IEC 60684-3-216

Edition 2.0 2019-08
REDLINE VERSION

INTERNATIONAL STANDARD

colour inside

Flexible insulating sleeving –
Part 3: Specifications for individual types of sleeving –
Sheet 216: Heat-shrinkable, flame-retarded, limited-fire-hazard sleeving

IEC 60684-3-216:2019-08 RLV(en)

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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 29.035.20

ISBN 978-2-8322-7287-9

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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FLEXIBLE INSULATING SLEEVING –

Part 3: Specifications for individual types of sleeving – Sheet 216: Heat-shrinkable, flame-retarded, limited-fire-hazard sleeving

FOREWORD

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This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

International Standard IEC 60684-3-216 has been prepared by IEC technical committee 15: Solid electrical insulating materials.

This second edition cancels and replaces the first edition published in 2001, Amendment 1:2005 and Amendment 2:2013. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) the temperature at which the sleeving is shrunk in a forced-air circulation oven for (5 ± 1) min has been increased from (150 ± 5) °C to (200 ± 5) °C.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
15/888/FDIS	15/902/RVD

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

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

A list of all parts in the IEC 60684 series, published under the general title *Flexible insulating sleeving*, can be found on the IEC website.

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

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- withdrawn,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

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

This International Standard is one of a series which deals with flexible insulating sleeving for electrical purposes.

The series consists of three parts:

Part 1: Definitions and general requirements (IEC 60684-1);

Part 2: Methods of test (IEC 60684-2);

Part 3: Specifications for individual types of sleeving (IEC 60684-3).

This document comprises one of the sheets of Part 3 as follows:

Sheet 216: Heat-shrinkable, flame-retarded, limited-fire-hazard sleeving

FLEXIBLE INSULATING SLEEVING –

Part 3: Specifications for individual types of sleeving – Sheet 216: Heat-shrinkable, flame-retarded, limited-fire-hazard sleeving

1 Scope

This ~~sheet~~ part of IEC 60684-3 gives the requirements for four types of heat-shrinkable, flame-retarded, limited-fire-hazard sleeving with a thermal endurance rating of 105 °C as shown below.

Class A:	thin wall	shrink ratio 2:1	internal diameter up to 102,0 mm
Class B:	medium wall	shrink ratio 2:1	internal diameter up to 60,0 mm
Class C:	thick wall	shrink ratio 2:1	internal diameter up to 51,0 mm
Class D:	medium wall	shrink ratio 3:1	internal diameter up to 40,0 mm

These sleevings are normally supplied in the following colours: black, red, green, blue, white, yellow and green/yellow.

Sizes or colours other than those listed in this document ~~may be~~ are available as custom items. These items ~~shall be~~ are considered to comply with this document if they comply with the property requirements listed in Tables 5, 6, 7 and 8, excluding dimensions and mass.

Materials which conform to this specification meet established levels of performance. However, the selection of a material by a user for a specific application ~~should~~ will be based on the actual requirements necessary for adequate performance in that application and not based on this specification alone.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 60684-1:~~1980~~2003, ~~*Specification for*~~ *Flexible insulating sleeving – Part 1: Definitions and general requirements*

IEC 60684-2:~~1997~~2011, *Flexible insulating sleeving – Part 2: Methods of test*

IEC 60757:1983, *Code for designation of colours*

ISO 846:~~1997~~2019, *Plastics – Evaluation of the action of microorganisms*

ISO 1817:~~1999~~2015, *Rubber, vulcanized or thermoplastic – Determination of the effect of liquids* ~~*(available in English only)*~~

3 Terms and definitions

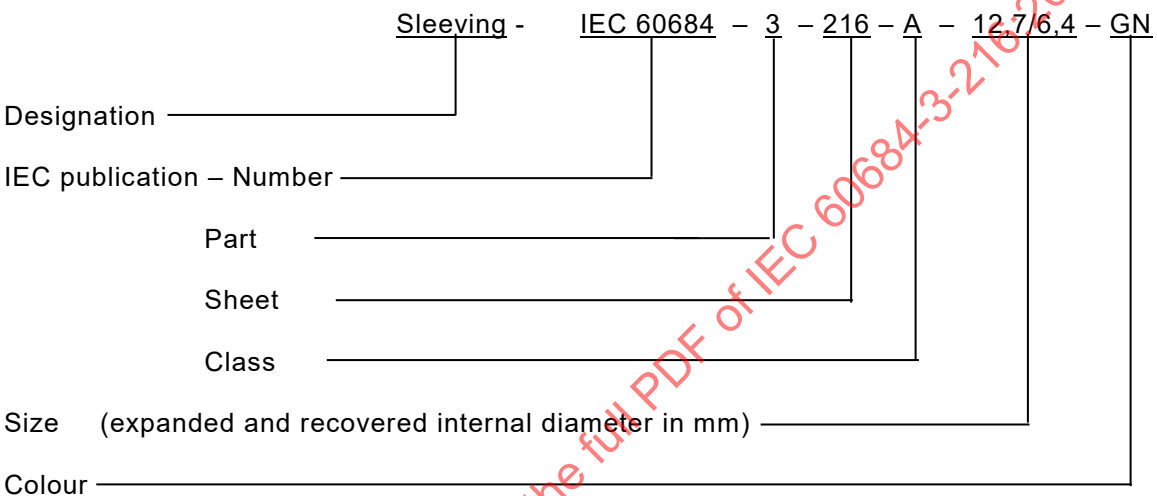
No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

4 Designation

This sleeving shall be identified by the following designation:



Any abbreviation of colour shall comply with IEC 60757. Where no abbreviation is given, the colour shall be written in full.

5 Conditions of test

Unless otherwise specified, the sleeving shall be shrunk in a forced-air circulation oven for (5 ± 1) min at (~~150~~200 ± 5) °C, prior to testing.

6 Requirements

In addition to the general requirements given in IEC 60684-1, the sleeving shall comply with the requirements in Tables 1 through 8.

7 Sleeving conformance

Conformance to the requirements of this specification shall normally be based on the results ~~from~~ for black colour of the following sizes:

- Class A: 12,7 mm/6,4 mm
- Class B: 12,0 mm/6,0 mm
- Class C: 12,7 mm/6,4 mm
- Class D: 18,0 mm/6,0 mm

~~of black colour.~~ The colour fastness to light shall be determined for all colours.

Table 1 – Dimensional and mass requirements – Class A

Size code	Internal diameter mm		Recovered wall thickness mm	Mass per unit length g/m Max.
	Expanded Min.	Recovered Max.		
3,2/1,6	3,2	1,6	0,50 ± 0,10	6,0
4,8/2,4	4,8	2,4	0,50 ± 0,10	8,2
6,4/3,2	6,4	3,2	0,65 ± 0,15	13,5
9,5/4,8	9,5	4,8	0,65 ± 0,15	19,5
12,7/6,4	12,7	6,4	0,65 ± 0,15	25,0
19,0/9,5	19,0	9,5	0,75 ± 0,15	43,0
25,4/12,7	25,4	12,7	0,90 ± 0,15	67,0
38,0/19,0	38,0	19,0	1,00 ± 0,20	112
51,0/25,4	51,0	25,4	1,15 ± 0,25	175
76,0/38,0	76,0	38,0	1,25 ± 0,25	281
102,0/51,0	102,0	51,0	1,40 ± 0,25	404

Table 2 – Dimensional and mass requirements – Class B

Size code	Internal diameter mm		Recovered wall thickness mm	Mass per unit length g/m Max.
	Expanded Min.	Recovered Max.		
3,0/1,5	3,0	1,5	0,70 ± 0,10	8,5
5,0/2,5	5,0	2,5	0,75 ± 0,15	13,5
8,0/4,0	8,0	4,0	0,80 ± 0,15	21,0
12,0/6,0	12,0	6,0	0,90 ± 0,15	33,0
18,0/9,0	18,0	9,0	1,00 ± 0,20	54,0
24,0/12,0	24,0	12,0	1,10 ± 0,20	77,0
40,0/20,0	40,0	20,0	1,30 ± 0,25	146
60,0/30,0	60,0	30,0	1,50 ± 0,30	250

Table 3 – Dimensional and mass requirements – Class C

Size code	Internal diameter mm		Recovered wall thickness mm	Mass per unit length g/m
	Expanded Min.	Recovered Max.		Max.
3,2/1,6	3,2	1,6	0,75 ± 0,15	9,9
4,8/2,4	4,8	2,4	0,85 ± 0,20	15,8
6,4/3,2	6,4	3,2	0,90 ± 0,20	21,0
9,5/4,8	9,5	4,8	1,00 ± 0,20	32,0
12,7/6,4	12,7	6,4	1,20 ± 0,30	53,6
19,0/9,5	19,0	9,5	1,45 ± 0,35	91,6
25,4/12,7	25,4	12,7	1,80 ± 0,45	155
38,0/19,0	38,0	19,0	2,40 ± 0,50	294
51,0/25,4	51,0	25,4	2,80 ± 0,50	435

Table 4 – Dimensional and mass requirements – Class D

Size code	Internal diameter mm		Recovered wall thickness mm	Mass per unit length g/m
	Expanded Min.	Recovered Max.		Max.
3,0/1,0	3,0	1,0	0,60 ± 0,10	5,5
6,0/2,0	6,0	2,0	0,70 ± 0,10	10,5
9,0/3,0	9,0	3,0	0,80 ± 0,15	17,0
12,0/4,0	12,0	4,0	0,85 ± 0,15	23,0
18,0/6,0	18,0	6,0	1,00 ± 0,20	39,0
24,0/8,0	24,0	8,0	1,20 ± 0,20	61,0
40,0/13,0	40,0	13,0	1,25 ± 0,20	98,5

Table 5 – Property requirements *(1 of 3)*

Property	IEC 60684-2 clause or subclause	Units	Max. or Min.	Requirements	Remarks
Dimensions	3				
– internal diameter	3.1.2	mm		Tables 1 to 4	
– wall thickness	3.3.2	mm		Tables 1 to 4	
– concentricity	3.3.3	%	Min.		
• expanded				65	
• recovered				85	
Heat shock	6				Heat the expanded sleeving at (150 ± 5) °C for (5 ± 1) min
– tensile strength	19.1 and 19.2	MPa	Min.	6	
– elongation at break	19.1 and 19.2	%	Min.	100	
Longitudinal change	9	%	Max.	−10 +5	The test is done on expanded sleeving
Bending at low temperature	14	–	–	No cracking shall be visible	Test at −30 °C after conditioning at that temperature for 4 h. For strips, the mandrel shall be between 20 and 22 times the wall thickness. Full section sleeving is tested unfilled and the mandrel shall be between 20 and 22 times the outer diameter

Property	IEC 60684-2 clause or subclause	Units	Max. or Min.	Requirements	Remarks
Dimensional stability during storage	16	–	–	The dimensions shall be as specified in tables 1 to 4	
Tensile strength Elongation at break	19.1 and 19.2 19.1 and 19.2	MPa %	Min. Min.	7 200	Use a jaw separation rate of 100 mm/min. For internal diameters <6,5 mm, use sleeving samples for testing. On 6,5 mm and larger diameter sleeving, use dumb-bell samples cut from the sleeving
Secant modulus at 2 % elongation	19.4	MPa MPa	Min. Max.	40 130	
Breakdown voltage	21	kV	Min.	Table 6	
Volume resistivity – at room temperature – after damp heat	23 23.4.2 23.4.4	 Ωm Ωm	 Min. Min.	 10^{11} 10^{10}	
Flame propagation – Time of burning – Length burned	26 Method C	 s mm	 Max. Max.	 30 75	
Oxygen index – at ambient temperature – at elevated temperature	27 27.1 27.2	 % °C	 Min. Min.	 29 250	
Copper corrosion	33	%	Max.	8	Heat the specimens for (16 ± 0,5) h at (150 ± 3) °C
Colour fastness to light	34			The colour contrast between the exposed and unexposed parts of the specimen shall be equal to or less than that of the fastness standard	Fastness standard 5

Property	IEC 60684-2 clause or subclause	Units	Max. or Min.	Requirements	Remarks
Resistance to selected fluids	36				Use the fluids and test temperatures specified in table 7
– Tensile strength	19.1 and 19.2	MPa	Min.	4	
– Elongation at break	19.1 and 19.2	%	Min.	100	
Thermal endurance Temperature index	37		Min.	105	The test to establish failure shall be elongation to break: the end point shall be 50 % absolute elongation at break
Mass per unit length	38	g/m	Max.	Tables 1 to 4	
Heat ageing	39				Heat at (135 ± 3) °C.
– Tensile strength	19.1 and 19.2	MPa	Min.	5	
– Elongation at break	19.1 and 19.2	%	Min.	150	
Water absorption	40	%	Max.	1,0	
Smoke index	43	–	Max.	20	
Toxicity index	44	–	Max.	5	
Halogen content	45				Expressed as chlorine
	45.1	%	Max.	0,2	
	45.2	%	Max.	0,1	
Acid gas generation	46				
	46.2	pH	Min.	3,5	
		pH	Max.	10,5	
		µS/mm	Max.	10,0	

Property	IEC 60684-2:2011 clause or subclause	Units	Max. or Min.	Requirements	Remarks
Dimensions	3				
– internal diameter	3.1.2	mm		Tables 1 to 4	
– wall thickness	3.3.2	mm		Tables 1 to 4	
– concentricity	3.3.3	%	Min.		
• expanded				65	
• recovered				85	
Heat shock	6				Heat the expanded sleeving at (150 ± 5) °C for (5 ± 1) min
– tensile strength	19.2 and 19.3	MPa	Min.	6	Use a jaw separation rate of 100 mm/min. For internal diameters < 6,5 mm, use sleeving samples for testing. On 6,5 mm and larger diameter sleeving, use dumb-bell samples cut from the sleeving
– elongation at break	19.2 and 19.3	%	Min.	100	
Longitudinal change	9	%	Max.	–10 +5	The test is done on expanded sleeving
Bending at low temperature	14	–	–	No cracking shall be visible	Test at –30 °C after conditioning at that temperature for 4 h. For strips, the mandrel shall be between 20 times and 22 times the wall thickness. Full section sleeving is tested unfilled and the mandrel shall be between 20 times and 22 times the outer diameter

Table 5 *(2 of 3)*

Property	IEC 60684-2:2011 clause or subclause	Units	Max. or Min.	Requirements	Remarks
Dimensional stability on storage	16	–	–	The dimensions shall be as specified in Tables 1 to 4	
Tensile strength Elongation at break	19.2 and 19.3 19.2 and 19.3	MPa %	Min. Min.	7 200	Use a jaw separation rate of 100 mm/min. For internal diameters < 6,5 mm, use sleeving samples for testing. On 6,5 mm and larger diameter sleeving, use dumb-bell samples cut from the sleeving
Secant modulus at 2 % elongation	19.5	MPa MPa	Min. Max.	40 130	
Breakdown voltage	21.2	kV	Min.	Table 6	
Volume resistivity – at room temperature – after damp heat	23 23.5.2 23.5.4	 Ωm Ωm	 Min. Min.	 10^{10} 10^{9}	
Flame propagation – Time of burning – Length burned	26 Method C	 s mm	 Max. Max.	 30 75	
Oxygen index – at ambient temperature – at elevated temperature	27 27.1 27.2	 % °C	 Min. Min.	 29 250	
Copper corrosion	33	%	Max.	8	Heat the specimens for (16 ± 0,5) h at (150 ± 3) °C
Colour fastness to light	34			The colour contrast between the exposed and unexposed parts of the specimen shall be equal to or less than that of the fastness standard	Fastness standard 5

Table 5 *(3 of 3)*

Property	IEC 60684-2:2011 clause or subclause	Units	Max. or Min.	Requirements	Remarks
Resistance to selected fluids	36				Use the fluids and test temperatures specified in Table 7
– Tensile strength	19.2 and 19.3	MPa	Min.	4	
– Elongation at break	19.2 and 19.3	%	Min.	100	Use a jaw separation rate of 100 mm/min. For internal diameters < 6,5 mm, use sleeving samples for testing. On 6,5 mm and larger diameter sleeving, use dumb-bell samples cut from the sleeving
Long term heat ageing	50 -	%	Min.	100	Ageing temperature shall be 105 °C ± 3 K
Elongation at break	19.2 and 19.3				Use a jaw separation rate of 100 mm/min. For internal diameters < 6,5 mm, use sleeving samples for testing. On 6,5 mm and larger diameter sleeving, use dumb-bell samples cut from the sleeving
Mass per unit length	38	g/m	Max.	Tables 1 to 4	
Heat ageing	39				Heat at (135 ± 3) °C.
– Tensile strength	19.2 and 19.32	MPa	Min.	5	
– Elongation at break	19.2 and 19.3	%	Min.	150	Use a jaw separation rate of 100 mm/min. For internal diameters < 6,5 mm, use sleeving samples for testing. On 6,5 mm and larger diameter sleeving, use dumb-bell samples cut from the sleeving
Water absorption	40	%	Max.	1,0	
Smoke index	43	–	Max.	20	
Toxicity index	44	–	Max.	5	
Halogen content	45				Expressed as chlorine
	45.1	%	Max.	0,2	
	45.2	%	Max.	0,1	
Acid gas generation	46				
	46.2	pH	Min.	3,5	
		pH	Max.	10,5	
		µS/mm	Max.	10,0	

The breakdown voltage shall be determined by any of the methods described in 21.2, 21.3 or 21.4 of IEC 60684-2:2011. The central value shall comply with the minimum value in Table 6.

The rate of application of the voltage shall be 500 V/s.

Table 6 – Requirements for breakdown voltage

Nominal recovered wall thickness mm	Breakdown voltage Min. kV
0,50	7,0
0,60	9,0
0,65	9,7
0,70	10,5
0,75	11,2
0,80	12,0
0,85	12,7
0,90	13,5
1,00	15,0
1,10	16,5
1,15	17,2
1,20	18,0
1,25	18,7
1,30	19,5
1,40	21,0
1,45	21,7
1,50	22,5
1,80	27,0
2,40	36,0
2,80	42,0
~~NOTE~~ For non-standard wall thicknesses, the breakdown voltage shall be at least that of the next smaller wall thickness. For wall thicknesses less than 0,50 mm, the dielectric strength shall be at least 15,0 kV/mm.	

Table 7 – Resistance to selected fluids

Fluids	Type	Standard or symbol	Immersion temperature (±2 °C)
Fuels	Gasoline	ISO 1817 liquid B	23
	Kerosene	ISO 1817 liquid F	23
Hydraulic fluids	Phosphate base	ISO 1817 fluid 103	23
	Silicone base	S-1714 [a]	23
	Mineral base	H-520 [a]	23
Oils	Synthetic base	ISO 1817 liquid 101	23
	Mineral base	ISO 1817 oil No. 2	23
	Mineral base	O-1176 [a]	23
	Mineral base	O-142 [a]	23
Cleaning fluids	Solvent	Isopropyl alcohol	23
		Propanol 25 % White spirit 75 %	23
		Methylethylketone	23
De-icing fluids	Runway de-icers	Inhibited potassium acetate in water, 50 %	23
	Aircraft de-icers	Ethylene glycol 80 % Water 20 %	23

[a] These are commercially available fluids identified in aviation fluid guides. Other fluids and/or temperatures may be specified for customers with specific needs. These additional fluids and/or temperatures shall be applicable when incorporated into agreements between the supplier and the customer.

Table 8 – Additional property requirements

Property	IEC 60684-2:2011 clause or subclause	Units	Max. or Min.	Requirement	Remarks
Fungus resistance – Tensile strength – Elongation	19.~~1~~2 and 19.3	 MPa %	 Min. Min.	 7 200	The test method shall be ISO 846 method B. 56 days exposure Use a jaw separation rate of 100 mm/min. For internal diameters < 6,5 mm, use sleeving samples for testing. On 6,5 mm and larger diameter sleeving, use dumb-bell samples cut from the sleeving
Shelf life [a]	–	–	–	The dimensions shall be as specified in Tables 1 to 4	Condition the sleeving for 60 months at ambient temperature prior to testing. Interim measurements are to be made every 12 months

[a] Due to the length of time required for this test, lack of completion shall not preclude certification to this specification. Additional evidence of compliance with this requirement in the interim shall be as agreed between the supplier and/or the approval authority and/or customer.

Bibliography

IEC 60684-3 (all sheets), *Flexible insulating sleeving – Part 3: Specifications for individual types of sleeving*

IEC 60684-3-216

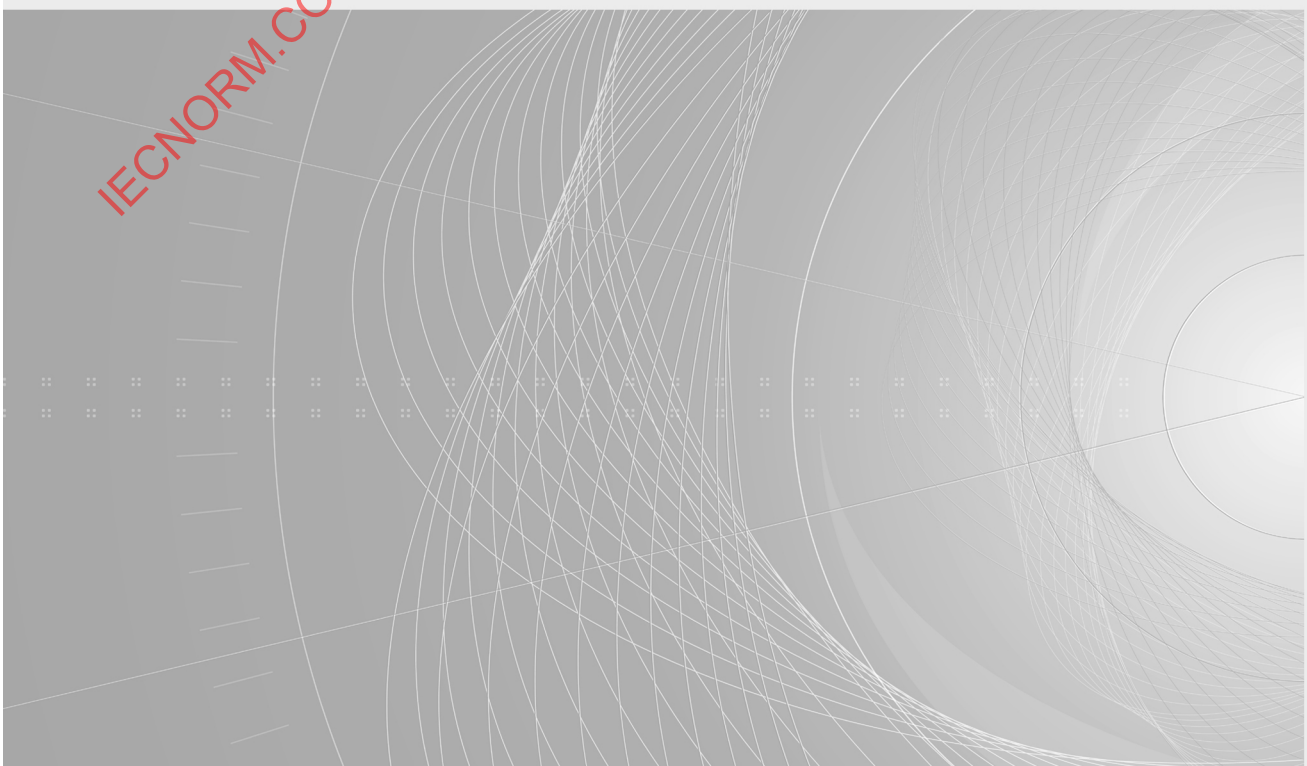
Edition 2.0 2019-08

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Flexible insulating sleeving –
Part 3: Specifications for individual types of sleeving –
Sheet 216: Heat-shrinkable, flame-retarded, limited-fire-hazard sleeving

Gaines isolantes souples –
Partie 3: Spécifications pour types particuliers de gaines –
Feuille 216: Gaines thermorétractables, ignifugées, au risque de feu limité



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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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FLEXIBLE INSULATING SLEEVING –

Part 3: Specifications for individual types of sleeving – Sheet 216: Heat-shrinkable, flame-retarded, limited-fire-hazard sleeving

FOREWORD

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International Standard IEC 60684-3-216 has been prepared by IEC technical committee 15: Solid electrical insulating materials.

This second edition cancels and replaces the first edition published in 2001, Amendment 1:2005 and Amendment 2:2013. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) the temperature at which the sleeving is shrunk in a forced-air circulation oven for (5 ± 1) min has been increased from (150 ± 5) °C to (200 ± 5) °C.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
15/888/FDIS	15/902/RVD

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

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

A list of all parts in the IEC 60684 series, published under the general title *Flexible insulating sleeving*, can be found on the IEC website.

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

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

INTRODUCTION

This International Standard is one of a series which deals with flexible insulating sleeving for electrical purposes.

The series consists of three parts:

Part 1: Definitions and general requirements (IEC 60684-1);

Part 2: Methods of test (IEC 60684-2);

Part 3: Specifications for individual types of sleeving (IEC 60684-3).

This document comprises one of the sheets of Part 3 as follows:

Sheet 216: Heat-shrinkable, flame-retarded, limited-fire-hazard sleeving

FLEXIBLE INSULATING SLEEVING –

Part 3: Specifications for individual types of sleeving – Sheet 216: Heat-shrinkable, flame-retarded, limited-fire-hazard sleeving

1 Scope

This part of IEC 60684-3 gives the requirements for four types of heat-shrinkable, flame-retarded, limited-fire-hazard sleeving with a thermal endurance rating of 105 °C as shown below.

Class A:	thin wall	shrink ratio 2:1	internal diameter up to 102,0 mm
Class B:	medium wall	shrink ratio 2:1	internal diameter up to 60,0 mm
Class C:	thick wall	shrink ratio 2:1	internal diameter up to 51,0 mm
Class D:	medium wall	shrink ratio 3:1	internal diameter up to 40,0 mm

These sleevings are normally supplied in the following colours: black, red, green, blue, white, yellow and green/yellow.

Sizes or colours other than those listed in this document are available as custom items. These items are considered to comply with this document if they comply with the property requirements listed in Tables 5, 6, 7 and 8, excluding dimensions and mass.

Materials which conform to this specification meet established levels of performance. However, the selection of a material by a user for a specific application will be based on the actual requirements necessary for adequate performance in that application and not based on this specification alone.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 60684-1:2003, *Flexible insulating sleeving – Part 1: Definitions and general requirements*

IEC 60684-2:2011, *Flexible insulating sleeving – Part 2: Methods of test*

IEC 60757:1983, *Code for designation of colours*

ISO 846:2019, *Plastics – Evaluation of the action of microorganisms*

ISO 1817:2015, *Rubber, vulcanized or thermoplastic – Determination of the effect of liquids*

3 Terms and definitions

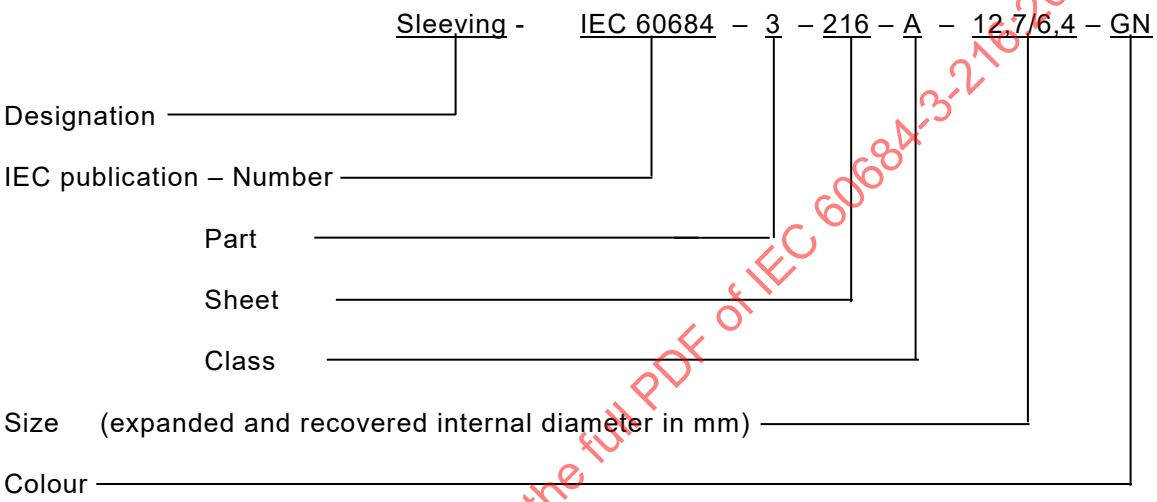
No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

4 Designation

This sleeving shall be identified by the following designation:



Any abbreviation of colour shall comply with IEC 60757. Where no abbreviation is given, the colour shall be written in full.

5 Conditions of test

Unless otherwise specified, the sleeving shall be shrunk in a forced-air circulation oven for (5 ± 1) min at (200 ± 5) °C, prior to testing.

6 Requirements

In addition to the general requirements given in IEC 60684-1, the sleeving shall comply with the requirements in Tables 1 through 8.

7 Sleeving conformance

Conformance to the requirements of this specification shall normally be based on the results for black colour of the following sizes:

- Class A: 12,7 mm/6,4 mm
- Class B: 12,0 mm/6,0 mm
- Class C: 12,7 mm/6,4 mm
- Class D: 18,0 mm/6,0 mm

The colour fastness to light shall be determined for all colours.

Table 1 – Dimensional and mass requirements – Class A

Size code	Internal diameter mm		Recovered wall thickness mm	Mass per unit length g/m Max.
	Expanded Min.	Recovered Max.		
3,2/1,6	3,2	1,6	0,50 ± 0,10	6,0
4,8/2,4	4,8	2,4	0,50 ± 0,10	8,2
6,4/3,2	6,4	3,2	0,65 ± 0,15	13,5
9,5/4,8	9,5	4,8	0,65 ± 0,15	19,5
12,7/6,4	12,7	6,4	0,65 ± 0,15	25,0
19,0/9,5	19,0	9,5	0,75 ± 0,15	43,0
25,4/12,7	25,4	12,7	0,90 ± 0,15	67,0
38,0/19,0	38,0	19,0	1,00 ± 0,20	112
51,0/25,4	51,0	25,4	1,15 ± 0,25	175
76,0/38,0	76,0	38,0	1,25 ± 0,25	281
102,0/51,0	102,0	51,0	1,40 ± 0,25	404

Table 2 – Dimensional and mass requirements – Class B

Size code	Internal diameter mm		Recovered wall thickness mm	Mass per unit length g/m Max.
	Expanded Min.	Recovered Max.		
3,0/1,5	3,0	1,5	0,70 ± 0,10	8,5
5,0/2,5	5,0	2,5	0,75 ± 0,15	13,5
8,0/4,0	8,0	4,0	0,80 ± 0,15	21,0
12,0/6,0	12,0	6,0	0,90 ± 0,15	33,0
18,0/9,0	18,0	9,0	1,00 ± 0,20	54,0
24,0/12,0	24,0	12,0	1,10 ± 0,20	77,0
40,0/20,0	40,0	20,0	1,30 ± 0,25	146
60,0/30,0	60,0	30,0	1,50 ± 0,30	250

Table 3 – Dimensional and mass requirements – Class C

Size code	Internal diameter mm		Recovered wall thickness mm	Mass per unit length g/m Max.
	Expanded Min.	Recovered Max.		
3,2/1,6	3,2	1,6	0,75 ± 0,15	9,9
4,8/2,4	4,8	2,4	0,85 ± 0,20	15,8
6,4/3,2	6,4	3,2	0,90 ± 0,20	21,0
9,5/4,8	9,5	4,8	1,00 ± 0,20	32,0
12,7/6,4	12,7	6,4	1,20 ± 0,30	53,6
19,0/9,5	19,0	9,5	1,45 ± 0,35	91,6
25,4/12,7	25,4	12,7	1,80 ± 0,45	155
38,0/19,0	38,0	19,0	2,40 ± 0,50	294
51,0/25,4	51,0	25,4	2,80 ± 0,50	435

Table 4 – Dimensional and mass requirements – Class D

Size code	Internal diameter mm		Recovered wall thickness mm	Mass per unit length g/m Max.
	Expanded Min.	Recovered Max.		
3,0/1,0	3,0	1,0	0,60 ± 0,10	5,5
6,0/2,0	6,0	2,0	0,70 ± 0,10	10,5
9,0/3,0	9,0	3,0	0,80 ± 0,15	17,0
12,0/4,0	12,0	4,0	0,85 ± 0,15	23,0
18,0/6,0	18,0	6,0	1,00 ± 0,20	39,0
24,0/8,0	24,0	8,0	1,20 ± 0,20	61,0
40,0/13,0	40,0	13,0	1,25 ± 0,20	98,5

Table 5 – Property requirements *(1 of 3)*

Property	IEC 60684-2:2011 clause or subclause	Units	Max. or Min.	Requirements	Remarks
Dimensions – internal diameter – wall thickness – concentricity • expanded • recovered	3 3.1.2 3.3.2 3.3.3	 mm mm %	 Min.	 Tables 1 to 4 Tables 1 to 4 65 85	
Heat shock – tensile strength – elongation at break	6 19.2 and 19.3 19.2 and 19.3	 MPa %	 Min. Min.	 6 100	Heat the expanded sleeving at (150 ± 5) °C for (5 ±1) min Use a jaw separation rate of 100 mm/min. For internal diameters < 6,5 mm, use sleeving samples for testing. On 6,5 mm and larger diameter sleeving, use dumb-bell samples cut from the sleeving
Longitudinal change	9	%	Max.	$^{-10}_{+5}$	The test is done on expanded sleeving
Bending at low temperature	14	–	–	No cracking shall be visible	Test at –30 °C after conditioning at that temperature for 4 h. For strips, the mandrel shall be between 20 times and 22 times the wall thickness. Full section sleeving is tested unfilled and the mandrel shall be between 20 times and 22 times the outer diameter

Table 5 *(2 of 3)*

Property	IEC 60684-2:2011 clause or subclause	Units	Max. or Min.	Requirements	Remarks
Dimensional stability on storage	16	–	–	The dimensions shall be as specified in Tables 1 to 4	
Tensile strength Elongation at break	19.2 and 19.3 19.2 and 19.3	MPa %	Min. Min.	7 200	Use a jaw separation rate of 100 mm/min. For internal diameters < 6,5 mm, use sleeving samples for testing. On 6,5 mm and larger diameter sleeving, use dumb-bell samples cut from the sleeving
Secant modulus at 2 % elongation	19.5	MPa MPa	Min. Max.	40 130	
Breakdown voltage	21.2	kV	Min.	Table 6	
Volume resistivity – at room temperature – after damp heat	23 23.5.2 23.5.4	 Ωm Ωm	 Min. Min.	 10^{10} 10^{9}	
Flame propagation – Time of burning – Length burned	26 Method C	 s mm	 Max. Max.	 30 75	
Oxygen index – at ambient temperature – at elevated temperature	27 27.1 27.2	 % °C	 Min. Min.	 29 250	
Copper corrosion	33	%	Max.	8	Heat the specimens for (16 ± 0,5) h at (150 ± 3) °C
Colour fastness to light	34			The colour contrast between the exposed and unexposed parts of the specimen shall be equal to or less than that of the fastness standard	Fastness standard 5

Table 5 *(3 of 3)*

Property	IEC 60684-2:2011 clause or subclause	Units	Max. or Min.	Requirements	Remarks
Resistance to selected fluids	36				Use the fluids and test temperatures specified in Table 7
– Tensile strength	19.2 and 19.3	MPa	Min.	4	
– Elongation at break	19.2 and 19.3	%	Min.	100	Use a jaw separation rate of 100 mm/min. For internal diameters < 6,5 mm, use sleeving samples for testing. On 6,5 mm and larger diameter sleeving, use dumb-bell samples cut from the sleeving
Long term heat ageing	50 -	%	Min.	100	Ageing temperature shall be 105 °C ± 3 K
Elongation at break	19.2 and 19.3				Use a jaw separation rate of 100 mm/min. For internal diameters < 6,5 mm, use sleeving samples for testing. On 6,5 mm and larger diameter sleeving, use dumb-bell samples cut from the sleeving
Mass per unit length	38	g/m	Max.	Tables 1 to 4	
Heat ageing	39				Heat at (135 ± 3) °C.
– Tensile strength	19.2 and 19.32	MPa	Min.	5	
– Elongation at break	19.2 and 19.3	%	Min.	150	Use a jaw separation rate of 100 mm/min. For internal diameters < 6,5 mm, use sleeving samples for testing. On 6,5 mm and larger diameter sleeving, use dumb-bell samples cut from the sleeving
Water absorption	40	%	Max.	1,0	
Smoke index	43	–	Max.	20	
Toxicity index	44	–	Max.	5	
Halogen content	45				Expressed as chlorine
	45.1	%	Max.	0,2	
	45.2	%	Max.	0,1	
Acid gas generation	46				
	46.2	pH	Min.	3,5	
		pH	Max.	10,5	
		µS/mm	Max.	10,0	

The breakdown voltage shall be determined by any of the methods described in 21.2, 21.3 or 21.4 of IEC 60684-2:2011. The central value shall comply with the minimum value in Table 6.

The rate of application of the voltage shall be 500 V/s.

Table 6 – Requirements for breakdown voltage

Nominal recovered wall thickness mm	Breakdown voltage Min. kV
0,50	7,0
0,60	9,0
0,65	9,7
0,70	10,5
0,75	11,2
0,80	12,0
0,85	12,7
0,90	13,5
1,00	15,0
1,10	16,5
1,15	17,2
1,20	18,0
1,25	18,7
1,30	19,5
1,40	21,0
1,45	21,7
1,50	22,5
1,80	27,0
2,40	36,0
2,80	42,0
For non-standard wall thicknesses, the breakdown voltage shall be at least that of the next smaller wall thickness. For wall thicknesses less than 0,50 mm, the dielectric strength shall be at least 15,0 kV/mm.	

Table 7 – Resistance to selected fluids

Fluids	Type	Standard or symbol	Immersion temperature (±2 °C)
Fuels	Gasoline	ISO 1817 liquid B	23
	Kerosene	ISO 1817 liquid F	23
Hydraulic fluids	Phosphate base	ISO 1817 fluid 103	23
	Silicone base	S-1714 [a]	23
	Mineral base	H-520 [a]	23
Oils	Synthetic base	ISO 1817 liquid 101	23
	Mineral base	ISO 1817 oil No. 2	23
	Mineral base	O-1176 [a]	23
	Mineral base	O-142 [a]	23
Cleaning fluids	Solvent	Isopropyl alcohol	23
		Propanol 25 % White spirit 75 %	23
		Methylethylketone	23
De-icing fluids	Runway de-icers	Inhibited potassium acetate in water, 50 %	23
	Aircraft de-icers	Ethylene glycol 80 % Water 20 %	23

[a] These are commercially available fluids identified in aviation fluid guides. Other fluids and/or temperatures may be specified for customers with specific needs. These additional fluids and/or temperatures shall be applicable when incorporated into agreements between the supplier and the customer.

Table 8 – Additional property requirements

Property	IEC 60684-2:2011 clause or subclause	Units	Max. or Min.	Requirement	Remarks
Fungus resistance – Tensile strength – Elongation	19.2 and 19.3	 MPa %	 Min. Min.	 7 200	The test method shall be ISO 846 method B. 56 days exposure Use a jaw separation rate of 100 mm/min. For internal diameters < 6,5 mm, use sleeving samples for testing. On 6,5 mm and larger diameter sleeving, use dumb-bell samples cut from the sleeving
Shelf life [a]	–	–	–	The dimensions shall be as specified in Tables 1 to 4	Condition the sleeving for 60 months at ambient temperature prior to testing. Interim measurements are to be made every 12 months

[a] Due to the length of time required for this test, lack of completion shall not preclude certification to this specification. Additional evidence of compliance with this requirement in the interim shall be as agreed between the supplier and/or the approval authority and/or customer.

Bibliography

IEC 60684-3 (all sheets), *Flexible insulating sleeving – Part 3: Specifications for individual types of sleeving*

SOMMAIRE

COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

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GAINES ISOLANTES SOUPLES –

Partie 3: Spécifications pour types particuliers de gaines – Feuille 216: Gaines thermorétractables, ignifugées, au risque de feu limité

AVANT-PROPOS

1) La Commission Electrotechnique Internationale (IEC) est une organisation mondiale de normalisation composée de l'ensemble des comités électrotechniques nationaux (Comités nationaux de l'IEC). L'IEC a pour objet de favoriser la coopération internationale pour toutes les questions de normalisation dans les domaines de l'électricité et de l'électronique. A cet effet, l'IEC – entre autres activités – publie des Normes internationales, des Spécifications techniques, des Rapports techniques, des Spécifications accessibles au public (PAS) et des Guides (ci-après dénommés "Publication(s) de l'IEC"). Leur élaboration est confiée à des comités d'études, aux travaux desquels tout Comité national intéressé par le sujet traité peut participer. Les organisations internationales, gouvernementales et non gouvernementales, en liaison avec l'IEC, participent également aux travaux. L'IEC collabore étroitement avec l'Organisation Internationale de Normalisation (ISO), selon des conditions fixées par accord entre les deux organisations.
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La Norme internationale IEC 60684-3-216 a été établie par le comité d'études 15 de l'IEC: Matériaux isolants électriques solides.

Cette deuxième édition annule et remplace la première édition parue en 2001, l'Amendement 1:2005 et l'Amendement 2:2013. Cette édition constitue une révision technique.

Cette édition inclut la modification technique majeure suivante par rapport à l'édition précédente:

a) la température à laquelle les gaines sont rétreintes dans une étuve à circulation d'air forcée pendant (5 ± 1) min a été augmentée de (150 ± 5) °C à (200 ± 5) °C.

Le texte de cette Norme internationale est issu des documents suivants:

FDIS	Rapport de vote
15/888/FDIS	15/902/RVD

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à l'approbation de cette Norme internationale.

Ce document a été rédigé selon les Directives ISO/IEC, Partie 2.

Une liste de toutes les parties de la série IEC 60684, publiées sous le titre général *Gaines isolantes souples*, peut être consultée sur le site web de l'IEC.

Le comité a décidé que le contenu de ce document ne sera pas modifié avant la date de stabilité indiquée sur le site web de l'IEC sous "http://webstore.iec.ch" dans les données relatives au document recherché. A cette date, le document sera

- reconduit,
- supprimé,
- remplacé par une édition révisée, ou
- amendé.

INTRODUCTION

La présente Norme internationale fait partie d'une série traitant des gaines isolantes souples à usages électriques.

Cette série est constituée de trois parties:

Partie 1: Définitions et exigences générales (IEC 60684-1);

Partie 2: Méthodes d'essai (IEC 60684-2);

Partie 3: Spécifications pour types particuliers de gaines (IEC 60684-3).

Le présent document contient l'une des feuilles qui composent la Partie 3, comme suit:

Feuille 216: Gaines thermorétractables, ignifugées, au risque de feu limité

GAINES ISOLANTES SOUPLES –

Partie 3: Spécifications pour types particuliers de gaines – Feuille 216: Gaines thermorétractables, ignifugées, au risque de feu limité

1 Domaine d'application

La présente partie de l'IEC 60684-3 donne les exigences relatives à quatre types de gaines thermorétractables, ignifugées, au risque de feu limité, ayant un indice d'endurance thermique de 105 °C, comme cela est indiqué ci-dessous.

Classe A:	paroi mince	rapport de rétreint 2:1	diamètre intérieur allant jusqu'à 102,0 mm
Classe B:	paroi moyenne	rapport de rétreint 2:1	diamètre intérieur allant jusqu'à 60,0 mm
Classe C:	paroi épaisse	rapport de rétreint 2:1	diamètre intérieur allant jusqu'à 51,0 mm
Classe D:	paroi moyenne	rapport de rétreint 3:1	diamètre intérieur allant jusqu'à 40,0 mm

Ces gaines sont normalement disponibles dans les couleurs suivantes: noir, rouge, vert, bleu, blanc, jaune et vert/jaune.

Des dimensions et des couleurs autres que celles indiquées dans le présent document sont disponibles comme articles spéciaux. Ces articles sont considérés comme conformes au présent document s'ils satisfont aux exigences relatives aux propriétés indiquées dans les Tableaux 5, 6, 7 et 8, à l'exception des dimensions et de la masse.

Les matériaux qui sont conformes à la présente spécification satisfont à des niveaux de performances établis. Cependant, le choix d'un matériau par un utilisateur, pour une application spécifique, est fondé sur les exigences réelles nécessaires pour obtenir des performances adéquates pour l'application concernée, et n'est pas fondé sur cette seule spécification.

2 Références normatives

Les documents suivants sont cités dans le texte de sorte qu'ils constituent, pour tout ou partie de leur contenu, des exigences du présent document. Pour les références datées, seule l'édition citée s'applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

IEC 60684-1:2003, *Spécification pour gaines isolantes souples – Partie 1: Définitions et exigences générales.*

IEC 60684-2:2011, *Gaines isolantes souples – Partie 2: Méthodes d'essai*

IEC 60757:1983, *Code de désignation de couleurs*

ISO 846:2019, *Plastiques – Évaluation de l'action des micro-organismes*

ISO 1817:2015, *Caoutchouc vulcanisé ou thermoplastique – Détermination de l'action des liquides*