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Selection of optical fibre cable specifications relative to mechanical, ingress, climatic or electromagnetic characteristics – Guidance

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Selection of optical fibre cable specifications relative to mechanical, ingress, climatic or electromagnetic characteristics – Guidance

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SELECTION OF OPTICAL FIBRE CABLE SPECIFICATIONS RELATIVE TO MECHANICAL, INGRESS, CLIMATIC OR ELECTROMAGNETIC CHARACTERISTICS – GUIDANCE

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IEC 62362 which is a technical report, has been prepared by subcommittee 86A: Fibres and cables, of IEC technical committee 86: Fibre optics.

The text of this technical report is based on the following documents:

Enquiry draft	Report on voting
86A/1297/DTR	86A/1302/RVC

Full information on the voting for the approval of this technical report can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

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INTRODUCTION

Optical fibre cable specification standards are defined in the IEC 60794 series, which are listed in Annex B. They are organized in a hierarchy similar to the IECQ system. They differ from the IECQ system in that they are all performance standards. Optical fibre cable standards mainly cover the attributes and tests that protect the fibre from the environment, including installation, and the fibre attributes that may be affected by cabling. The attributes of the fibres within the cable are defined by reference to optical fibre specification standards of the IEC 60793 series, which are listed in Annex C. A complete and up-to-date listing of standards in the IEC 60793 and IEC 60794 series is available on website of the IEC: http://www.iec.ch.

The different levels of hierarchy are: general, sectional, family, and product. The primary distinction between these is the level of detail. Typically more options or wider ranges are present at the higher level. At a given level, the distinctions are with respect to application or cable construction. The references section of this document gives a more complete mapping. Parts of the family specification include blank detail specifications for various attributes that do not have normative requirements.

At the sectional specification level, two main categories are indoor and outdoor cables. Typically the outdoor cables have tougher tests than the indoor cables. At the product specification level, there are series of standards intended to support ISO/IEC 11801 for premises cabling, using both indoor and outdoor varieties.

This guidance will not attempt to reproduce the requirements of all the different specifications. For each of the MICE attributes, it will discuss the situation and mention the key options.

SELECTION OF OPTICAL FIBRE CABLE SPECIFICATIONS RELATIVE TO MECHANICAL, INGRESS, CLIMATIC OR ELECTROMAGNETIC CHARACTERISTICS – GUIDANCE

1 Scope

The purpose of this guidance is to provide information on the specification of optical fibre cables with respect to the mechanical, ingress, climatic or electromagnetic characteristics (MICE) as classified within ISO/IEC 24702.

In this classification system each letter of the four initials of the acronym are subscripted with a value of from one to three to indicate different severities. The current attributes and severities are found in Annex A.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60794-1-2, *Optical fibre cables – Part 1-2: Generic specification – Basic optical cable test procedures*

IEC 60794-2 (all parts), *Optical fibre cables – Part 2: Indoor optical fibre cables*

IEC 60794-3 (all parts), *Optical fibre cables – Part 3: Outdoor cables*

ISO/IEC 24702, *Information technology – Generic cabling – Industrial premises*

ISO/IEC 11801, *Information technology – Generic cabling for customer premises*

3 Acronyms

MICE Mechanical, ingress, climatic and chemical, electromagnetic

4 MICE attributes and severities

4.1 General

The MICE classification system has three levels of severity:

– the first level of severity ($M_1I_1C_1E_1$) describes a typical environment such as that assumed within ISO/IEC 11801; (i.e. office premises etc.);

– the second level of severity ($M_2I_2C_2E_2$) describes a worst-case light industrial environment;

– the third level of severity ($M_3I_3C_3E_3$) describes a worst-case industrial environment.

See Annex A for a more detailed description of the MICE severity levels.

4.2 Mechanical

4.2.1 Shock/bump

Shock and bump are not specified for optical fibre cables. They are inherently robust in this respect. A more important attribute is bending.

4.2.2 Vibration

Vibration in the industrial premises (as opposed to wind induced vibration on aerially deployed cables) is not specified for optical fibre cables. They are inherently robust in this respect.

4.2.3 Tensile force

For outdoor premises cables specified in IEC 60794-3 series, manufacturers specify a rated tensile force. The requirement is that the fibre shall not exceed a percentage of the proof test strain (to be agreed between customer and supplier) when the cable is tested at the rated load.

For indoor cables, the different family specifications of IEC 60794-2 series have different requirements on the tensile load.

4.2.4 Crush

For optical fibre cables, the crushing force is applied in a plate to plate test.

For indoor cables, crush is specified at 500 N. For outdoor cables, different levels are specified depending on whether the cable is armoured or not. For unarmoured cable, values of between 1 500 N and 3 000 N may be specified. For armoured cable, values between 2 200 N and 10 000 N may be specified.

4.2.5 Impact

For indoor cables a value of 1 J with a 12,5 mm radius is specified. For un-armoured outdoor cables, a value of either 10 J with a 300 mm radius or 3 J with a 10 mm radius is specified.

4.2.6 Bending, flexing and torsion

All the family specifications have requirements on these attributes.

For bending, there are multiple tests such as bending under tension, repeated bending and simple bending. The bending diameter is typically 20 times the cable diameter.

For torsion, the test length, load, and number of turns varies depending on the family specification. For indoor cables, the length is from 250 mm to 1 000 mm, loaded at 20 N with 20 cycles applied.

4.3 Ingress

4.3.1 Basic consideration

Optical fibre cables come in a variety of constructions. Some examples are slotted core, loose tube, tight buffered. The slotted core and loose tube can be filled or unfilled. These different constructions have different ingress characteristics.

4.3.2 Particulate ingress

Particulate ingress is not specified for optical fibre cables. They are inherently robust in this respect.

4.3.3 Water immersion

On cables for which water immersion is specified, the test is different from that found in Annex A. The requirement is that a pressure equivalent to 1 m of water is applied at or near one end of a short (<3m) cable. After 24 h, the requirement is: No water found at the other end.

It is expected that cables passing this test would pass both I_2 and I_3 severities.

4.4 Climatic

4.4.1 General

Terminations such as cable closures are generally considered separately from the cables and are covered by IEC SC 86B.

NOTE The values that appear in Tables 1 to 3b below indicate levels of resistance to climatic phenomena. Values of 1 – 3 correspond to the relevant level of severity in the MICE classification system. A value of 0 indicates no effective resistance to the climatic phenomena described.

4.4.2 Ambient temperature

The different specifications allow different ranges of values to be specified by the customer, depending on the climate in which the cable will be installed. For the detailed specifications for premises cabling, –20 ºC to +60 ºC are specified. Other ranges and combinations from –45 ºC to +70 ºC are also found as options in the family specifications.

4.4.3 Rate of change of temperature

This is not specified. All the cables that pass the other requirements will, however, have the capability of 3 °C/min.

4.4.4 Humidity

For further study.

4.4.5 Solar radiation

Resistance to solar radiation in the industrial premises environment is not specified. Resistance to solar radiation is a property of the sheath material. The severities associated with some common generic materials are indicated in Table 1.

A specific grade of the generic material may have a different performance to that identified in the Table 1.

Table 1 – Resistance to solar radiation

Material	Natural	Stabilized	With ~2,5 % of active carbon black content
Medium-density polyethylene	0	3	3
Track-resistant medium-density polyethylene	0	3	3
High-density polyethylene	0	3	3
Thermoplastic (co)polyester elastomer	0	3	3
Polyvinyl chloride	1	3	3

Material	Natural	Stabilized	With ~2,5 % of active carbon black content
Polyvinylidene fluoride	1	3	3
Nylon 12 (polyamide)	1	3	3
Thermoplastic polyurethane (TPU)	1	3	3

4.4.6 Liquid pollution

Resistance to liquid pollution is not specified. Resistance to liquid pollution is a property of the sheath material. The severities associated with some common generic materials are indicated in Table 2.

A specific grade of the generic material may have a different performance to that identified in the Table 1.

Table 2 – Liquid pollution

Material	Pollutant				
	Sodium chloride (salt/sea water)	Oil (dry-air concentration)	Sodium stearate (soap)	Detergent	Conductive materials in solution
Low-density polyethylene	3	3	3	3	3
Medium-density polyethylene	3	3	3	3	3
Track-resistant medium-density polyethylene	3	3	3	3	3
High-density polyethylene	3	3	3	3	3
Thermoplastic (co)polyester elastomer	3	3	3	3	3
Polyvinyl chloride	2	2	2	2	3
Polyvinylidene fluoride	3	3	3	3	3
Nylon (polyamid 12)	2	2	2	2	3
Thermoplastic polyurethane (TPU)	3	3	3	3	3

4.4.7 Gaseous pollution

Resistance to gaseous pollution is not specified. Resistance to gaseous pollution is a property of the sheath material. The severities associated with some common generic materials are indicated in Tables 3 and 4.

A specific grade of the generic material may have a different performance to that identified in the Table 1.

Table 3 – Gaseous pollution resistance

Material	Pollutant				
	Hydrogen sulphide	Sulphur dioxide	Chlorine wet	Chlorine dry	Hydrogen chloride 10%
Low-density polyethylene	2	2	0	0	2
Medium-density polyethylene	2	2	0	0	2
Track resistant medium-density polyethylene	2	2	0	0	2
High-density polyethylene	2	2	0	0	2
Thermoplastic (co)polyester elastomer	2	2	1	1	0
Polyvinyl chloride	3	3	1	0	3
Polyvinylidene fluoride	3	2	3	3	3
Nylon (polyamid 12)	3	1	0	0	0
Thermoplastic polyurethane (TPU)	3	3	2	2	3

Table 4 – Gaseous pollution resistance

Material	Pollutant				
	Hydrogen chloride 37 %	Hydrogen fluoride	Ammonia	Oxides of nitrogen	Ozone 100 %
Low-density polyethylene	2	2	3	0	0
Medium-density polyethylene	2	0	3	0	0
Track tesistant medium-density polyethylene	2	0	3	0	0
High-density polyethylene	2	0	3	0	0
Thermoplastic (co)polyester elastomer	0	0	0	0	0
Polyvinyl chloride	3	2	3	1	1
Polyvinylidene fluoride	3	3	3	2	2
Nylon (polyamid 12)	0	0	3	1	1
Thermoplastic polyurethane (TPU)	3	2	3	3	3

4.5 Electromagnetic

Cables can be dielectric, or can contain metallic elements such as armour, strength members or sheaths. With the exception of possible damage on cables with metallic sheathes due to lightning strikes, optical fibre cables are immune to the all the attributes for this category.

Annex A
(informative)

Details of MICE classification

The details associated with ISO/IEC 24702 are presented in the following tables.

Table A.1 – Details of MICE classification (Mechanical)

Mechanical	M_1	M_2	M_3
Shock/bump ([a])			
Peak acceleration	40 ms^2	100 ms^2	250 ms^2
Vibration			
Displacement amplitude (2 Hz to 9 Hz)	1,5 mm	7,0 mm	15,0 mm
Acceleration amplitude (9 Hz to 500 Hz)	5 ms^2	20 ms^2	50 ms^2
Tensile force	See [b]	See [b]	See [b]
Crush	45 N over 25 mm (linear) min.	1 100 N over 150 mm (linear) min.	2 200 N over 150 mm (linear) min.
Per IEC 60794-1-2, Method E.3	180 N	735 N	1470 N
Impact	1 J	10 J	30 J
Bending, flexing and torsion	See [b]	See [b]	See [b]

Table A.2 – Details of MICE classification (Ingress)

Ingress	I_1	I_2	I_3
Particulate ingress (dia. max)	12,5 mm	50 µm	50 µm
Immersion	None	Intermittent liquid jet <=12,5 l/min >= 6,3 mm jet > 2,5 m distance	Intermittent liquid jet <=12,5 l/min >= 6,3 mm jet > 2,5 m distance and immersion (<=1 m for <=30 min)

Table A.3 – Details of MICE classification (Chemical)

Climatic and chemical	C_1	C_2	C_3
Ambient temperature	–10° C to +60° C	–25° C to +70° C	–40° C to +70° C
Rate of change of temperature	0,1° C per minute	1,0° C per minute	3,0° C per minute
Humidity	5 % to 85 % (non-condensing)	5 % to 95 % (condensing)	5 % to 95 % (condensing)
Solar radiation	700 Wm^2	1 120 Wm^2	1 120 Wm^2
Liquid pollution [c] Contaminants	Concentration × 10^{-6}	Concentration × 10^{-6}	Concentration × 10^{-6}
Sodium chloride (salt/sea water)	0	<0,3	<0,3
Oil (dry-air concentration) (for oil types see [b])	0	<0,005	<0,5
Sodium stearate (soap)	None	5 × 10^4 aqueous non-gelling	>5 × 10^4 aqueous gelling

Climatic and chemical	C_1	C_2	C_3
Detergent	None	For further study	For further study
Conductive materials	None	Temporary	Present

Table A.4 – Details of MICE classification (Gas)

Gaseous pollution (see Note 3) Contaminants	Mean/Peak (Concentration × 10^{-6})	Mean/Peak (Concentration × 10^{-6})	Mean/Peak (Concentration × 10^{-6})
Hydrogen sulphide	<0,003/<0,01	<0,05/<0,5	<10/<50
Sulphur dioxide	<0,01/<0,03	<0,1/<0,3	<5/<15
Sulphur trioxide (ffs)	<0,01/<0,03	<0,1/<0,3	<5/<15
Chlorine wet (>50 % humidity)	<0,000 5/<0,001	<0,005/<0,03	<0,05/<0,3
Chlorine dry (<50 % humidity)	<0,002/<0,01	<0,02/<0,1	<0,2/<1,0
Hydrogen chloride	-/<0,06	<0,06/<0,3	<0,6/3,0
Hydrogen fluoride	<0,001/<0,005	<0,01/<0,05	<0,1/<1,0
Ammonia	<1/<5	<10/<50	<50/<250
Oxides of nitrogen	<0,05/<0,1	<0,5/<1	<5/<10
Ozone	<0,002/<0,005	<0,025/<0,05	<0,1/<1

Table A.5 – Details of MICE classification (Electromagnetic)

Electromagnetic	E1	E2	E3
Electrostatic discharge – Contact (0,667 µC)	4 kV	4 kV	4 kV
Electrostatic discharge – Air (0,132 µC)	8 kV	8 kV	8 kV
Radiated RF – AM	3 V/m @ (80 to 1 000) MHz 3 V/m @ (1 400 to 2 000) MHz 1 V/m @ (2 000 to 2 700) MHz	3 V/m @ (80 to 1 000) MHz 3 V/m @ (1 400 to 2 000) MHz 1 V/m @ (2 000 to 2 700) MHz	10 V/m @ (80 to 1 000) MHz 3 V/m @ (1 400 to 2 000) MHz 1 V/m @ (2 000 to 2 700) MHz
Conducted RF	3 V@ 150 kHz to 80 MHz	3 V@ 150 kHz to 80 MHz	10 V@ 150 kHz to 80 MHz
EFT/B (comms)	500 V	1 000 V	1 000 V
Surge (transient ground potential difference) – signal, line to earth	500 V	1 000 V	1 000 V
Magnetic field (50/60 Hz)	1 Am-1	3 Am-1	30 Am-1
Magnetic field (60 Hz to 20 000 Hz)	For further study.	For further study.	For further study.

[a] Bump: the repetitive nature of the shock experienced by the channel shall be taken into account.

[b] This aspect of environmental classification is installation-specific and should be considered in association with IEC 61918 and the appropriate component specification.

[c] A single dimensional characteristic, i.e. concentration × 10^{-6}, was chosen to unify limits from different standards."

Annex B
(informative)

IEC cable standards

The following is a list of existing IEC optical cable standards:

IEC 60794-1-1, *Optical fibre cables – Part 1-1: Generic specification – General*

IEC 60794-1-2, *Optical fibre cables – Part 1-2: Generic specification – Basic optical cable test procedures*

IEC 60794-2, *Optical fibre cables – Part 2: Indoor cables – Sectional specification*

IEC 60794-2-10, *Optical fibre cables – Part 2-10: Indoor cables – Family specification for simplex and duplex cables*

IEC 60794-2-11, *Optical fibre cables – Part 2-11: Indoor optical fibre cables – Detailed specification for simplex and duplex cables for use in premises cabling*

IEC 60794-2-20, *Optical fibre cables – Part 2-20: Indoor cables – Family specification for multi-fibre optical distribution cables*

IEC 60794-2-21, *Optical fibre cables – Part 2-21: Indoor optical fibre cables – Detailed specification for multi-fibre optical distribution cables for use in premises cabling*

IEC 60794-2-30, *Optical fibre cables – Part 2-30: Indoor cables – Family specification for optical fibre ribbon cables*

IEC 60794-2-31, *Optical fibre cables – Part 2-31: Indoor optical fibre cables – Detailed specification for optical fibre ribbon cables for use in premises cabling*

IEC 60794-2-40, *Optical fibre cables – Part 2-40: Indoor cables – Family specification for cables with plastic optical fibres*

IEC 60794-3, *Optical fibre cables – Part 3: Sectional specification – Outdoor cables*

IEC 60794-3-10, *Optical fibre cables – Part 3-10: Outdoor cables – Family specification for duct and directly buried optical telecommunication cables*

IEC 60794-3-11, *Optical fibre cables – Part 3-11 Outdoor cables – Duct and directly buried optical telecommunication cables – Detailed specification*

IEC 60794-3-12, *Optical fibre cables – Part 3-12: Outdoor cables – Detailed specification for duct and directly buried optical telecommunication cables for use in premises cabling*

IEC 60794-3-20, *Optical fibre cables – Part 3-20: Outdoor cables – Family specification for optical self-supporting aerial telecommunication cables*

IEC 60794-3-21, *Optical fibre cables – Part 3-21: Outdoor cables – Detailed specification for optical self-supporting aerial telecommunication cables for use in premises cabling*

IEC 60794-3-30, *Optical fibre cables – Part 3-30: Outdoor cables – Family specification for optical telecommunication cables for lake and river crossings*

IEC 60794-4, *Optical fibre cables – Part 4: Sectional specification – Aerial optical cables along electrical power lines*

IEC 60794-4-10, *Optical fibre cables – Part 4-10: Aerial optical cables along electrical power lines – Family specification for OPGW (Optical Ground Wire)*

IEC 60794-5, *Optical fibre cables – Part 5: Sectional specification – Microduct cabling for installation by blowing*

IEC 60794-2-41, *Optical fibre cables – Part 2-41: Indoor cables – Product specification for simplex and duplex buffered A4 fibres*

IEC 60794-2-42, *Optical fibre cables – Part 2-42: Indoor optical fibre cables – Product specification for simplex and duplex cables with A4 fibres*

IEC 60794-2-50, *Optical fibre cables – Part 2-50: Indoor cables – Family specification for simplex and duplex cables for use in terminated cable assemblies*

Annex C
(informative)

Fibre specifications and tests

C.1 Specifications

The fibre specifications are organized as a series of sectional specification standards beneath a general specification. Within each sectional specification there is a series of normative annexes that define the requirements for the different family specifications. Within the single-mode fibre sectional specification, IEC 60793-2-50, for example, are the family specifications for the B1.1, B1.2, B1.3, B2, B4, B5 and B6 fibre categories.

IEC 60793-2, *Optical fibres – Part 2: Product specifications – General*

IEC 60793-2-10, *Optical fibres – Part 2-10: Product specifications – Sectional specification for category A1 multimode fibres*

IEC 60793-2-20, *Optical fibres – Part 2-20: Product specifications – Sectional specification for category A2 multimode fibres*

IEC 60793-2-30, *Optical fibres – Part 2-30: Product specifications – Sectional specification for category A3 multimode fibres*

IEC 60793-2-40, *Optical fibres – Part 2-40: Product specifications – Sectional specification for category A4 multimode fibres*

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

C.2 Measurements and tests

The fibre tests and measurements are under a general and guidance standard and organized into groups relating to dimensional, mechanical, optical, and environmental attributes. When multiple measurement methods are defined, they appear as different normative annexes of these documents.

IEC 60793-1-1, *Optical fibres – Part 1-1: Measurement methods and test procedures – General and guidance*

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

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

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

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

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