

# Low Smoke 0-Halogen Flame-retardant Identification Sleeves

## TECHNICAL DATA SHEET

Revision Number. 1.4  
Last Edited 27. apr.2022



The ZH heat Shrinkable Wire Markers are made of halogen-free, flame retardant and low smoke heat shrinkable polyolefin tubing with ideal printability properties where limited fire hazard and low smoke characteristics are required.

The zero halogen material coupled with low smoke and low toxic fume emissions makes this product ideal in enclosed spaces such as mass transit, marine and industrial installations. ZH meets the NFPA 130 Standard and EN 60684-3-216. Test report available. The ZH material is classified with EN45545-2 Class HL3 requirement set R22 (interior) - R23 (exterior) and R24.

The ZH material can be used without any restriction for any railway application using the standards above.

## Industries



Industry



Marine



Wind power



Commercial



Aerospace



Construction



Railway



Military



Electrical installations



Petrochemical



Telecom

### STANDARD TUBE COLORS



### TUBE COLORS ON REQUEST



### BACKING TAPE COLORS



### MATERIAL

Extruded, cross linked polyolefin.

### SHRINK RATIO

2:1

### OPERATING TEMPERATURE

-55°C up to +105°C

(-67°F to 221°F)

Shrink Temperature

≥90° (194°F)

### COMPLIANCES

Mark Permanence:

SAE AS-5942 (FTI-X & FTI-HXX)

LUL 3349 (FTI-X)

Print Resistance to solvents:

MIL-STD-202

Test method 215

(FTI-X & FTI-HXX)

### RECOMMENDED BLACK RIBBONS

FTI-X, FTI-HXX

### ALTERNATIVE RIBBONS

FTI-Y, FTI-HX

### RECOMMENDED WHITE RIBBON

FTI-HLD-CO-WE

### LASER PRINT

UV lasers 355nm

### INDUSTRY STANDARDS

EN 60684-3-216

EN45545-2 Class HL3 R22-23-R24

NFPA 130

NF F 16-101

London Underground

1-085 A3

BOEING BSS 7239

UNI CEI 11170-3 (LR4)

DIN 5510-2

BS6853: 1999 vehicle category 1a

### STORAGE

Cool and dry in original packaging. Recommended temperature at +10°C to +25°C and 45-55% relative humidity. Use within 2 years from date of manufacture.

### APPLICATIONS

Specifically developed for the industries marked in green to the left. Can also be used for insulation, wire bundling and mechanical protection.

# General Tests for Identification Products

## PHYSICAL

PROPERTIES	TEST METHOD	TYPICAL VALUE
Tensile strength	ASTM D 638	10.0 N/mm <sup>2</sup> .
Elongation at break	ASTM D 638	≥200%
Longitudinal change	ASTM D 2671	-10% to +5%
Water absorption	ASTM D 570	≤ 0,15%
Specific gravity	ASTM D 792	1,40

## ELECTRICAL

PROPERTIES	TEST METHOD	TYPICAL VALUE
Dielectric strength	ASTM D 2671	20.0 kV/mm <sup>2</sup>
Volume resistivity	ASTM D 257	≥ 10 <sup>14</sup> Ω/cm

## CHEMICAL

PROPERTIES	TEST METHOD	TYPICAL VALUE
Chemical resistance	EN 60684-2-36	Good - Pass
Copper corrosion	EN 60684-2-33	No chemical interaction: PASS
Copper stability	N-A	N-A

## THERMAL

PROPERTIES	TEST METHOD	TYPICAL VALUE
Heat shock 4 hours at 175°C	ASTM D 2671	No dripping, cracking or flowing
Heat aging 168 hours at 150°C	ASTM D 638	Elongation ≥ 100%
Flammability	ASTM D 2671 Procedure C	Pass » flame retardant
Low temperature flexibility / Bending	1h at - 55°C EN 60684-2	No cracking, no break, no detachment of coating
Optical density of smoke (D <sub>s</sub> )	ASTM E 662	Flaming mode 41 , non flaming mode 111
Smoke index	NF F 16-101	Smoke class F1
Surface Flammability of Materials - Flame Spread Index - Tested on 19.1 mm sleeve.	ASTM E 162	Specified Maximum = 35
Heat and visible smoke release rate	ASTM E 1354	Average Heat Release Rate & Average specific Extinguishing area M <sup>2</sup> / kg at 3 minutes is measured
Generation of Toxic gases 3x3 inches sample burning in controlled settings	BSS 7239	Toxicity for CO, HF, HCN, HCl, SO <sub>2</sub> and NO <sub>x</sub> in Combustion Gases

## FIRE PROPAGATION COMPARISON

NORMATIVES	TOXICITY	LOW OXYGEN INDEX (LOI)	SMOKE DENSITY	FLAMMABILITY SPREAD INDEX	CAPACITY OF FORMING DROPS
EN45545-2	HL3	HL3	HL3	-	-
NF F 16 101	-	-	Class F1	Class I4	-
BS 6853 - Superseded	1a	1a	1a	-	-
DIN 5510-2	Pass	-	SR2	-	ST1
NFPA130	Pass	-	Pass	Pass	-
UNI CEI 11170-3	LR4	LR4	-	LR4	-

## Fire behavior Standard Classification for Identification Products

STANDARDS	CLASSIFICATION	USAGE
EN 45545-2 (R22 - R23 - R24)	HL3	Unlimited Usage All Vehicles
BS6853	1a	Unlimited Usage All Vehicles
UNI CEI 11170-3	LR4	Unlimited Usage All Vehicles
DIN 5510-2	SR2, ST1	Usage Limited
NF F 16-101	F1 & I4	Usage Limited to External Vehicles
NFPA 130	National Fire Protection Association	Usage Permitted upon agreement with end user
BSS 7239	Boeing	Usage Permitted upon agreement with end user

## Compliance on fire behavior for Identification Products

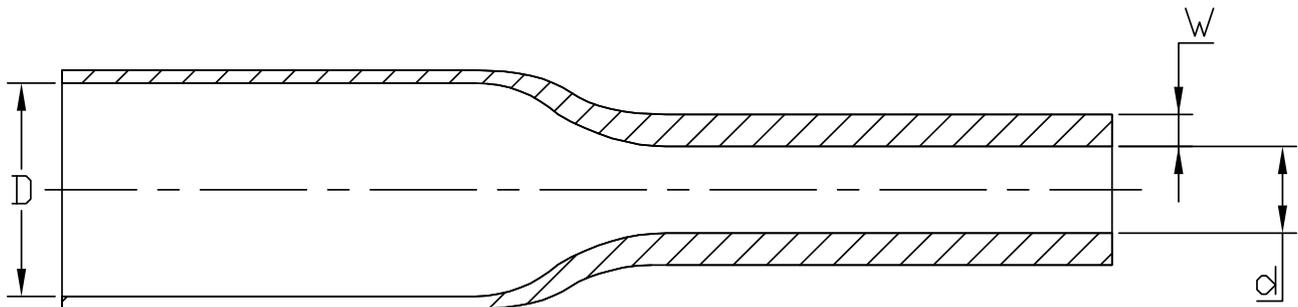
### TEST METHOD

STANDARDS	FLAME PROPAGATION FLAME SPREAD INDEX	TOXICITY	SMOKE OPTICAL DENSITY	LOW OXYGEN INDEX	HEAT AND VISIBLE SMOKE RELEASE
<b>BS6853</b>		BS 6853 appendix B1 or NF X-70-100	BS 6853 D8.3	ISO 4589-2	
<b>NF F-16 101</b>	NF EN 60-695-2	NF X 70-100	NF X 10-702-1 & 2	ISO 4589-2	
<b>NFPA130</b>	ASTM E 162	BSS 7239	ASTM E 662	N/A	ASTM E 1354
<b>EN 45545-2</b>		NF X 70-100 600°C	EN ISO 5659-2	ISO 4589-2	
<b>DIN 5510-2</b>	DIN 54837	DIN ISO 5510-2	DIN 54837		

# Product Dimensions

## DIMENSIONS 2:1

SIZE, INCHES	SIZE, MM	MINIMUM ID (D), AS SUPPLIED MM (INCHES)	MAXIMUM ID, RECOVERED (D) MM (INCHES)	RECOVERED WALL THICKNESS (W), MM (INCHES)
3/32	2.4	2.5 (0.098)	1.2 (0.047)	0.43 (0.017)
1/8	3.2	3.6 (0.142)	1.6 (0.063)	0.55 (0.022)
3/16	4.8	5.2 (0.189)	2.4 (0.094)	0.55 (0.022)
1/4	6.4	6.7 (0.263)	3.2 (0.126)	0.65 (0.025)
3/8	9.5	10.0 (0.393)	4.8 (0.189)	0.65 (0.025)
1/2	12.7	13.6 (0.53)	6.4 (0.250)	0.65 (0.025)
3/4	19.1	20.4 (0.80)	9.5 (0.374)	0.70 (0.027)
1	25.4	27.0 (1.06)	12.7 (0.500)	0.85(0.033)
1 ½	38.1	40.0 (1.57)	19.1 (0.750)	0.90(0.035)
2	50.8	50.8 (2)	25.4 (1.0)	0.90(0.035)

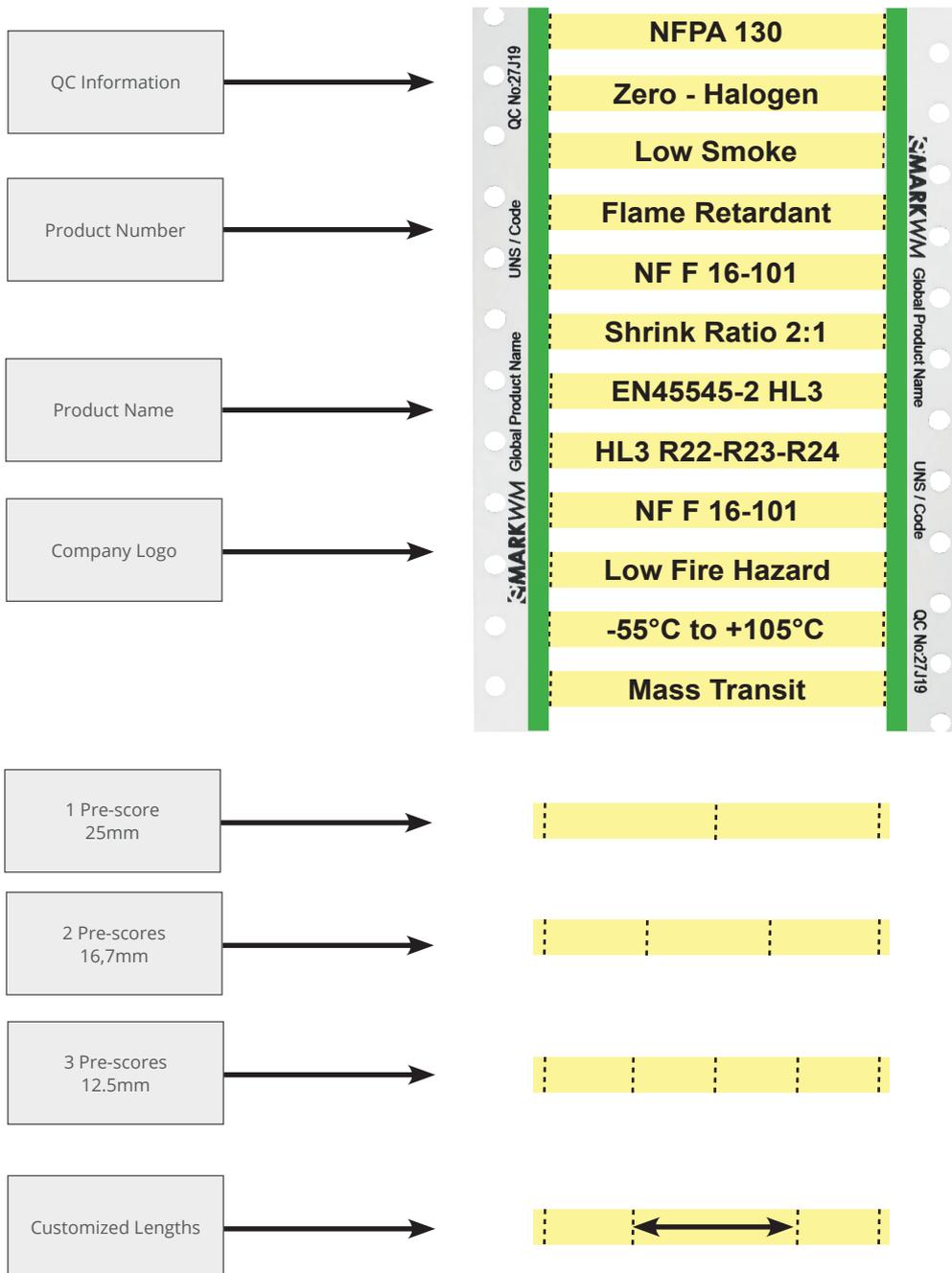


Heat Shrink Product in as supplied "D" and fully recovered state "d" with recovered wall "W"

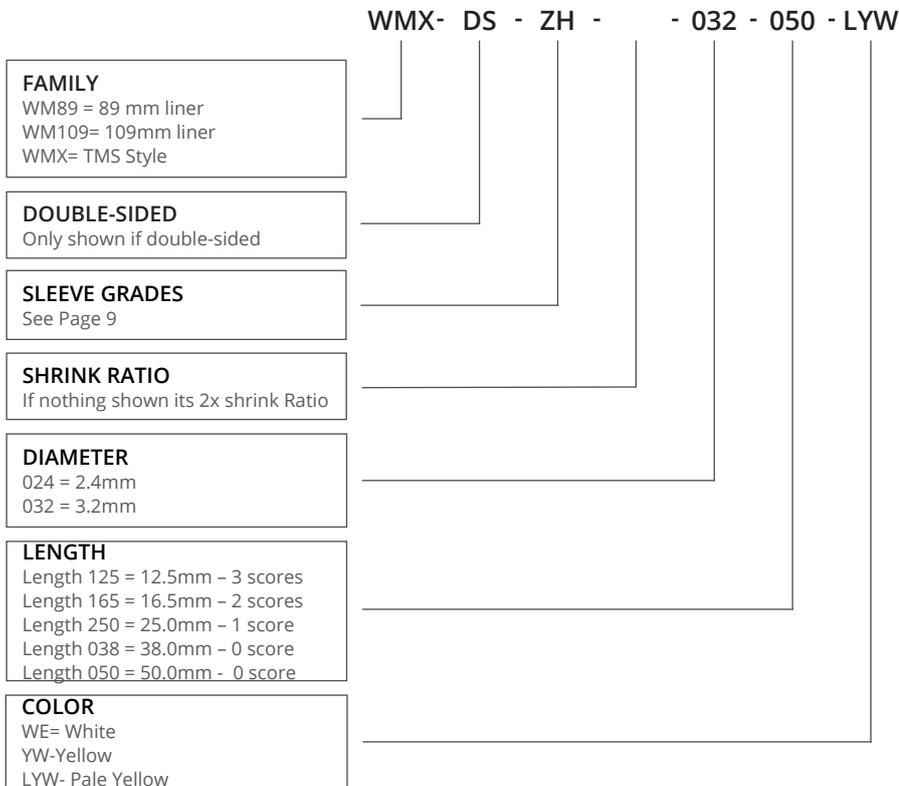
# Available Formats



## Customized liner information example



## Product code example



## Available options -

SIZE MM	SIZE INCHES	STANDARD	BULK	JUMBO
2,4 x 50 mm	3/32 - 2.0	1.000	5.000	10.000
3,2 x 50 mm	1/8 - 2.0	1.000	5.000	10.000
4,8 x 50 mm	3/16 - 2.0	1.000	5.000	10.000
6,4 x 50 mm	1/4 - 2.0	1.000	3.000	6.000
9,5 x 50 mm	3/8 - 2.0	500	2.000	4.000
12,7 x 50 mm	1/2 - 2.0	500	1.500	3.000
19,0 x 50 mm	3/4 - 2.0	500	1.500	3.000
25,4 x 50 mm	1 - 2.0	300	1.000	2.000
38,1 x 50 mm	1 1/2 - 2.0	100	600	1.200
50,8 x 50 mm	2 - 2.0	100	600	1.200

## Other Spool sizes on request -

## Ordering description

ORDERING DESCRIPTION EXAMPLES	STANDARD PACK SIZE	SUPPLIED DIAMETER		RECOVERED DIAMETER		RECOMMENDED USE RANGE (MIN-MAX)	
		pcs	mm	inches	mm	inches	mm
Family-Tube Grade-2X-024-50-Color	1.000	2,4 x 50mm	3/32-2.0	0.7	0.031	0.8-1.9	0.032-0.075
Family-Tube Grade-2X-032-50-Color	1.000	3,2 x 50mm	1/8-2.0	1.0	0.042	1.1-2.6	0.044-0.105
Family-Tube Grade-2X-048-50-Color	1.000	4,8 x 50mm	3/16-2.0	1,5	0.062	1.7-4.0	0.069-0.160
Family-Tube Grade-2X-064-50-Color	1.000	6,4 x 50mm	1/4-2.0	2.3	0,095	2.3-5.4	0.091-0.215
Family-Tube Grade-2X-095-50-Color	500	9,5 x 50mm	3/8-2.0	3.1	0.125	3.4-8.1	0.137-0.320
Family-Tube Grade-2X-127-50-Color	500	12,7 x 50mm	1/2-2.0	4.75	0,187	4.6-10.7	0.183-0.425
Family-Tube Grade-2X-190-50-Color	500	19,0 x 50mm	3/4-2.0	6.35	0.250	6.9-16.2	0.275-0.640
Family-Tube Grade-2X-254-50-Color	300	25,4 x 50mm	1-2.0	8.47	0.33	9.2-21.5	0.366-0.850
Family-Tube Grade-2X-381-50-Color	100	38,1 x 50mm	1 1/2-2.0	12.9	0.51	20.9-33.0	0.825-1.300
Family-Tube Grade-2X-508-50-Color	100	50,8 x 50mm	2-2.0	17.2	0.68	27.9-44.9	1.100-1.750

# Available Tube Grades

PRODUCT GROUP	TUBE GRADE	CHARACTERISTICS	COMPLIANCES
WMX-WM89-WM109	C3	The C3- 3:1 shrink ratio, heat shrinkable wire markers are made of flame retardant heat shrinkable polyolefin tubing with ideal printability properties for identification purposes. C3 meets NFPA 130 requirements. The C3 material is fabricated to meet the material performance requirements of the AMS-DTL-23053/5 class 1 and meets the features in Airbus specification NSA 937201. The compound is also UL224 and CSA compliant. Ideal for aerospace, military, industrial and energy applications. The marker sleeves meets the mark permanence requirements of AS5942 and MIL 202 Method 215K	EN 60684-3-209 NFPA 130 UL224 CSA 22.2 No. 198- SAE-AMS-DTL-23053/5 SAE AS 5942 MIL-STD-202F method 215 AMS-DTL-23053/5 AIRBUS NSA937201
WMX-WM89-WM109	ZH	The ZH heatshrink tubing is made of halogen-free, flame retardant, heat shrinkable polyolefin tubing with ideal printability properties for identification purposes. The compound of the tubing is excluded for halogens and offers excellent fire safety characteristics combined with minimal smoke emission. The material meets Boeing BS 7239 for toxic gas generation M7 specification, and is classified with EN45545-2 Class HL3 requirement set R22 (interior) and R23 (exterior). R24 by test method EN ISO 4589-2, burning behavior determined by Oxygen Index only and be used without any restriction for any application. NFPA 130 & EN 60684-3-216 test report are available on request	EN 45545-2 HL3, R22/R23/R24 NFPA 130 EN 60684-3-216 LUL 1-085 A3 compliant BS 6853 (1999) cat 1a DIN5510-2 UNI CEI 11170-3 NF F 16 101 ASTM E 662, BSS 7239 SAE 5942 MIL-STD-202 method 215
WMX-WM89-WM109	LFH	The LFH printable heatshrink tubing is made of halogen-free flame retardant and low smoke heat shrinkable polyolefin tubing with ideal printing properties for identification purposes. The compound is excluded for halogens and offers excellent low fire hazard characteristics combined with minimal smoke emission.	UL224 CSA 22.2 No. 198- SAE AS 81531 / 5942 MIL-STD-202 method 215 EN50343 Annex H Section H.3
WMX-WM89-WM109	LFH-3X	The LFH printable heatshrink tubing is made of halogen-free flame retardant and low smoke heat shrinkable polyolefin tubing with ideal printing properties for identification purposes. The compound is excluded for halogens and offers excellent low fire hazard characteristics combined with minimal smoke emission.	UL224 CSA 22.2 No. 198- SAE AS 5942 MIL-STD-202 method 215 EN50343 Annex H Section H.3
WMX-WM89-WM109	HT	The HT printable heatshrink tubing is made of semi-flexible highly flame retardant polyvinylidene fluoride tubing. High-temperature rated thin wall markers with high transparency. Excellent chemical resistance to most industrial fuels, chemicals, solvents and high degree of mechanical strength properties suitable for aerospace, defense and mass transit applications. It is inherently flame retardant, semi-rigid and highly resistant to most industrial fuels, chemicals and solvents.	UL224 SAE-AMS-DTL-23053/8 SAE AS 5942 MIL-STD-202 method 215
WMX-WM89-WM109	DR	The DR printable is printable irradiated cross-linked, flame retardant, semi-rigid, diesel oil resistant heat shrinkable polyolefin tubing. Especially suitable for railway and complies with SNCF requirements NF F 00608 cat. A & H. Used where resistance to organic fluids, common fuels, lubricants and solvents properties are required for use in mass transit, aerospace, marine and industrial installations.	NF F 00-608 Class A & H UL224 SAE-AMS-DTL-23053/6 Class 1 SAE AS 5942 MIL-STD-202 method 215
WMX-WM89-WM109	AMD	The AMD printable heatshrink is made of highly flame retardant, self-extinguishing and very flexible heat shrinkable polyolefin tubing with ideal printability properties for identification purposes within aerospace, military and defence specified applications. UL VW1/CSA recognized and complies to AMS-DTL-23053/5 Class 1&3. This heatshrink are very versatile through excellent balance of chemical, electrical and mechanical properties.	NFPA 130 UL224 SAE-AMS-DTL-23053/5 Class 1 & 3 SAE AS 5942 MIL-STD-202 method 215
WMX-WM89-WM109	AMD-3X	The AMD printable heatshrink is made of highly flame retardant, self-extinguishing and very flexible heat shrinkable polyolefin tubing with ideal printability properties for identification purposes within aerospace, military and defence specified applications. UL VW1/CSA recognized and complies to AMS-DTL-23053/5 Class 1&3. This heatshrink is very versatile through excellent balance of chemical, electrical and mechanical properties.	NFPA 130 UL224 SAE-AMS-DTL-23053/5 SAE AS 5942 MIL-STD-202 method 215
WMX-WM89-WM109	3-1	The 3-1 flexible heatshrink tubing is made of flame retarded, heat shrinkable polyolefin tubing with ideal printability properties for identification purposes. The 3-1 tubing meets the requirements of a wide range of industrial standards such as SAE-AMS-DTL 23053/5 class 1 & 3. Yellow green version available. Material: Irradiated cross-linked flexible flame-retarded polyolefin Shrink Temperature: Min 90 dgc.	SAE-AMS-DTL-23053/5 class 1&3 UL224 600V VW-1 rating CSA 22.2 No. 198.1-98 SAE AS 5942 MIL-STD-202 method 215
WMX-WM89-WM109	ZHR	ZHR-2X and 3X heat-shrinkable wire markers are made of halogen-free, flame retardant and low smoke heat shrinkable polyolefin tubing, which provides fluid resistance as per EN50343. The product meets rail standards EN50343 Appendix H and EN45545-2 requirement set R22/R23/24 hazard level classification 1 and 2. The compound of the tubing is excluded for halogens and offers excellent low fire hazard characteristics combined with minimal smoke emission. It can also be used for applications where limited fire hazard characteristics are necessary.	Diesel Resistance: EN50343 annex H (section 6.6) Fire Propagation: EN45545-1 HL3, R22-R23-R24 Chemical and Diesel Resistance: EN50343 annex H (section 6.6) MIL-STD-202 Method 215 Mark Permanence: EN50343 annex H (section 6.6) & SAE AS-5942

This information and data is believed to be accurate and reliable. Although the information and recommendations set forth herein are presented in good faith and believed to be correct as of this date, Link Solutions makes no representations as to the completeness or accuracy thereof. We place at your disposal the technical information necessary for the correct use of our products. As conditions and methods of use are beyond our control, that the person receiving the same will make their own determination as to the suitability for their purpose. We reserve the right to modify characteristics with the aim of improving the product and adapting it to the requirements of the market.

## Related Standard Test Methods And Documents

Document	Description
ASTM D638	Tensile strength and ultimate elongation
ASTM D638	Heat aging 168 at 150°C
ASTM D2671 heat shock (section 26-30), procedure b	Heat shock 4 hours at 175°C
ASTM D2671	Longitudinal change
ASTM D2671 (Section 79-80) ASTM D570	Water absorption. 2 Maximum
ASTM D149	Dialectrical strength. 20 minimum
ASTM D2671B replaced by EN 60684-2-33	Copper corrosion (Section 93 procedure A) damaged area of copper mirror,
EN 60684-2-36	Chemical resistance to selected fluids
ASTM D257	Volume resistivity
ASTM D 635-HB -	Flamiability resistance - Fire propagation
ASTM D E 662	Optical density of smoke generated by solid matrials, (Ds) measured in flaming mode and non flaming mode in single smoke chamber test.
ASTM D E 162	Flame Spread Index . Surface Flammability of Materials Using a Radiant Heat Energy Source
ASTM D E 1354	Heat and Visible Smoke Release Rates of Materials and Products using an Oxygen Comsumption (Cone) Calorimeter
ASTM D792 Method A	Specific gravity
Boeing BS 7239	Toxic gas generation M7. Gases produced for analysis are generated in a specified, calibrated smoke chamber during standard rate of smoke generation testing (ASTM E 662), in both flaming combustion and non-flaming pyrolytic decomposition test modes
BS EN ISO 4589-1: 1999 - Oxygen Index	Limited Oxygen Index- flammability hazard rating.Determination of burning behavior by oxygen index - part 2: ambient temperature test. 32% minimum
BS 6853 (1999) vehicle catagory 1a	Code of practice for fire precautions in the design and construction of passenger carrying trains
DIN 54837	DIN 54837 Testing of materials, small components and component sections for rail vehicles- determination of burning behaviour using a gas burner
DIN 5510-2	German railway normative related to fire protection on railway vehicles
ISO 5659-2: 2017	Optical density of smoke (D <sub>m</sub> ) measured in flaming mode and non flaming mode in single smoke chamber test.
EN45545-2 HL3 - HL 1 - HL 2 - HL 3	Railway applications. Rolling stock fire protection on railway vehicles. - Part 2 requirements for fire behavior of materials and components. Fire hazard class. HL1,2 & 3 R22 (Interior) & R23 (exterior) R24 - PCB - EN ISO 4589-2 , burning behavior determined by LOI - Low Oxygen Index only
IEC 60684-3-216	IEC 60684-3-216: 2019 gives the requirements for four types of heat-shrinkable, flame-retarded, limited-fire-hazard sleeving with a thermal endurance rating of 105 °C.
London Underground Standard 1-085	Revision A3, Fire safety performance of materials
NF C 20-455	Fire hazard testing glowin/hot-wire based test methods. Glow-wire apparatus and common test procedure.c Replaced by EN ISO 60695-2-11
NF F 16-101: 1988	Railway rolling stock fire behavior choice of materials Rolling stock classification A1.
NF X 70-100: 1986	Fire tests analysis of pyrolysis and cumbustion gases tube furnace method
NF X 10-702-1/2	Determination of the opacity of smoke in a non-renewed atmosphere. The resulting density /time curve is used to calculate the smoke index
NF T 51-071: 1999	Oxygen index test. This test has been replaced by IEC 60695-2-11/EN 60965-2-11
NFPA 130	National Fire Protection Association. Standard for fixed guideway transit and passenger rail systems This standard specifies fire protection and life safety requirements for underground, surface and elevated fixed guideway transit and passenger rail systems.
MIL 202 Method 215	Resistance to solvents. Test methods for electronic and electrical component parts.
SAE AS5942;2014	Marking og insulation materials- Print permanence testing using the mechanical crockmeter

## Abstract from IEC 60684-3-216:2019 Standard

IEC 60684-3-216:2019 is available as IEC 60684-3-216:2019 RLV which contains the International Standard and its Redline version, showing all changes of the technical content compared to the previous edition. IEC 60684-3-216: 2019 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 sleeveings are normally supplied in the following colours: black, red, green, blue, white, yellow and green/yellow. Sizes or colors 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. 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: 1. the temperature at which the sleeving is shrunk in a forced-air circulation oven for  $(5 \pm 1)$  min has been increased from  $(150 \pm 5)$  °C to  $(200 \pm 5)$  °C. Keywords: flexible insulating sleeving for electrical purposes