 2$ Newtons (N), where M is the mass of 1 km of cable in kilograms. This load shall not produce a strain exceeding 0.2% in the fibres, nor cause any damage or deformation to the component parts of the cable or cable sheath.
- f) The cable shall be a heavy duty duct cable and shall be metal free.
- g) The heavy duty duct cable shall have a double polyethylene sheath with a glass yarn or glass composite layer in-between for rodent resistance requirements.
- h) The cable outer sheath shall be either black or orange in colour.
- i) The metal-free cable shall have a minimum bending radius of no greater than 150 mm.
- j) The metal-free cable shall withstand a compressive load of 1000 N without deformation.
- k) The required number and type of loose buffered multimode fibres to be incorporated in the cable is specified in the Contract Document. Each fibre shall be uniquely identified in an approved manner. Details shall be provided.

- l) For a stranded buffer tube designed cable, a maximum of 12 fibres shall be enclosed in each buffer tube. The “marker” buffer tube shall be red in colour and the “reference” buffer tube shall be green in colour. The remaining buffer tubes, and “fillers”, if used, shall be opaque.
- m) For a central “maxitube” designed cable with more than 12 fibres, a maximum of twelve fibres shall be bundled together by a coloured thread, and each bundle shall be clearly identifiable.
- n) The buffer tube(s) shall be filled with a non-hygroscopic, non-nutritive to fungus, electrically non-conductive, homogenous gel. The gel shall be free from dirt and foreign matter. The gel shall be readily removable with conventional non-toxic solvents.
- o) The fibres shall not adhere to the inside of the buffer tube.
- p) The jacket is to be smooth and of a constant thickness with external markings as detailed in section 3.5.2.

3.3 Environmental

- a) The performance of the fibre optic cables shall not be degraded under the following ambient conditions:
 - 1) Temperature : -10° to 50°C in the shade
 - 2) Altitude : 0 to 2500 metres (ASL)
 - 3) Relative Humidity : 100%
 - 4) Barometric Pressure : 76 kPa – 104 kPa
- b) IEC Guide 104 should be taken into account as far as possible in regard to environmental and product safety requirements. The materials of the cables in contact with the environment shall not be hazardous to environment and personnel. If requested the manufacturer shall provide details on the environmental impact of the cable.

3.4 Tests

3.4.1 Optical

- a) During manufacture each fibre shall be tested at both 850 nm and 1310 nm for attenuation, numerical aperture and dispersion characteristics. The results are to be supplied to Eskom.
- b) During manufacture, or subsequent works testing, the entire length of each fibre shall be subject to a proof test of at least 1% elongation.
- c) Each fibre shall be measured for continuity and length once the cable has been placed on the drum prior to delivery. Eskom may require an inspector to be present when these final measurements are performed. Eskom's attendance shall not relieve the supplier of his responsibility for the satisfactory performance of the cable during subsequent testing at site and thereafter to the end of the warranty period.

3.4.2 Mechanical

The mechanical tests called for in this specification are considered as type tests. Eskom is prepared to review the results of similar tests which the supplier may have performed in the past.

3.4.2.1 Tensile Strength

The cables shall be tested according to IEC Recommendation 60794-1-E1 to prove compliance with clause e) on page 5. The load shall be applied for 10 minutes and the strain of the fibre monitored.

3.4.2.2 Crush Resistance

The fibres and component parts of the cable shall not suffer permanent damage or any impairment to the optical transmission properties of any fibre, when subjected to the compression loads stated j) in section 3.2. The test is to be performed as described in IEC Recommendation 60794-1-E3. The two flat plates described in the recommendation shall have dimensions of 50 mm x 50 mm. The load shall be applied for 1 minute.

3.4.2.3 Impact Resistance

- a) The cable shall be tested as per IEC Recommendation 60794-1-E4. The anvil radius is to be 25 mm.

Metal-free cable shall be able to withstand a single 50 Nm impact without impairment.

- b) Cable Bending

The fibre and component parts of the cable must not suffer permanent damage when the complete cable is repeatedly wrapped and unwrapped 4 complete turns for 10 complete cycles at room temperature, around a mandrel of 150 mm diameter for metal-free cable.

- c) Water Penetration

The cable shall fulfil the requirements of the water penetration test detailed in IEC Recommendation 60794-1-F5 (1 m, 24 h, optical element only, no water drip).

3.4.3 Environmental

No specific test is specified, but the supplier is requested to provide detailed information on design tests performed to prove the capability of the cable to withstand temperature extremes, together with rapid temperature variations without causing deterioration effects on the transmission properties of the optical fibres.

3.4.3.1 Temperature Cycling

The cable shall be subjected to a minimum temperature of -20°C and a maximum temperature of +70°C. The test shall be performed in accordance with IEC 60794-1-2-F1. To simulate the behaviour under operating conditions, the cable shall be wound on a steel drum during the test with a certain tension, so that the cable elongation is between 0.1% and 0.2%. The change in fibre attenuation shall not be greater than the uncertainty of measurement.

3.5 Marking, labelling and packaging

3.5.1 Closing of Cable Ends

The ends of the cable shall be sealed by an approved method immediately after completion of the final optical test detailed in clause 3.4.1 c) on page 6. The supplier shall provide details of the technique to be used.

3.5.2 Identification and Labelling

The following information must be clearly marked on the cable at intervals of 1 metre. The markings must be permanent:

- a) Name of Manufacturer
- b) Year of Manufacture
- c) Type of Fibre (coded)
- d) Number of Fibres
- e) Metre position of this mark
- f) The words "Fibre Optic Cable"

Coding for fibre type:

- g) G5 = graded index 50/125 μm dual window 850/1310 nm

3.5.3 Cable Drums

- a) The cables shall be supplied to Eskom on strong wooden drums or suitable alternatives.
- b) The cable shall be wrapped on the drum in such a manner that the beginning (lowest value marker) is on the inside of the roll. The inside trailing end must be easily accessible for testing.
- c) The drum shall have the following information indelibly marked on it:
- 1) Eskom
 - 2) Contract or Order Number
 - 3) Unique Drum Number
 - 4) Type of cable and number of fibres
 - 5) Length of cable in metres
 - 6) Gross mass of cable and drum in kilograms
 - 7) Manufacturer's name
 - 8) Place of manufacture
 - 9) Destination
 - 10) The words "Not to be laid flat" unless the manufacturer guarantees that the drum may be laid flat without damage to the cable
 - 11) An arrow or the words "Roll this way" shall be used to indicate the direction in which the drum is to be rolled, in order to prevent the cable from unwinding, unless the manufacturer guarantees that the drum may be rolled in either direction without damage to the cable.
 - 12) The outer end of the cable shall be accessible for testing purposes.

3.5.4 Packaging

- a) The cable shall be supplied tightly and uniformly wound onto wooden cable drums. The wound length of cable on each drum shall be specified.
- b) The drum shall be of such construction that no damage to the cable will occur during shipping and handling, and be fitted with wooden battens around the periphery of the drum to ensure adequate protection. The outer layer of the cable shall be protected by a water-resistant wrapping over the exposed surface, to prevent ingress of moisture and dirt during shipping and handling
- c) Each end of the cable shall be properly sealed to prevent the ingress of moisture into the optical fibre elements during shipment or storage, i.e. heat shrink end-cap to be used for sealing.

3.5.5 Documentation

- a) The Contractor shall supply, on completion of the work, full details of the cable provided, including all test results and design information called for in this specification.
- b) All documentation called for in clause a) above shall be provided in electronic format as well as in hard-covered ring files which comply with the following requirements:
- 1) Supplied in English
 - 2) A4 size
 - 3) A construction which can open flat at any page

-
- 4) Any drawings and descriptions included shall conform to the A4 series (295mm x220mm). Larger drawing shall be folded in a single panel, along the 220mm axis of the standard A4 size. Drawings which must be folded in two directions are not acceptable
- 5) Different sections of the documentation shall be separated by means of thumb-tag separators.
- c) The documentation shall include the following:
- 1) Index
 - 2) Details of fibre numbering and colour coding
 - 3) Attenuation and Dispersion characteristics, as well as Numerical Aperture, of the fibres incorporated in the cable
 - 4) Manufacturer's specification sheet, including details of cable construction
 - 5) Fibre over-length (%)
 - 6) Test Certificates for tests done in compliance with clause 3.4
- d) Three copies of the required documentation shall be delivered to the referenced person in the enquiry documentation.

3.6 Spares

Not applicable.

4. Authorization

This document has been seen and accepted by:

Name and surname	Designation
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

Date	Rev	Compiler	Remarks
Oct 2020	3	V Naidu	Cable sheath colour includes both black or orange.
Feb 2018	2	V Naidu	Included new spec of cable with double polyethylene sheath with glass yarn/composite layer.
May 2016	1	K Jose	Adapted from TSP 41-665.

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6. Development team

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

- Krupa Jose
- Tejin Gosai
- Antonio Pereira

7. Acknowledgements

- DC Smith

Annex A – Contractual - Schedule A/B - Technical Particulars

Enquiry No: Tenderer's name:

Tenderer's Signature: Date:

A.1 A.1 Optical Fibres

Item No.	Sub-clause of 240-72274830	Description	Schedule A Particulars of Eskom's Requirements	Schedule B Guaranteed Technical Particulars Offered
		No. of Fibres	As per Scope of Work	
		Type of Fibres (OM2/OM3)	As per scope of Work	
		Core diameter	50 μm ± 6%	
		Cladding diameter	125 μm ± 1.0μm	
		Core/Cladding concentricity error	Specify	
		Cladding non-circularity	Specify	
		Core non-circularity	Specify	
		Cladding Configuration (depressed / matched / other)	Specify	
		Numerical aperture	0.2250 ± 0.02	
		Attenuation Coefficient at 850 nm at 1310 nm	<2.5 dB/km <0.8 dB/km	
		Normalised Modal Distortion Bandwidth at 850 nm at 1310 nm	>400 MHz.km >630 MHz.km	
		Proof Test	≥1% elongation	

Enquiry No: Tenderer's name:

Tenderer's Signature: Date:

A.2 Cable

Item No.	Sub-clause of 240-72274830	Description	Schedule A Particulars of Eskom's Requirements	Schedule B Guaranteed Technical Particulars Offered
		Cable Diameter (mm)	Specify	
		Weight of Cable (kg/km)	Specify	
		Ultimate Tensile Strength (kN)	Specify	
		Maximum Short Term Load(Maximum strain less than 33 % fibre proof strain level) (kN)	Specify	
		Test Load(wher fiber strain does not exceed 0.2% in the fibres) (kN)	Specify	
		Maximum continuous load(fiber under no strain) (kN)	Specify	
		Minimum Bending Radius (mm) Metal free cable	≤ 150 mm	
		Crush Resistance Metal free cable	≥ 1000N	
		Impact Resistance Metal free cable	≥ 1 x 50 Nm	
		Rodent Resistant	Yes/No	
		HDD with double polyethylene sheath and glass yarn/composite layer	Yes/No	
		Colour of Cable sheath	Black or Orange	
		Maximum Cable Length available per drum Metal free cable	Specify	

Enquiry No: Tenderer's name:

Tenderer's Signature: Date:

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A.3 Guide to Statement of Compliance

A.3.1 Guide to tenderer on completing the Compliance Schedule

A.3.2 The specification contains A and B schedules and a clause by clause statement of compliance. The attached compliance schedule shall be filled in together with the relevant technical schedule.

A.3.3 Column 1: The relevant sub-clause of 240-42990189

A.3.4 Column 2: Statement of full compliance. (Yes or No). (If not filled in it will be assumed that the tender does not comply with the specific clause)

A.3.5 Column 3: Stipulate deviations and any other relevant information as required per the specification

Table A.1: Example Statement of Compliance

1	2	3
Clause	Fully Comply	Comments/Deviations
4.1	Yes	-
	No	xxxxxxx
	No	yyyyyy
4.2	Yes	dddddd
4.3	Yes	-

The material and equipment supplied on this contract complies in all respects with the requirements of the specification and Schedule A/B.

A.4 Statement of Compliance

Enquiry No: Tenderer's name:		
Tenderer's Signature:		Date:
Compliance Schedule		
1	2	3
Clause	Fully Comply	Comments/Deviations
3.1 a)		
3.1 b)		
3.1 c)		
3.1 d)		
3.1 e)		
3.1 f)		
3.1 g)		
3.2 a)		

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Enquiry No: Tenderer's name:		
Tenderer's Signature:		Date:
Compliance Schedule		
1	2	3
Clause	Fully Comply	Comments/Deviations
3.2 b)		
3.2 c)		
3.2 d)		
3.2 e)		
3.2 f)		
3.2 g)		
3.2 h)		
3.2 i)		
3.2 j)		
3.2 k)		
3.2 l)		
3.2 m)		
3.2 n)		
3.2 o)		
3.2 p)		
3.3 a)		
3.3 b)		
3.4.1 a)		
3.4.1 b)		
3.4.1 c)		
3.4.2.1		
3.4.2.2		
3.4.2.3 a)		

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Enquiry No: Tenderer's name:		
Tenderer's Signature:		Date:
Compliance Schedule		
1	2	3
Clause	Fully Comply	Comments/Deviations
3.4.2.3 b)		
3.4.2.3 c)		
3.4.3.1		
3.5.1		
3.5.2 a)		
3.5.2 b)		
3.5.2 c)		
3.5.2 d)		
3.5.2 e)		
3.5.2 f)		
3.5.2 g)		
3.5.3 a)		
3.5.3 b)		
3.5.3 c) 1)		
3.5.3 c) 2)		
3.5.3 c) 3)		
3.5.3 c) 4)		
3.5.3 c) 5)		
3.5.3 c) 6)		
3.5.3 c) 7)		
3.5.3 c) 8)		
3.5.3 c) 9)		
3.5.3 c) 10)		

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Enquiry No: Tenderer's name:		
Tenderer's Signature:		Date:
Compliance Schedule		
1	2	3
Clause	Fully Comply	Comments/Deviations
3.5.3 c) 11)		
3.5.3 c) 12)		
3.5.4 a)		
3.5.4 b)		
3.5.4 c)		
3.5.5 a)		
3.5.5 b) 1)		
3.5.5 b) 2)		
3.5.5 b) 3)		
3.5.5 b) 4)		
3.5.5 b) 5)		
3.5.5 c) 1)		
3.5.5 c) 2)		
3.5.5 c) 3)		
3.5.5 c) 4)		
3.5.5 c) 5)		
3.5.5 c) 6)		
3.5.5 d)		