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SINGLE-MODE NON-DISPERSION SHIFTED OPTICAL FIBRES

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Foreword

This specification was prepared on behalf of the Electricity Suppliers Liaison Committee (ESLC) and approved by it for use by supply authorities and other users.

This specification was prepared by a working group which, at the time of publication, comprised the following members:

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A Manufacturers' Interest Group (MIG) was consulted on the contents of this specification and its comments were incorporated where the working group was in agreement. The MIG comprised the following members:

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This document supersedes NRS 081:2005 (edition 1).

Annexes A and B are for information only.

NRS 081:2014

Introduction

This specification has been prepared to establish and provide uniform requirements for single-mode non-dispersion shifted optical fibres. This specification is intended to enable purchasers to acquire the specified item without the need for detailed and extensive contract documents.

The ESLC expresses the wish that, in the national interest and in support of government policy to foster local manufacturing industry and stimulate exports, all purchasers will adopt the requirements of this specification in so far as their particular conditions will permit. Any differences between the requirements of this specification and the corresponding purchaser's requirements should, as far as possible, be clearly indicated in the schedules set out in the annexes, and which should, where appropriate, be submitted for consideration in future revisions of this specification.

Keywords

fibre optics, optical fibres.

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SINGLE-MODE NON-DISPERSION SHIFTED OPTICAL FIBRES

1 Scope

This specification details the requirements of single-mode non-dispersion shifted optical fibres used in both the 1 310 nm and 1 550 nm wavelength regions. This specification is suitable for optical fibres used in aerial and duct cable applications.

NOTE 1 A guide to purchasers on preparing an enquiry is given in annex A.

NOTE 2 A model form for schedules A and B is given in annex B.

2 Normative references

The following documents contain provisions which, through reference in this text, constitute provisions of this specification. All documents are subject to revision and, since any reference to a document is deemed to be a reference to the latest edition of that document, parties to agreements based on this specification are encouraged to take steps to ensure the use of the most recent editions of the documents listed below. Information on currently valid national and international standards can be obtained from the SABS Standards Division.

EIA/TIA 598-C, *Optical fibre cable colour coding*.

ITU-T Recommendation G.652, *Characteristics of a single-mode optical fibre and cable*.

SANS 60793-1-20/IEC 60793-1-20, *Optical fibres – Part 1-20: Measurement methods and test procedures – Fibre geometry*.

SANS 60793-1-21/IEC 60793-1-21, *Optical fibres – Part 1-21: Measurement methods and test procedures – Coating geometry*.

SANS 60793-1-22/IEC 60793-1-22, *Optical fibres – Part 1-22: Measurement methods and test procedures – Length measurement*.

SANS 60793-1-30/IEC 60793-1-30, *Optical fibres – Part 1-30: Measurement methods and test procedures – Fibre proof test*.

SANS 60793-1-31/IEC 60793-1-31, *Optical fibres – Part 1-31: Measurement methods and test procedures – Tensile strength*.

SANS 60793-1-32/IEC 60793-1-32, *Optical fibres – Part 1-32: Measurement methods and test procedures – Coating strippability*.

SANS 60793-1-33/IEC 60793-1-33, *Optical fibres – Part 1-33: Measurement methods and test procedures – Stress corrosion susceptibility*.

SANS 60793-1-34/IEC 60793-1-34, *Optical fibres – Part 1-34: Measurement methods and test procedures – Fibre curl.*

SANS 60793-1-40/IEC 60793-1-40, *Optical fibres – Part 1-40: Measurement methods and test procedures – Attenuation.*

SANS 60793-1-42/IEC 60793-1-42, *Optical fibres – Part 1-42: Measurement methods and test procedures – Chromatic dispersion.*

SANS 60793-1-44/IEC 60793-1-44, *Optical fibres – Part 1-44: Measurement methods and test procedures – Cut-off wavelength.*

SANS 60793-1-45/IEC 60793-1-45, *Optical fibres – Part 1-45: Measurement methods and test procedures – Mode field diameter.*

SANS 60793-1-47/IEC 60793-1-47, *Optical fibres – Part 1-47: Measurement methods and test procedures – Macrobending loss.*

SANS 60793-1-48/IEC 60793-1-48, *Optical fibres – Part 1-48: Measurement methods and test procedures – Polarization mode dispersion.*

SANS 60793-1-50/IEC 60793-1-50, *Optical fibres – Part 1-50: Measurement methods and test procedures – Damp heat (steady state).*

SANS 60793-1-51/IEC 60793-1-51, *Optical fibres – Part 1-51: Measurement methods and test procedures – Dry heat.*

SANS 60793-1-52/IEC 60793-1-52, *Optical fibres – Part 1-52: Measurement methods and test procedures – Change of temperature.*

SANS 60793-1-53/IEC 60793-1-53, *Optical fibres – Part 1-53: Measurement methods and test procedures – Water immersion.*

SANS 60793-2-50/IEC 60793-2-50, *Optical fibres – Part 2-50: Product specifications – Sectional specification for class B single-mode fibres.*

3 Terms, definitions and abbreviations

For the purposes of this specification, the following terms, definitions and abbreviations apply.

3.1 Terms and definitions

cladding

dielectric material of an optical fibre that surrounds the core

coloured coating

thin coating applied over the primary coating in order to make each fibre distinguishable by its colour

core

central region of an optical fibre, generally with higher refractive index than the surrounding cladding region, and through which most of the optical power is transmitted

primary coating

thin coating applied directly to the cladding, usually at the time of the fibre drawing, in one or more layers, to preserve the integrity of the cladding surface

single-mode fibre

optical fibre in which the radiation of only one bound mode can propagate at the wavelength of interest

3.2 Abbreviations

λ_c : fibre cut-off wavelength

λ_{cc} : cable cut-off wavelength

PMD: polarization mode dispersion

PMD_Q: statistical parameter for link PMD

UV: ultraviolet

4 Requirements**4.1 General**

4.1.1 The fibre shall comply with the general requirements of fibres of type B1.3 in SANS 60793-2-50, the requirements of type G.652D in ITU-T Recommendation G.652, and the requirements of this specification. In the case of a dispute, this specification shall apply.

4.1.2 The fibre is made up of an inner core, which carries an optical signal, covered by a cladding and a primary coating.

4.1.3 The core and cladding of the optical fibre shall be made from predominantly purified silica (SiO₂) with a defined and closely controlled refractive index. The refraction index of either the core or the cladding (or both) shall be controlled by the inclusion of small amounts of highly purified dopant materials.

4.1.4 The primary coating shall consist of a double layer of UV cured acrylate. The coating shall be easy to remove from the fibre. The method of removal shall be specified.

4.1.5 The fibres shall have a colour coating and be distinguishable by means of colour coding with the 12 different colours in accordance with EIA/TIA 598-C. The fibre colours shall be stable during the lifetime of the cable in which they are used, shall not fade, smear onto one another or into any gel filling material and shall not cause the fibres to stick together.

4.1.6 All fibres shall be sufficiently free of surface imperfections and inclusions and shall comply with the optical, mechanical and environmental requirements of this specification.

4.1.7 Optical fibres used in cables shall be free from any splices.

4.1.8 No point discontinuities that exceed 0,10 dB shall be permitted in any optical fibre.

4.2 Properties

4.2.1 The main geometrical, optical and mechanical properties of single-mode non-dispersion shifted optical fibres are shown in table 1.

4.2.2 The fibres incorporated into a cable shall maintain their properties under all operating conditions.

4.3 Fibre parameters

4.3.1 When tested in accordance with 5.2.1, the stress corrosion susceptibility parameter n shall be ≥ 20 .

4.3.2 When tested in accordance with 5.2.2, the attenuation increase due to macrobending shall be $\leq 0,05$ dB.

4.3.3 When tested in accordance with 5.2.3, the peak force necessary to strip the primary coating shall be between 1 N and 8,9 N.

4.3.4 When tested in accordance with 5.2.4, the fibre curl shall be ≥ 2 m.

4.3.5 When tested in accordance with 5.2.5, the attenuation change due to damp heat shall be $< 0,05$ dB/km.

4.3.6 When tested in accordance with 5.2.6, the attenuation change due to dry heat shall be $< 0,05$ dB/km.

Table 1 — Main geometrical, optical and mechanical properties

1	2	3	4
Geometrical characteristics	Mode field	Diameter at 1 310 nm Diameter at 1 550 nm	9,2 μm ± 0,4 μm 10,5 μm ± 1,0 μm
	Cladding	Diameter	125 μm ± 1 μm
		Non-circularity	≤ 1,0 %
	Core	Concentricity error	≤ 0,5 μm
	Primary coating (uncoloured)	Material	Double UV curable acrylate
		Diameter	245 μm ± 10 μm
		Concentricity error	≤ 10 μm
Optical characteristics	Attenuation	1 310 nm	≤ 0,35 dB/km ^a
		1 383 nm	≤ 0,35 dB/km ^a
		1 550 nm	≤ 0,22 dB/km ^a
	Chromatic dispersion	1 290 nm to 1 330 nm	≤ 3,0 ps/(nm·km)
		1 550 nm	≤ 18,0 ps/(nm·km)
		Zero dispersion wavelength	1 300 nm ≤ λ _c ≥ 1 324 nm
		Slope	≤ 0,092 ps/nm ² ·km
	PMD _Q M = 20 cables Q = 0,01 %		≤ 0,2 ps/√km
	Fibre cut-off wavelength		1 150 nm ≤ λ _c ≥ 1 330 nm
	Cable cut-off wavelength		λ _{cc} ≤ 1 260 nm
Mechanical characteristics	Proof test level	≥ 1 %	
	Macrobending loss (30 mm, 100 turns)	≤ 0,1 dB at 1 625 nm	

^a This is uncabled fibre attenuation. The cabled attenuation shall be agreed upon between the supplier and the user.

4.3.7 When tested in accordance with 5.2.7, the attenuation change during temperature cycling shall be $< 0,05$ dB/km at 1 310 nm and 1 550 nm.

4.3.8 When tested in accordance with 5.2.8, the attenuation change due to water immersion shall be $< 0,05$ dB/km.

4.3.9 When tested in accordance with 5.3.1, the fibre geometry shall comply with the requirements given in table 1.

4.3.10 When tested in accordance with 5.3.2, the coating geometry shall comply with the requirements given in table 1.

4.3.11 When tested in accordance with 5.3.4, the fibre shall withstand a proof test level of ≥ 1 %.

4.3.12 When tested in accordance with 5.3.5, the fibre attenuation shall be $\leq 0,35$ dB/km at both 1 310 nm and 1 383 nm, and shall be $\leq 0,22$ dB/km at 1 550 nm.

4.3.13 When tested in accordance with 5.3.6, the fibre chromatic dispersion shall be $\leq 3,0$ ps/(nm·km) at 1 290 nm to 1 330 nm, and ≤ 18 ps/(nm·km) at 1 550 nm.

4.3.14 When tested in accordance with 5.3.7, the fibre cut-off wavelength shall be between 1 150 nm and 1 330 nm.

4.3.15 The fibre mode field diameter shall be $9,2 \mu\text{m} \pm 0,4 \mu\text{m}$ at 1 310 nm (see table 1).

4.3.16 The PMD_Q shall be as specified in schedule A.

5 Tests

5.1 Extent of testing

5.1.1 Type tests

Carry out type tests before delivery of any product to ensure compliance with the specification. Should the supplier have the results of type tests done on products similar to those to be supplied, these results can be submitted instead of carrying out new type tests. Should there be any change made to the materials used or to the manufacturing process, new type tests shall be carried out.

5.1.2 Routine tests

Carry out the manufacturer's standard routine tests on every fibre before delivery.

5.2 Type tests

5.2.1 Stress corrosion susceptibility

Perform the stress corrosion susceptibility test in accordance with annex A or annex B of SANS 60793-1-33:2001. Check for compliance with 4.3.1.

5.2.2 Macrobending loss

Perform the macrobending loss measurement test in accordance with SANS 60793-1-47 using 100 turns around a mandrel of 60 mm diameter. Check for compliance with 4.3.2.

5.2.3 Coating strippability

Perform the coating strippability test in accordance with SANS 60793-1-32. Check for compliance with 4.3.3.

5.2.4 Fibre curl

Perform the fibre curl test in accordance with SANS 60793-1-34. Check for compliance with 4.3.4.

5.2.5 Damp heat

Perform the damp heat test in accordance with SANS 60793-1-50. Check for compliance with 4.3.5.

5.2.6 Dry heat

Perform the dry heat test in accordance with SANS 60793-1-51. Check for compliance with 4.3.6.

5.2.7 Change of temperature

Perform the change of temperature test in accordance with SANS 60793-1-52 with $T_A = -60\text{ °C}$ and $T_B = 85\text{ °C}$. Check for compliance with 4.3.7.

5.2.8 Water immersion

Perform the water immersion test in accordance with SANS 60793-1-53. Check for compliance with 4.3.8.

5.3 Routine tests

5.3.1 Fibre geometry

Perform the fibre geometry tests in accordance with SANS 60793-1-20. Check for compliance with 4.3.9.

5.3.2 Coating geometry

Perform the coating geometry tests in accordance with SANS 60793-1-21. Check for compliance with 4.3.10.

5.3.3 Length measurement

Perform the length measurement test in accordance with method B in SANS 60793-1-22.

5.3.4 Fibre proof test

Perform the fibre proof test in accordance with SANS 60793-1-30. Check for compliance with 4.3.11.

5.3.5 Attenuation

Perform the fibre attenuation test in accordance with SANS 60793-1-40. Check for compliance with 4.3.12.

5.3.6 Chromatic dispersion

Perform the fibre chromatic dispersion test in accordance with SANS 60793-1-42. Check for compliance with 4.3.13.

5.3.7 Cut-off wavelength

Perform the cut-off wavelength test in accordance with SANS 60793-1-44. Check for compliance with 4.3.14.

5.3.8 Mode field diameter

Perform the fibre mode field diameter test in accordance with SANS 60793-1-45. Check for compliance with 4.3.15.

5.3.9 Polarization mode dispersion

Perform the fibre polarization mode dispersion test in accordance with SANS 60793-1-48. Check for compliance with 4.3.16.

5.3.10 Hydrogen aging

Perform the hydrogen aging test in accordance with SANS 60793-2-50, in accordance with B1.3 fibre category. Check for compliance with 4.3.12.

6 Marking, labelling and packaging

Not applicable.

7 Documentation

7.1 The fibre manufacturer shall provide results of type tests and all routine tests (see annex B) to prove compliance with the optical fibre specifications. The fibre manufacturer should also supply the effective group index of refraction (see annex B) at 1 310 nm and 1 550 nm.

7.2 All documentation called for shall be provided in hard-covered ring files that can open flat on any page and the documentation shall comply with the following requirements:

- a) all documentation, including type-test reports, shall be supplied in triplicate in English;
- b) all documentation on paper shall be in standard A4 size;
- c) different sections of the documentation shall be separated by means of thumb-tag file separators;
- d) documentation in electronic format, preferably in pdf format, shall also be accepted, subject to approval.

Annex A

(informative)

Guide to purchasers on preparing an enquiry

A.1 General

A model form is given in annex B to provide the purchaser with a convenient aid to purchasing. The use of this form is intended to obviate the need for preparing a detailed technical specification.

The purchaser need only specify compliance with this specification, provide the tenderers with details of his particular requirements, and set out the information he requires the tenderer to provide, as indicated below.

A.2 Schedules

A.2.1 General

The model form in annex B provides the purchaser with examples of a schedule A and a schedule B. In his enquiry, the purchaser should provide his own schedule A and schedule B, based on these examples.

A.2.2 Schedule A

Schedule A lists the requirements to be specified by the purchaser in enquiries and orders. These requirements include references to the relevant subclauses in this specification, to assist in compiling the schedules.

Where the text of any referenced standard stipulates that the purchaser shall indicate his requirements, these requirements should also be specified in schedule A. The purchaser should set out his particular requirements and choices in his own schedule A.

A.2.3 Schedule B

The purchaser should draw up his own schedule B (based on the schedule B in the model form in annex B), and require the tenderer to fill in this schedule. By doing this, the tenderer will be stating compliance with this specification and will provide the information the purchaser has requested.

NOTE 1 Where this specification allows the purchaser to make a choice, the example of schedule A (in the model form in annex B) lists the preferred items/values/quantities. In the interests of standardization, purchasers are encouraged not to deviate from these preferences.

NOTE 2 When preparing his own schedule A and schedule B from the examples in the model form in annex B, the purchaser need only include the items he considers to be relevant or necessary.

NOTE 3 These schedules, when completed, become normative annexes to the enquiry specification.

A.3 Commercial conditions

A purchaser will furthermore need to indicate the commercial conditions applicable and draw up a price schedule. Requirements for delivery, storage, packaging and marking should be included in this part of the enquiry.

Annex A

(concluded)

A.4 Quality assurance

This specification does not cover the purchaser's possible requirements in respect of quality assurance, quality control, inspections, etc., since each purchaser needs to consider the criticality of the application of each component, and his own policy towards these matters. Purchasers are referred to SANS 9001 for guidance.

A.5 Testing

Attention should be paid to the subject of tests and the related costs. Tests should be carried out by an accredited laboratory and tenderers should be requested to provide assurances in this regard. Price schedules should be so drawn up and covering letters so worded that the costs of all services, such as tests, delivery and spares, are declared and allowed for in the tender.

Before type tests, routine tests and sample tests are carried out, the number of samples used and the frequency of sampling should be agreed upon with the supplier.

A.6 Revisions of standards used as normative references

This specification, as has been indicated, is based on a set of defined standards, which might have been revised or amended. Most purchasers would, in principle, wish to employ the latest standards. The recommended approach is to secure an undertaking from a supplier to review the latest versions and amendments and to incorporate these where possible and agreeable to both parties. A blanket commitment to work to the "latest" versions of standards creates legal difficulties of interpretation and risks for both parties and should be properly assessed. This invariably cannot be done in the time available.

Annex B

(informative)

Model form for schedules A and B

The model form is provided as a convenient aid to purchasing. Guidance on preparing an enquiry using this form is given in annex A.

Schedule A: Purchaser's specific requirements

Schedule B: Particulars of equipment to be supplied (to be completed by tenderer)

Item	Sub-clause	Description	Schedule A	Schedule B
B.1	4.1	General	Comply	_____
B.2	4.2	Properties	Comply	_____
B.3	4.3	Fibre parameters	Comply	_____
B.4	4.3.12	Attenuation	$\leq 0,35$ dB/km at 1 310 nm	xxxxxxxxxxxx
B.5	4.3.12	Attenuation	$\leq 0,35$ dB/km at 1 383 nm	xxxxxxxxxxxx
B.6	4.3.12	Attenuation	$\leq 0,22$ dB/km at 1 550 nm	xxxxxxxxxxxx
B.7	4.3.16	Statistical parameter for link PMD (PMD _Q) M = 20 cables Q = 0,01 %	$\leq 0,2$ ps/ $\sqrt{\text{km}}$	_____
B.8	7	Documentation (type-test results)	xxxxxxxxxxxx	_____
B.9	7	Documentation (effective group index of refraction)	xxxxxxxxxxxx	_____
B.10	7	Documentation (routine-test results)	xxxxxxxxxxxx	_____

Bibliography

SANS 9001/ISO 9001, *Quality management systems — Requirements*.

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