



## NEXT GENERATION RETB

### MATERIALS INVENTORY LIST

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Issue: 4

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#### Endorsement and Authorisation

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## Issue Record

Issue	Date	Comment
1	20.05.14	First Issue
2	04.07.14	Second Issue – changes have been highlighted using a vertical line on the RHS of the page
3	07.10.14	Items 4.32 – 4.43 added as a result of cable changes in the design package.
4	28.11.14	Items 1.7 – 1.13 and 3.2 - 3.3 added. Changes have been highlighted using a vertical line on the RHS of the page

## Contents

1	Introduction .....	2
2	Scope .....	2
3	Material Inventory List.....	3
	Appendix A – Reference Documentation .....	17

## **1 Introduction**

Network Rail are in the process of developing a replacement RETB (Radio Electronic Token Block) radio system for the Far North Line (FNL) and West Highland Lines (WHL) in Scotland. After a life extension of infrastructure systems, the Next Generation RETB (RETB NG) project is planning to replace the radio system element (NRN) as the frequencies used are due to be returned to Ofcom at the end of 2015. This requires a new train radio and token exchange unit to be installed in all driving cabs of vehicles used on the FNL and WHL.

Multipulse Electronics Limited (Multipulse) has recently been awarded the contract to undertake the installation design, approvals and physical installation of the trainborne equipment. Multipulse has subsequently contracted the installation design aspects of the project to dg8 design and engineering limited (dg8), for the purposes of this document all dg8 employees will be known as the Multipulse Installation Design Team.

The Multipulse Installation Design Team is an ISO 9001:2008 and ISO14001:2004 accredited body, and undertakes a wide variety of installation design and approval projects for the railway industry.

## **2 Scope**

This document provides a list of the materials to be used in the installation.

The scope of work includes the installation of the following equipment; roof mounted antenna, cab mounted 'Combined Cab Display Unit and Radio' (CDR), junction box, handset and speaker.

The design also takes account of all associated cabling between the system components being installed.

### 3 Material Inventory List

Item	Component/Assembly	Material Description	GM/RT2130 – Issue 4 / BS 6853: 1999 Category 1b Mandatory Performance	Compliant? Y/N	Comments
<b>1</b>	<b>General</b>				
1.1	Paint system	Copon Hycote EA9 WB Primer	BS 476 Part 6 $i_1 < 6$ , $l < 12$	Y	$I_1 = 0.0$ , $l = 0.5$ (Warres No. 59206)
		Copon Hycote EA9 WB Finish Coat	BS 476 Part 7 Class 1	Y	Achieves Class 1 (Warres No.59205)
		Steel substrate	BS 6853 Annex D panel test, $A_o$ (on) $< 4.2$ , $A_o$ (off) $< 6.3$	Y	$A_o$ (on) $= 0.96$ , $A_o$ (off) $= 1.15$ (FT93/392/1)
			BS 6853 Annex B, $R < 1.6$	Y	$R = 0.173$
1.2	Threadlock	Loctite Part Nos. 243 222	N/A	N/A	Small quantity of combustible material; qualifies as an unspecified material. No requirements.
1.3	Sealant	RS Part No 423- 6786	N/A	N/A	Small quantity of combustible material; qualifies as an unspecified material. No requirements.
1.4	Jointing Compound	Unial	N/A	N/A	Small quantity of combustible material; qualifies as an unspecified material. No requirements.

1.5	Powder Coat – CDR	Tiger Drylac Series 29	N/A	N/A	The total coating area is approximately 0.104m <sup>2</sup> and qualifies as an unspecified material. No requirements.
1.6	Powder Coat – Junction Box	Tiger Drylac Series 29	N/A	N/A	The total coating area is approximately 0.08m <sup>2</sup> and qualifies as an unspecified material. No requirements.
1.7	32mm Conduit	PMA Part No. PLUG-29B	BS EN ISO 4589-3:1996, Annex A, FT>300°C Or BS ISO 4589-2, OI>34  BS 6853 Annex D, small scale test, Ao <0.027  BS 6853 Annex B, R < 1.6	Y  Y  Y	BS6853 Cat. 1a compliant (see manufacturer's datasheet)
1.8	Conduit Clip	PMA Part No. BFH-29-0	N/A	N/A	Small quantity of combustible material; qualifies as an unspecified material. No requirements.
1.9	End Cap	Adaptaflex Part No. ECB 28	N/A	N/A	Small quantity of combustible material; qualifies as an unspecified material. No requirements.
1.10	Silicone Sealant	Loctite 5368 RS Part No. 258-5979	N/A	N/A	Small quantity of combustible material; qualifies as an unspecified material. No requirements.
1.11	Zinc Primer	Cromwell Part No. RUS-775-2120H	N/A	N/A	Small quantity of combustible material; qualifies as an unspecified material. No requirements.

					requirements.
1.12	M16 Cable Gland	Adaptaflex Part No. ESM20-11B-LN	N/A	N/A	Small quantity of combustible material; qualifies as an unspecified material. No requirements.
1.13	M20 Cable Gland	Adaptaflex Part No. ESM20-12B-LN	N/A	N/A	Small quantity of combustible material; qualifies as an unspecified material. No requirements.
<b>2</b>	<b>Internal Equipment Installation</b>				
2.1	Speaker	Comms Design Part No. TBA	N/A	N/A	Small quantity of combustible material; qualifies as an unspecified material. No requirements.
2.2	Handset	Comms Design Part No. TBA	N/A	N/A	<p>The material has been tested and is compliant to UL 94 and is HB classified (see datasheet).</p> <p>The handset is located within the driver's cab where it is not accessible to passengers. The handset has been previously fitted on Class 375 vehicles for South Eastern and has had no reported safety issues relating to the fire performance of the handset. Due to the relatively small number of handsets required, specifying a compliant product to meet functional requirements has been found to be difficult.</p> <p>The handset is considered to be in accordance with clause 2.8.6 of the standard.</p>

2.3	CDR Unit	Comms Design Part No. TBA	N/A	N/A	Equipment is housed in a non combustible box and is therefore in accordance with clause 2.7.2 of the standard.
2.4	Grommet	Reevite Part No. RB77	N/A	N/A	Small quantity of combustible material; qualifies as an unspecified material. No requirements.
2.5	Grommet	Reevite Part No. PV839	N/A	N/A	Small quantity of combustible material; qualifies as an unspecified material. No requirements.
2.6	Grommet	Reevite Part No. PV732	N/A	N/A	Small quantity of combustible material; qualifies as an unspecified material. No requirements.
2.7	Junction Box	Comms Design Part No. TBA	N/A	N/A	Equipment is housed in a non combustible box and is therefore in accordance with clause 2.7.2 of the standard.
2.8	Dummy Receptacle	Amphenol Part No. R164.329.16NH	N/A	N/A	Small quantity of combustible material; qualifies as an unspecified material. No requirements.
2.8	Dummy Receptacle	Amphenol Part No. M0262-16NH	N/A	N/A	Small quantity of combustible material; qualifies as an unspecified material. No requirements.
2.9	Junction Box cable glands (x7)		N/A	N/A	Small quantity of combustible material; qualifies as an unspecified material. No requirements.

<b>3</b>	<b>Antenna Installation</b>				
3.1	Antenna	CDL LP3, ABS cover of mass <2kg:	BS 476-7 Class 2  BS 6853 Annex D panel test, Ao (max) <590  BS 6853 Annex B, R < 13.5	Acceptable	The Antenna made of the same material as the existing NRN antenna and is located externally on the roof of the vehicle where it is not accessible to passengers. It is therefore isolated and presents minimal risk to the fire performance of the vehicle. Due to the relatively small number of handsets required, specifying a compliant product to meet functional requirements has been found to be difficult. The antenna is considered to be in accordance with clause 2.8.6 of the standard.
3.2	Vertical Whip Antenna Mount	Panorama Antennas Part No. ML9-UHF	N/A	N/A	Small quantity of combustible material; qualifies as an unspecified material. No requirements.
3.3	GPS Patch Antenna	Siretta Tango 20	N/A	N/A	Small quantity of combustible material; qualifies as an unspecified material. No requirements.
<b>4</b>	<b>Cable Harnesses</b>				
4.1	Multicore 1mmsq	Huber & Suhner RADOX GKW-LW/S 14 x 1.0 12582064	BS 4066-3, burn length (max)a = 2.5m  BS 6853 Annex D, cable test, Ao (ON) = 1a requirements x 1.6, Ao (OFF) = 1a requirements x 1.6	Y  Y	BS 6853 category 1a compliant (see manufacturers datasheet)



			BS 6853 Annex B, R < 1.6	Y	
4.2	Multicore 0.5mmsq	Huber & Suhner RADOX GKW-LW/S 5 x 2 x 0.5 12566533	BS 4066-3, burn length (max)a = 2.5m  BS 6853 Annex D, cable test, Ao (ON) = 1a requirements x 1.6, Ao (OFF) = 1a requirements x 1.6  BS 6853 Annex B, R < 1.6	Y  Y  Y	BS 6853 category 1a compliant (see manufacturers datasheet)
4.3	Multicore 0.5mmsq	Huber & Suhner RADOX GKW-LW/S 4 x 2 x 0.5 12555605	BS 4066-3, burn length (max)a = 2.5m  BS 6853 Annex D, cable test, Ao (ON) = 1a requirements x 1.6, Ao (OFF) = 1a requirements x 1.6  BS 6853 Annex B, R < 1.6	Y  Y  Y	BS 6853 category 1a compliant (see manufacturers datasheet)
4.4	Multicore 0.5mmsq	Huber & Suhner RADOX GKW-LW/S 2 x 0.5 12556756	BS 4066-3, burn length (max)a = 2.5m  BS 6853 Annex D,	Y	BS 6853 category 1a compliant (see manufacturers datasheet)

			<p>cable test, Ao (ON) = 1a requirements x 1.6, Ao (OFF) = 1a requirements x 1.6</p> <p>BS 6853 Annex B, R &lt; 1.6</p>	<p>Y</p> <p>Y</p>	
4.5	Coaxial Cable	Huber & Suhner SX_04172_B-60	<p>BS 4066-3, burn length (max)a = 2.5m</p> <p>BS 6853 Annex D, cable test, Ao (ON) = 1a requirements x 1.6, Ao (OFF) = 1a requirements x 1.6</p> <p>BS 6853 Annex B, R &lt; 1.6</p>	<p>Acceptable</p> <p>Acceptable</p> <p>Acceptable</p>	<p>The cable meets the following standards:</p> <p>Flammability EN 60332-1-2, IEC 60332-3-22, IEC 60092-359, EN 50266-2-2 NF C 32-070 C2, NF C 32-070 C1, EN 50264-1</p> <p>Smoke density EN 61034-2, NF X 10-702</p> <p>Halogen free IEC 60754</p> <p>Toxic fume NF X 70-100</p> <p>EN 45545 compliant (see manufacturers datasheet)</p> <p>BS 6853:1999 and GM/RT 2130 compliant. (see test report NDL-CBL-REP-001 Issue 01)</p>
4.6	Multicore 2.5mmsq	Huber & Suhner RADOX GKW-LW/S 2 x 2.5 12556794	<p>BS 4066-3, burn length (max)a = 2.5m</p> <p>BS 6853 Annex D,</p>	Y	BS 6853 category 1a compliant (see manufacturers datasheet)

			<p>cable test, Ao (ON) = 1a requirements x 1.6, Ao (OFF) = 1a requirements x 1.6</p> <p>BS 6853 Annex B, R &lt; 1.6</p>	<p>Y</p> <p>Y</p>	
4.7	Single core 6mmsq	Huber & Suhner RADOX 4GKW-AX 12536696	<p>BS 4066-3, burn length (max)a = 2.5m</p> <p>BS 6853 Annex D, cable test, Ao (ON) = 1a requirements x 1.6, Ao (OFF) = 1a requirements x 1.6</p> <p>BS 6853 Annex B, R &lt; 1.6</p>	<p>Y</p> <p>Y</p> <p>Y</p>	BS 6853 category 1a compliant (see manufacturers datasheet)
4.8	End of Cable Sleeve	Adhesive Heatshrink Sheath MW-HSAL-19/6 BLK	N/A	N/A	Small quantity of combustible material; qualifies as an unspecified material. No requirements.
4.9	Label	RPS Heatshrink Sleeve TYCO HX- SCE	N/A	N/A	Small quantity of combustible material; qualifies as an unspecified material. No requirements.
4.10	Bootlace Ferrule Crimp	Cablecraft CET0.5	N/A	N/A	Small quantity of combustible material; qualifies as an unspecified material. No requirements.

4.11	Crimp	Cablecraft CET1.0	N/A	N/A	Small quantity of combustible material; qualifies as an unspecified material. No requirements.
4.12	Crimp	Amphenol SS20M1F	N/A	N/A	Small quantity of combustible material; qualifies as an unspecified material. No requirements.
4.13	Backshell	Amphenol ROTB-16CG-S1	N/A	N/A	Small quantity of combustible material; qualifies as an unspecified material. No requirements.
4.14	Cable Sleeve	Cablecraft MW-HSAL-19/6 BLK	N/A	N/A	Small quantity of combustible material; qualifies as an unspecified material. No requirements.
4.15	Cable Ident	Siegrist-Orel LHM Range KBX-LHM05-0-9	N/A	N/A	Small quantity of combustible material; qualifies as an unspecified material. No requirements.
4.16	Crimp	Amphenol AMP 151730	N/A	N/A	Small quantity of combustible material; qualifies as an unspecified material. No requirements.
4.17	Crimp	Molex 46235-0002	N/A	N/A	Small quantity of combustible material; qualifies as an unspecified material. No requirements.
4.18	6.3mm Spade Crimp	AMP PIDG FASTEN - RED	N/A	N/A	Small quantity of combustible material; qualifies as an unspecified material. No requirements.
4.19	Plug	RT0616-19SNH	N/A	N/A	Small quantity of combustible material; qualifies as an unspecified material. No requirements.

					requirements.
4.20	Plug	Molex 43025-0800	N/A	N/A	Small quantity of combustible material; qualifies as an unspecified material. No requirements.
4.21	Ferrule Crimps	Cablecraft CET2.5	N/A	N/A	Small quantity of combustible material; qualifies as an unspecified material. No requirements.
4.22	M6 Ring Tongue Crimp	TYCO (AMP) 342063 054/119568	N/A	N/A	Small quantity of combustible material; qualifies as an unspecified material. No requirements.
4.23	BNC Cable Plug	50ohm RG58 TE 1-5227079-1	N/A	N/A	Small quantity of combustible material; qualifies as an unspecified material. No requirements.
4.24	Strain Relief Sleeve	Cablecraft MW-HSAL 25/8 BLK & 19/6 BLK	N/A	N/A	Small quantity of combustible material; qualifies as an unspecified material. No requirements.
4.25	QN Cable Plug	50ohm RG58 Huber & Suhner 11_QN- 50-3-2/133_NE	N/A	N/A	Small quantity of combustible material; qualifies as an unspecified material. No requirements.
4.26	BNC Cable Jack	50ohm RG58 TE 1-1337442-0	N/A	N/A	Small quantity of combustible material; qualifies as an unspecified material. No requirements.
4.27	Cable Tie	RS 212-8087	N/A	N/A	Small quantity of combustible material; qualifies as an unspecified material. No requirements.

4.28	Red PIDG Flat blade Crimp	RS 448-092	N/A	N/A	Small quantity of combustible material; qualifies as an unspecified material. No requirements.
4.29	Cable Ties	RS 212-8087	N/A	N/A	Small quantity of combustible material; qualifies as an unspecified material. No requirements.
4.30	Cable Ties	RS 190-3326	N/A	N/A	Small quantity of combustible material; qualifies as an unspecified material. No requirements.
4.31	Sheath	Siegrist-Orel SVSR200	N/A	N/A	Small quantity of combustible material; qualifies as an unspecified material. No requirements.
4.32	Multicore 1mmsq	Huber & Suhner RADOX TENUIS-TW/S EMC 12 x 1 12581355	BS 4066-3, burn length (max)a = 2.5m  BS 6853 Annex D, cable test, Ao (ON) = 1a requirements x 1.6, Ao (OFF) = 1a requirements x 1.6  BS 6853 Annex B, R < 1.6	Y  Y  Y	BS 6853 category 1a compliant (see manufacturers datasheet)
4.33	Multicore 1mmsq	Huber & Suhner RADOX TENUIS-TW/S EMC 6 x 2 x 1 12584412	BS 4066-3, burn length (max)a = 2.5m  BS 6853 Annex D, cable test, Ao (ON) = 1a	Y  Y	BS 6853 category 1a compliant (see manufacturers datasheet)

			requirements x 1.6, Ao (OFF) = 1a requirements x 1.6  BS 6853 Annex B, R < 1.6	Y	
4.34	Multicore 0.5mmsq	Huber & Suhner RADOX TENUIS-TW/S EMC 4 x 2 x 0.5 12568122	BS 4066-3, burn length (max)a = 2.5m  BS 6853 Annex D, cable test, Ao (ON) = 1a requirements x 1.6, Ao (OFF) = 1a requirements x 1.6  BS 6853 Annex B, R < 1.6	Y  Y  Y	BS 6853 category 1a compliant (see manufacturers datasheet)
4.35	Multicore 1mmsq	Huber & Suhner RADOX TENUIS-TW 2 x 1 12568052	BS 4066-3, burn length (max)a = 2.5m  BS 6853 Annex D, cable test, Ao (ON) = 1a requirements x 1.6, Ao (OFF) = 1a requirements x 1.6  BS 6853 Annex B, R < 1.6	Y  Y  Y	BS 6853 category 1a compliant (see manufacturers datasheet)

4.36	Multicore 2.5mmsq	Huber & Suhner RADOX TENUIS- TW 4 x 2.5 12566306	BS 4066-3, burn length (max)a = 2.5m  BS 6853 Annex D, cable test, Ao (ON) = 1a requirements x 1.6, Ao (OFF) = 1a requirements x 1.6  BS 6853 Annex B, R < 1.6	Y  Y  Y	BS 6853 category 1a compliant (see manufacturers datasheet)
4.37	Backshell	Amphenol ROTB- 16CG-S2	N/A	N/A	Small quantity of combustible material; qualifies as an unspecified material. No requirements.
4.38	Crimp	Amphenol SS16M1F	N/A	N/A	Small quantity of combustible material; qualifies as an unspecified material. No requirements.
4.39	Ferrule Crimps	Cablecraft CET0.75	N/A	N/A	Small quantity of combustible material; qualifies as an unspecified material. No requirements.
4.40	Sealing Plug	Amphenol Part No. CA-4016-59	N/A	N/A	Small quantity of combustible material; qualifies as an unspecified material. No requirements.
4.41	Cable Ident	Siegrist-Orel LHM Range KBX- LHM075-0-9	N/A	N/A	Small quantity of combustible material; qualifies as an unspecified material. No requirements.



4.42	Cable Ident	Siegrist-Orel LHM Range KBX-LHM20- 0-9	N/A	N/A	Small quantity of combustible material; qualifies as an unspecified material. No requirements.
4.43	Ferrule Crimps	Cablecraft CET2.5	N/A	N/A	Small quantity of combustible material; qualifies as an unspecified material. No requirements.

## **Appendix A – Reference Documentation**

# TEST REPORT

WARRES NO. 59206

BS 476: PART 6: 1989

METHOD OF TEST FOR  
FIRE PROPAGATION FOR PRODUCTS

SPONSORED BY

E WOOD LIMITED

Standard Way, Northallerton, North Yorkshire, DL6 2XA

THE PROFESSIONALS IN FIRE SAFETY •

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**FIRE**  
*research*  
CONSULTANCY • TESTING

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## **TEST REPORT**

**WARRES NO. 59206**

**BS 476: PART 6: 1989**

### **METHOD OF TEST FOR FIRE PROPAGATION FOR PRODUCTS**

**SPONSORED BY**

**E WOOD LIMITED  
Standard Way  
Northallerton  
North Yorkshire  
DL6 2XA**

#### **PURPOSE OF TEST**

To determine the performance of a product when it is subjected to the conditions of the test specified in British Standard 476: Part 6: 1989 'Fire tests on building materials and structures, method of test for fire propagation for products'.

#### **SCOPE OF TEST**

BS 476: Part 6: 1989 specifies a method of test, the result being expressed as a fire propagation index, that provides a comparative measure of the contribution to the growth of fire made by an essentially flat material, composite or assembly. It is primarily intended for the assessment of the performance of internal wall and ceiling linings.

#### **DESCRIPTION OF TEST SPECIMENS**

The description of the specimens given below has been prepared from information provided by the sponsor of the test. All values quoted are nominal, unless tolerances are given.

2 mm thick mild steel plate which had been grit blasted to SA 2.1/2 on one face and then degreased, was coated on the grit blasted face as follows :

One coat of 'Copon EA9 WB (colour reference 'grey')' primer, spray applied to a dry film thickness of 60 microns.

One coat of 'Copon EA9 WB semi gloss finish (colour reference 'grey')', spray applied to a dry film thickness of 60 microns.

The specimens were supplied by the sponsor. Warrington Fire Research Centre was not involved in any selection or sampling procedure.



### CONDITIONING OF SPECIMENS

The specimens were received on 22nd February 1993.

Prior to testing the specimens were conditioned to constant mass at a temperature of  $23 \pm 2^{\circ}\text{C}$  and a relative humidity of  $50 \pm 10\%$ .

### DATE OF TEST

The test was performed on 2nd and 3rd March 1993.

### TEST PROCEDURE

The test was performed in accordance with the procedure specified in BS 476: Part 6: 1989 and this report should be read in conjunction with that British Standard.

### FORM IN WHICH SPECIMENS WERE TESTED

The specimens were tested in the form of a composite.

### EXPOSED FACE

The coated face of the specimens was exposed to the heating conditions of the test.

### TEST RESULTS

The test results relate only to the behaviour of the test specimens of the product under the particular conditions of test, they are not intended to be the sole criterion for assessing the potential fire hazard of the product in use.

The test results relate only to the specimens of the product in the form in which they were tested. Small differences in the composition or thickness of the product may significantly affect the performance during the test and may therefore invalidate the test results. Care should be taken to ensure that any product which is supplied or used is fully represented by the specimens which were tested.

A total of three specimens was tested. The laboratory record sheet relating to each of the test specimens is appended to this report.

Throughout the test on each specimen careful observation was made of the product's behaviour within the apparatus and special note was taken of any of the phenomena listed in clause 10.2 of the Standard. None of the listed phenomena was observed and the test results on all three specimens tested were valid.

The following test results were obtained for the product.

Fire propagation index, I	=	0.5
subindex, $i_1$	=	0.0
subindex, $i_2$	=	0.4
subindex, $i_3$	=	0.1

Note: If a suffix 'R' is included in the above fire propagation index, I, then this indicates that the results should be treated with caution.

**INTERPRETATION OF TEST RESULTS**

Attention is drawn to Appendix 1, entitled 'Effect of thermal characteristics on the performance of assemblies'.

**Responsible Officer**

*P. E. Lythgoe*

**P. E. LYTHGOE**  
Manager - Reaction to Fire Testing

**Approved**

*R. J. Shaw*

**R. J. SHAW**  
Director  
for and on behalf of  
**WARRINGTON FIRE RESEARCH CENTRE**

Date of issue: 9th March 1993

bj7657



## APPENDIX 1

### Effect of Thermal Characteristics on the Performance of Assemblies

The result of a test in accordance with BS 476: Part 6: 1989 is applicable only to the specimens in the form in which they were tested. Small differences in the composition or thickness of the product may significantly affect the performance during the test and may therefore invalidate the test result. It is important that the specimens which are tested fully represent the product which is supplied and the manner in which it will be used. This may require a product to be tested in a number of different ways to determine the classification which will be achieved in its different methods of use.

A surface coating, for example, may be applied to a selected substrate using a particular method and application rate. The test classification which is achieved for that set of specimens will be applicable only to that situation. If the substrate or method and rate of application in a particular practical situation are different from that which was tested, then it will be necessary to determine the classification which will be achieved for that situation. Similarly, specimens incorporating a wallcovering must be fully representative of the situation which occurs in practice and will normally consist of the wallcovering bonded to a chosen substrate with a chosen adhesive; the test result will apply only to that composite system. The same principle applies to any composite or assembly which is being investigated.

It is sometimes possible to assume a 'worst case' situation which will enable a chosen set, or sets, of specimens to be constructed and tested to provide a foundation for the assessment of the probable performance of variations within the system. Similarly, it is sometimes possible to formulate a series of exploratory tests to investigate the effect of variations within a product or system, usually culminating in a series of formal tests to provide the basis for a composite assessment of pre-determined variables. In such cases, however, it is essential that careful planning of the programmes is undertaken by suitably qualified fire safety practitioners.

The following is re-produced from Appendix B of BS 476: Part 6: 1989:

With thin materials or composites, particularly those with a high thermal conductivity, the presence of an air gap and the nature of any underlying construction may significantly affect the ignition performance of the exposed surface. Increasing the thermal capacity of the underlying construction increases the "heat sink" effect and may delay ignition of the exposed surface. Any backing provided to the test specimen and in intimate contact with it, such as the non-combustible packing pieces, may alter this "heat sink" effect and may be fundamental to the test result itself. The influence of the underlying layers on the performance of the assembly should be understood and care should be taken to ensure that the result obtained on any assembly is relevant to its use in practice.

The following advice is offered on the construction and preparation of test specimens:

- (a) Where the thermal properties of the product are such that no significant heat loss to the underlying layers can occur, e.g. a material/composite greater than approximately 6 mm thick of high thermal capacity and/or low thermal conductivity, then the product should be tested backed only by the specimen holder.
- (b) Where the product is normally used as a free-standing sheet and the characteristics noted in (a) do not apply, then an airspace should be provided at the back of the product by testing over asbestos cement perimeter battens 20 mm wide and 12.5 mm thick.
- (c) Where the product is to be used over a low density non-combustible substrate and the characteristics noted in (a) do not apply, then the product should be tested in conjunction with that substrate.
- (d) Where the product is to be used over a combustible substrate and the characteristics noted in (a) do not apply, then the product should be tested in conjunction with that substrate.

# LABORATORY RECORD SHEET

## FIRE PROPAGATION TEST - B.S.476:PART 6:1989

SPONSOR : E. WOOD LIMITED

SPECIMEN No : 1

DATE : 3/3/93

TIME mins t	SPECIMEN TEMPERATURE Deg C Ts	CALIBRATION TEMPERATURE Deg C Tc	Ts-Tc/10t	SUB INDEX OF PERFORMANCE
0.50	10.00	10.00	0.00	
1.00	15.00	14.50	0.05	
1.50	20.00	19.50	0.03	
2.00	24.00	24.50	0.00	
2.50	28.00	28.00	0.00	
3.00	32.00	32.50	0.00	0.08
4.00	54.00	54.00	0.00	
5.00	83.00	86.50	0.00	
6.00	108.00	112.50	0.00	
7.00	136.00	133.50	0.03	
8.00	158.00	151.50	0.08	
9.00	173.00	165.00	0.08	
10.00	187.00	175.00	0.12	0.31
12.00	201.00	192.50	0.07	
14.00	210.50	205.50	0.03	
16.00	218.00	212.50	0.03	
18.00	222.50	222.50	0.00	
20.00	229.50	230.00	0.00	0.13
TOTAL INDEX OF PERFORMANCE S = 0.52				

SUBINDEX  $S_1$  = 0.08

SUBINDEX  $S_2$  = 0.31

SUBINDEX  $S_3$  = 0.13

INDEX OF PERFORMANCE S = 0.52



LABORATORY RECORD SHEETFIRE PROPAGATION TEST - B.S.476:PART 6:1989SPONSOR : E. WOOD LIMITEDSPECIMEN No : 2DATE : 3/3/93

TIME mins t	SPECIMEN TEMPERATURE Deg C Ts	CALIBRATION TEMPERATURE Deg C Tc	Ts-Tc/10t	SUB INDEX OF PERFORMANCE
0.50	9.00	10.00	0.00	
1.00	13.00	14.50	0.00	
1.50	18.00	19.50	0.00	
2.00	23.00	24.50	0.00	
2.50	28.00	28.00	0.00	
3.00	32.00	32.50	0.00	0.00
4.00	55.00	54.00	0.02	
5.00	83.00	86.50	0.00	
6.00	104.50	112.50	0.00	
7.00	133.50	133.50	0.00	
8.00	156.50	151.50	0.06	
9.00	175.50	165.00	0.11	
10.00	186.50	175.00	0.11	0.30
12.00	201.00	192.50	0.07	
14.00	207.50	205.50	0.01	
16.00	214.50	212.50	0.01	
18.00	216.50	222.50	0.00	
20.00	222.00	230.00	0.00	0.09
TOTAL INDEX OF PERFORMANCE S =				0.39

SUBINDEX  $S_1$  = 0.00SUBINDEX  $S_2$  = 0.30SUBINDEX  $S_3$  = 0.09

INDEX OF PERFORMANCE S = 0.39

# LABORATORY RECORD SHEET

## FIRE PROPAGATION TEST - B.S.476:PART 6:1989

SPONSOR : E. WOOD LIMITED

SPECIMEN No : 3

DATE : 4/3/93

TIME mins t	SPECIMEN TEMPERATURE Deg C Ts	CALIBRATION TEMPERATURE Deg C Tc	Ts-Tc/10t	SUB INDEX OF PERFORMANCE
0.50	10.00	10.00	0.00	
1.00	14.00	14.50	0.00	
1.50	19.00	19.50	0.00	
2.00	24.00	24.50	0.00	
2.50	28.00	28.00	0.00	
3.00	33.00	32.50	0.01	0.01
4.00	56.00	54.00	0.05	
5.00	84.00	86.50	0.00	
6.00	110.50	112.50	0.00	
7.00	138.50	133.50	0.07	
8.00	161.00	151.50	0.11	
9.00	178.50	165.00	0.15	
10.00	189.50	175.00	0.14	0.52
12.00	203.00	192.50	0.08	
14.00	211.00	205.50	0.03	
16.00	216.00	212.50	0.02	
18.00	221.50	222.50	0.00	
20.00	228.00	230.00	0.00	0.13
TOTAL INDEX OF PERFORMANCE S =				0.66

SUBINDEX  $S_1$  = 0.01

SUBINDEX  $S_2$  = 0.52

SUBINDEX  $S_3$  = 0.13

INDEX OF PERFORMANCE S = 0.66

# TEST REPORT

WARRES NO. 59205

BS 476: PART 7: 1987  
METHOD FOR CLASSIFICATION OF THE  
SURFACE SPREAD OF FLAME OF PRODUCTS

SPONSORED BY

E WOOD LIMITED  
Standard Way, Northallerton, North Yorkshire, DL6 2XA

THE PROFESSIONALS IN FIRE SAFETY •

**W**arrington  
**FIRE**  
*research*  
CONSULTANCY • TESTING

Holmesfield Road, Warrington, UK WA1 2DS • Tel: 0925 55116 • Telex: 628743 WARRES G • Fax: 0925 55419



## TEST REPORT

WARRES NO. 59205

**BS 476: PART 7: 1987  
METHOD FOR CLASSIFICATION OF THE  
SURFACE SPREAD OF FLAME OF PRODUCTS**

### SPONSORED BY

**E WOOD LIMITED  
Standard Way  
Northallerton  
North Yorkshire  
DL6 2XA**

### PURPOSE OF TEST

To determine the performance of specimens of a product when they are subjected to the conditions of the test specified in British Standard 476: Part 7: 1987, "Fire tests on building materials and structures, method for classification of the surface spread of flame of products".

### SCOPE OF TEST

BS 476: Part 7: 1987 specifies a method of test for measuring the lateral spread of flame along the surface of a specimen of a product orientated in the vertical position, and a classification system based on the rate and extent of flame spread. It provides data suitable for comparing the performances of essentially flat materials, composites, or assemblies, which are used primarily as the exposed surfaces of walls or ceilings.

### DESCRIPTION OF TEST SPECIMENS

The description of the specimens given below has been prepared from information provided by the sponsor of the test. All values quoted are nominal, unless tolerances are given.

2 mm thick mild steel plate which had been grit blasted to SA 2.1/2 on one face and then degreased, was coated on the grit blasted face as follows :

One coat of 'Cupon EA9 WB (colour reference 'grey')' primer, spray applied to a dry film thickness of 60 microns.

One coat of 'Cupon EA9 WB semi gloss finish (colour reference 'grey')', spray applied to a dry film thickness of 60 microns.

The specimens were supplied by the sponsor. Warrington Fire Research Centre was not involved in any selection or sampling procedure.

### **CONDITIONING OF SPECIMENS**

The specimens were received on 22nd February 1993.

Prior to test the specimens were conditioned to constant mass at a temperature of  $23 \pm 2^{\circ}\text{C}$  and a relative humidity of  $50 \pm 10\%$ .

### **DATE OF TEST**

The test was performed on 3rd March 1993.

### **TEST PROCEDURE**

The test was performed in accordance with the procedure specified in BS 476: Part 7: 1987, as amended by AMD 6249 dated 31st January 1990, and this report should be read in conjunction with that British Standard.

### **FORM IN WHICH THE SPECIMENS WERE TESTED**

The specimens were tested in the form of a composite. The definitions for a material, composite and assembly have been assumed to be those given in BS 476: Part 6: 1989.

### **EXPOSED FACE**

The coated face of the specimens was exposed to the radiant heat of the test when the specimens were mounted in the test position.

### **TEST RESULTS**

The test results relate only to the behaviour of the test specimens of the product under the particular conditions of test; they are not intended to be the sole criterion for assessing the potential fire hazard of the product in use.

The test results relate only to the specimens of the product in the form in which they were tested. Small differences in the composition or thickness of the product may significantly affect the performance during the test and may therefore invalidate the test results. Care should be taken to ensure that any product which is supplied or used is fully represented by the specimens which were tested.

The test results for the individual specimens, together with observations made during the test and comments on any difficulties encountered during the test are given in Table 1.

In accordance with the class definitions given in BS 476: Part 7: 1987, the specimens tested are classified as Class 1.

Note: If the prefix 'D' or suffix 'R' or 'Y' is included in the classification, this indicates that the results should be treated with caution. An explanation of the reason for the prefix and suffixes is given in Appendix 1, together with the irradiance along the horizontal reference line of the specimen position during the test and the classification limits specified in the Standard.

**INTERPRETATION OF TEST RESULTS**

Attention is drawn to Appendix 2 entitled "Effect of thermal characteristics on the performance of assemblies".

**Responsible Officer**

*P. E. Lythgoe*

**P. E. LYTHGOE**

Manager - Reaction to Fire Testing

**Approved**

*R. J. Shaw*

**R. J. SHAW**

Director

for and on behalf of

**WARRINGTON FIRE RESEARCH CENTRE**

Date of issue: 9th March 1993

bj7658



**TABLE 1**

SPECIMEN No.	1	2	3	4	5	6
Maximum distance travelled at 1.5 minutes (mm)	NIL	NIL	NIL	NIL	NIL	NIL
Distance (mm)	Time to travel to indicated distance (minutes, seconds)					
75	-,--	-,--	-,--	-,--	-,--	-,--
165						
190						
215						
240						
265						
290						
375						
455						
500						
525						
600						
675						
710						
750						
785						
825						
900						
Time to reach maximum distance travelled (minutes, seconds)	-,--	-,--	-,--	-,--	-,--	-,--
Maximum distance travelled in 10 minutes (mm)	NIL	NIL	NIL	NIL	NIL	NIL

Note: Six specimens are usually tested. If the test on any specimen is deemed to be invalid, as defined in the Standard, it is permissible for up to a maximum of nine specimens to be tested in order to obtain the six valid test results.

Observations made during test and comments on any difficulties encountered during the test.

None.

## APPENDIX 1

Irradiance along the horizontal reference line of the specimen position during the test.

Distance along reference line from the hotter end of the specimen position (in mm)	75	225	375	525	675	825
Irradiance at points specified above (kW/m <sup>2</sup> )	32.5	21.0	14.5	10.0	7.0	5.0

Note: a tolerance of  $\pm 0.5$  kW/m<sup>2</sup> is specified on the irradiance measurement.

### Classification of spread of flame

Classification	Spread of flame at 1.5 min		Final spread of flame	
	Limit	Limit for one specimen in sample	Limit	Limit for one specimen in sample
	mm	mm	mm	mm
Class 1	165	165 + 25	165	165 + 25
Class 2	215	215 + 25	455	455 + 45
Class 3	265	265 + 25	710	710 + 75
Class 4	exceeding the limits for Class 3			

### Explanation of prefix and suffixes which may be added to the classification

1. A suffix R is added to the classification if more than six specimens are required in order to obtain six valid test results (e.g. class 2R).
2. A prefix D is added to the classification of any product which does not comply with the surface characteristics specified in the Standard and has therefore been tested in a modified form (e.g. class D3).
3. A suffix Y is added to the classification if any softening and/or other behaviour that may affect the flame spread occurs (e.g. class 3Y).

For example, a classification of D3RY could be achieved indicating (a) a modified surface has been used; (b) a class 3 result has been obtained; (c) additional specimens have been used to obtain 6 valid results and; (d) softening and/or other behaviour has occurred which is considered to have affected the test result.



## APPENDIX 2

### Effect of Thermal Characteristics on the Performance of Specimens

The result of a test in accordance with BS 476: Part 7: 1987 is applicable only to the specimens in the form in which they were tested. Small differences in the composition or thickness of the product may significantly affect the performance during the test and may therefore invalidate the test result. It is important that the specimens which are tested fully represent the product which is supplied and the manner in which it will be used. This may require a product to be tested in a number of different ways to determine the classification which will be achieved in its different methods of use.

A surface coating, for example, may be applied to a selected substrate using a particular method and application rate. The test classification which is achieved for that set of specimens will be applicable only to that situation. If the substrate or method and rate of application in a particular practical situation are different from that which was tested, then it will be necessary to determine the classification which will be achieved for that situation. Similarly, specimens incorporating a wallcovering must be fully representative of the situation which occurs in practice and will normally consist of the wallcovering bonded to a chosen substrate with a chosen adhesive; the test result will only apply to that composite system. The same principle applies to any composite or assembly which is being investigated.

It is sometimes possible to assume a 'worst case' situation which will enable a chosen set, or sets, of specimens to be constructed and tested to provide a foundation for the assessment of the probable performance of variations within the system. Similarly, it is sometimes possible to formulate a series of exploratory tests to investigate the effect of variations within a product or system, usually culminating in a series of formal tests to provide the basis for a composite assessment of pre-determined variables. In such cases, however, it is essential that careful planning of the programmes is undertaken by suitably qualified safety practitioners.

The following is re-produced from Appendix B of BS 476: Part 7: 1987;

With thin materials or composites, particularly those with a high thermal conductivity, the presence of an air gap and the nature of any underlying construction increases the 'heat sink' effect and may delay ignition of the exposed surface. Any backing provided to the test specimen and in intimate contact with it, such as the non-combustible spacers, may alter this 'heat sink' effect and may be fundamental to the test result itself. The influence of the underlying layers on the performance of the assembly should be understood and care should be taken to ensure that the result obtained on any assembly is relevant to its use in practice.

The following advice is offered on the construction and preparation of test specimens;

- (a) Where the thermal properties of the product are such that no significant heat loss to the underlying layers can occur, e.g. a material/composite greater than approximately 6 mm thick of high thermal capacity and/or low thermal conductivity, then the product should be tested backed only by the backing board.
- (b) Where the product is normally used as a free-standing sheet and the characteristics noted in (a) do not apply, then an air space should be provided at the back of the product by testing over spacers of non-combustible insulation board 20 mm wide and  $25 \pm 1$  mm thick.
- (c) Where the product is to be used over a low density non-combustible substrate and the characteristics noted in (a) do not apply, then the product should be tested in conjunction with that substrate.
- (d) Where the product is to be used over a combustible substrate and the characteristics noted in (a) do not apply, then the product should be tested in conjunction with that substrate.

Fire Technologist  
Room 105, Faraday House  
P.O. Box 2  
London Road  
Derby DE24 8YB

(0332) 264028

**THREE METRE CUBE SMOKE EMISSION TEST**

**BS 6853 : 1987 Appendix B5.2**

**Test Number: FT93/392/1**

**Test Date:** 16th February 1993

**Customer:** E.Wood Ltd  
Standard Way  
Northallerton  
North Yorkshire  
DL6 2XA

**Test Sample:** Copon EA9 WB Primer, 60 $\mu$  dft  
Copon EA9 WB Semi Gloss Finish, 60 $\mu$  dft  
on 2mm mild steel sheet.

Sample prepared by: E.Wood Ltd



### Test Procedure.

The test was carried out in accordance with the procedure specified in BS 6853:1987 Appendix B.5.2.

### Test Sample.

The test sample was conditioned for greater than 24 hours in a conditioning atmosphere of (50 +/-5)% Relative Humidity and (23 +/-2)°C.

The test sample was of dimensions 1000mm x 500mm x 2mm.

The sample was declared to have been prepared in the following manner:

The mild steel substrate was grit blasted to  $S_A 2\frac{1}{2}$ .

1st coat: Copon EA9 WB Primer coat spray applied to give 60μ dft.  
(The sample was overcoated after 16 hours at 20°C.)

2nd coat: Copon EA9 WB Semi Gloss Finish coat spray applied to give 60μ dft.  
The sample was then oven dried at 60°C for 2 hours, then allowed to fully cure for 7 days at 20°C.

### Ignition Source.

The ignition source used was BS 6853:1987 Appendix B.3 Source 1.

### Test Results.

The transmitted luminous intensity was measured continuously, and a plot of % Transmission (  $\%T = 100 \times I_t / I_o$  ) versus time is shown in Figure 1 ( page 4 ).

The measured results of % Transmission are:

$$\begin{aligned}\%T_{(on\ min)} &= 78.23 \text{ ( corresponds to } A_{o\&m(on\ max)} \text{ )} \\ \%T_{(on\ end)} &= 79.07 \text{ ( corresponds to } A_{o\&m(on\ end)} \text{ )} \\ \%T_{(off\ end)} &= 75.29 \text{ ( corresponds to } A_{m(off\ end)} \text{ )}\end{aligned}$$

The measured absorbance  $A_m$  is calculated in accordance with the Beer-Lambert law as follows:

$$A_m = \log_{10} (I_o / I_t)$$

where:

$I_o$  = initial luminous intensity;

$I_t$  = transmitted luminous intensity.

Hence:

$$A_m = \log_{10} ( 100 / \%T )$$

Figure 2 ( page 5 ) shows a plot of  $A_m$  versus time.

The value of  $A_m$  decreased from a maximum value during the "on" phase. Hence  $A_{m(off)}$  is corrected according to the following equation:

$$A_{m(off)} = A_{m(off\ end)} + A_{m(on\ max)} - A_{m(on\ end)}$$

The standard absorbance  $A_o$  is calculated as follows:

$$A_o = ( A_m \times V ) / ( n \times l )$$

where:

$V$  = volume of the cube (  $27m^3$  )

$l$  = optical path length (  $3m$  )

$n$  = number of samples (  $1$  )

The calculated results are as follows:

$$\begin{aligned} A_{o(on\ max)} &= 0.96 \text{ (abs) } m^2 / m^2 \\ A_{o(on\ end)} &= 0.92 \text{ (abs) } m^2 / m^2 \\ A_{o(off)} &= 1.15 \text{ (abs) } m^2 / m^2 \end{aligned}$$

#### Observations.

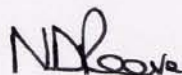
(all timings are approximate and from ignition of the alcohol ignition source)

At 3mins 45secs after ignition sustained surface flaming occurring from a single point, persisting to 6mins, intermittent flaming continuing to 10mins. Intermittent flaming occurred at two further points at 7mins persisting 20secs.

The test results relate only to the behaviour of the specimens under the particular conditions of this test; they are not intended to be the sole criterion for assessing the potential smoke hazard of the product in use.

The test results relate only to the specimens of the product in the form in which they were tested. Small differences in the thickness or composition of the product may affect the performance of the material under test and will therefore invalidate the test results.

Tested by:



N. Reeve  
Fire Technologist

Approved by:



J. Jarvis  
Fire Safety Engineer



Figure 1: % Transmission vs Time

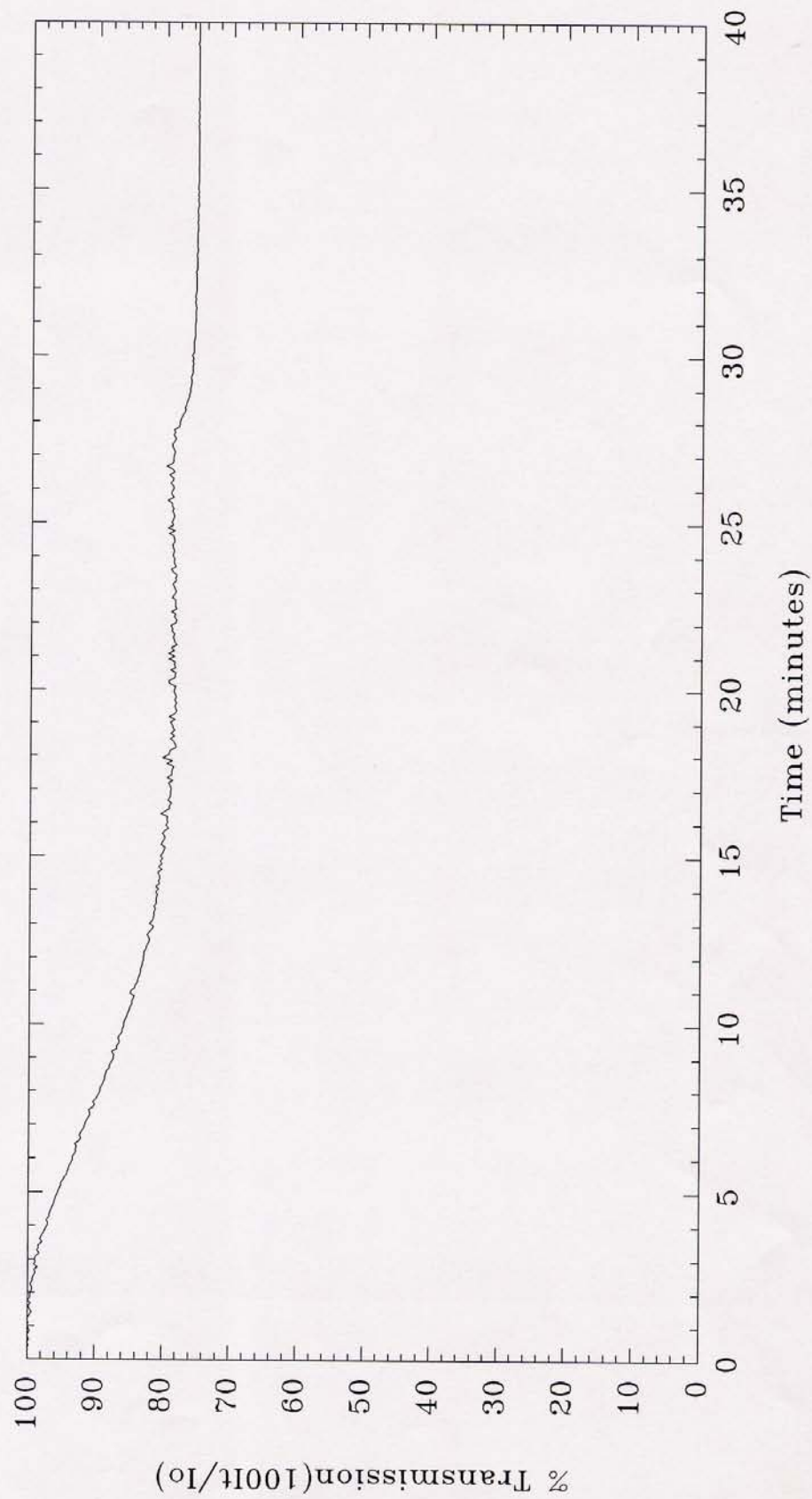
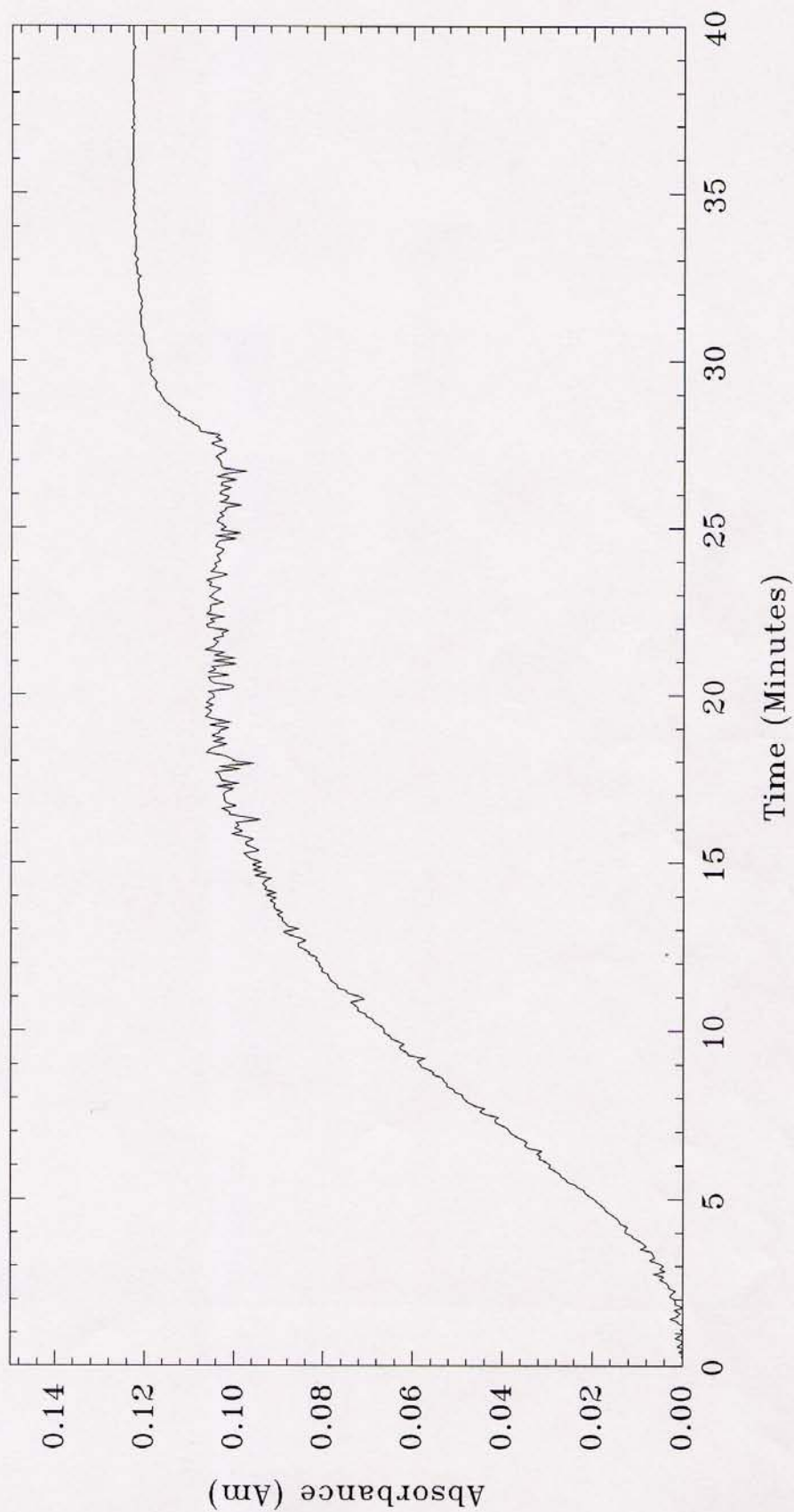
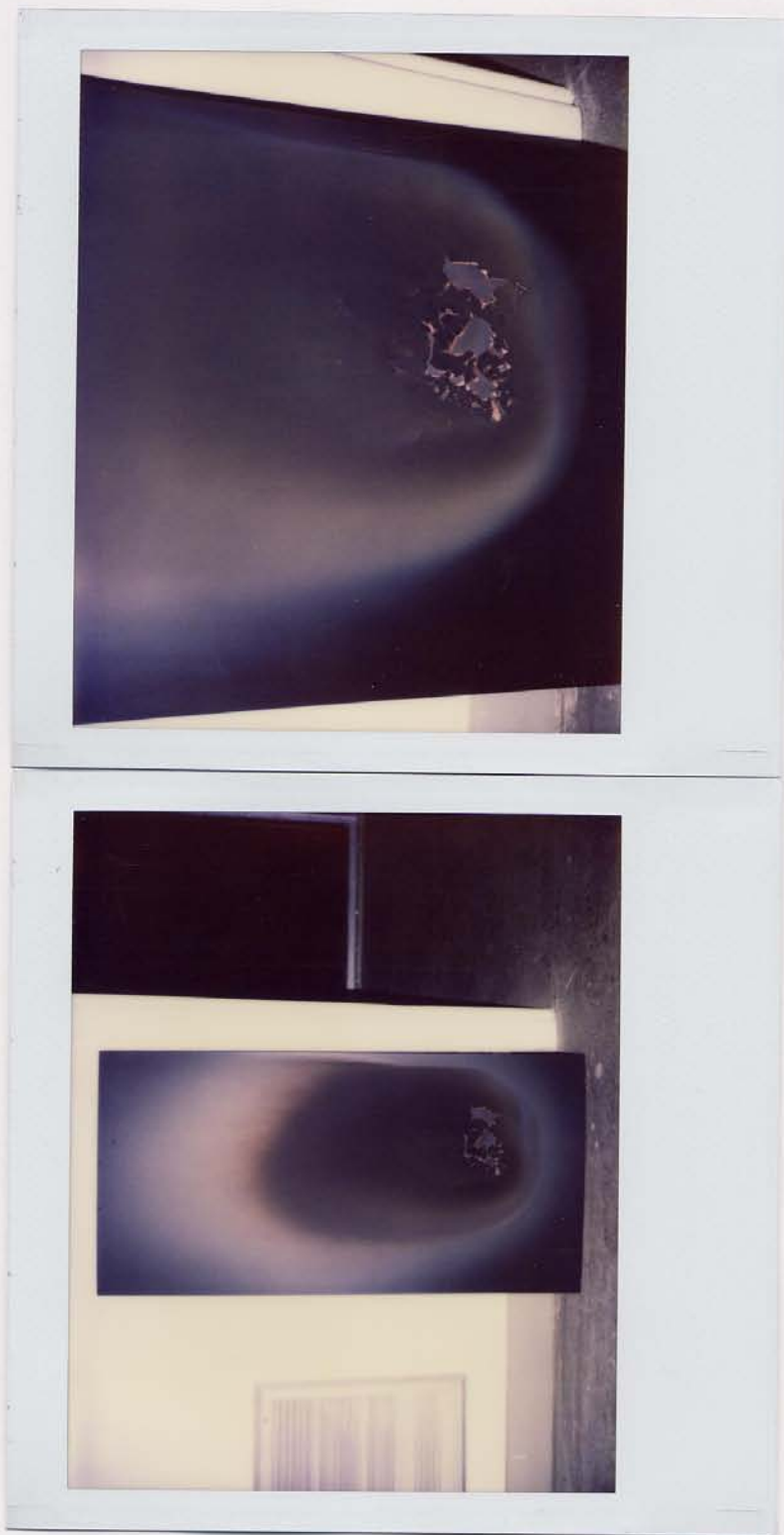


Figure 2: Am vs. Time

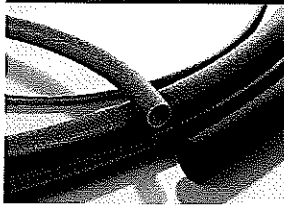




Sample after test.

Sample after test.  
(detail)

New Neu

**Conduit**flexible, medium-duty, semi-rigid,  
for static applications**Wellrohr**flexibel, mittelschwer, gute Steifigkeit,  
für statische Anwendungen**PLU**

PMAFLEX

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Underground

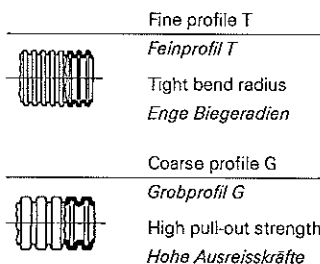
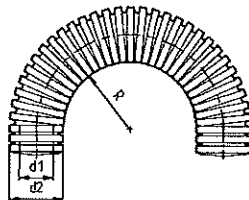
<b>application</b>	<ul style="list-style-type: none"> <li>for applications with the highest fire safety performance requirements</li> </ul>
<b>material</b>	<ul style="list-style-type: none"> <li>specialty modified polyolefin</li> </ul>
<b>characteristics</b>	<ul style="list-style-type: none"> <li>excellent flammability characteristics</li> <li>self-extinguishing</li> <li>free from halogens and cadmium</li> <li>very good insulating characteristics</li> <li>good flexibility</li> <li>impact resistant</li> <li>good resistance against strong acids and alkalies</li> </ul>
<b>suitable for</b>	PMAFIX, PMA Smart Line fittings
<b>colours</b>	black, grey

**Einsatzbereich** • für höchste Brandschutzanforderungen

<b>Material</b>	<ul style="list-style-type: none"> <li>speziell modifiziertes Polyolefin</li> </ul>
<b>Eigenschaften</b>	<ul style="list-style-type: none"> <li>hervorragende Brandeigenschaften</li> <li>selbstverlöschend</li> <li>halogen- und cadmiumfrei</li> <li>sehr gute Isolationseigenschaften</li> <li>gute Flexibilität</li> <li>schlag- und trittfest</li> <li>Beständigkeit gegenüber starken Säuren und Basen</li> </ul>
<b>passend zu</b>	PMAFIX, PMA Smart Line Verschraubungen
<b>Farben</b>	schwarz, grau

order no.		conduit size		fits to threads		dimensions in mm (nom.)			weight	packing unit
black	grey	NW	metric	metric	PG	d1	d2	stat. R.	kg/100 m	PU/m
<b>Bestell-Nr.</b>		<b>Rohrgrösse</b>		<b>passend zu Gewinde</b>		<b>Dimensionen in mm (nom.)</b>			<b>Gewicht</b>	<b>Verp.-Einheit</b>
schwarz	grau	NW	metrisch	metrisch	PG	d1	d2	stat. R.	kg/100 m	VE/m
PLUT-10B	PLUT-10S	10	12	M12 x 1.5	09	9.5	13.0	20	3.6	50
PLUT-12B	PLUT-12S	12	16	M16 x 1.5	11	11.8	15.8	30	4.7	50
PLUG-17B	PLUG-17S	17	20	M20 x 1.5	16	15.3	21.2	40	10.0	50
PLUG-23B	PLUG-23S	23	25	M25 x 1.5	21	22.4	28.5	45	13.5	50
PLUG-29B	PLUG-29S	29	32	M32 x 1.5	29	28.7	34.5	55	18.0	50
PLUG-36B	PLUG-36S	36	40	M40 x 1.5	36	36.3	42.5	60	22.0	30
PLUG-48B	PLUG-48S	48	50	M50 x 1.5	48	47.3	54.5	70	26.0	30

Our customer services dept. or local distribution partner will be pleased to help you concerning product availability and lead time  
 Unser Kundendienst oder die lokale PMA-Vertretung gibt Ihnen über die Artikelverfügbarkeit und Lieferzeit gerne Auskunft

**Dimensions Dimensionen**

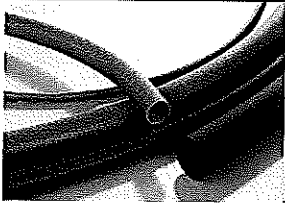

stat. R. = lowest recommended bending radius  
for static (fixed) installation  
kleinster empfohlener Biegeradius für  
statische (feste) Verlegung

Code reference	Nr.-Schlüssel
PLU = type	Typ
T = fine profile	Feinprofil
G = coarse profile	Grobprofil
17 = nominal width	Nennweite
B = colour-black	Farbe schwarz
S = colour-grey	Farbe grau

**PLU-Index**

min.	max.
ductility	Biegebarkeit
fatigue / reversed bending	Dauer- / Biegewechselfestigkeit
pressure resistance	Druck- / Trittfestigkeit
cold temperature performance	Kälteeigenschaften
weather resistance	Witterungseigenschaften



	<b>Conduit</b> flexible, medium-duty, semi-rigid, for static applications	 <b>CABLE PROTECTION</b> <b>KABELSCHUTZTECHNIK</b>
	<b>Wellrohr</b> flexibel, mittelschwer, gute Steifigkeit, für statische Anwendungen	

**PLU**  
PMAFLEX



London  
Underground



properties		unit	value	test method according to
<i>Eigenschaften</i>		<i>Einheit</i>	<i>Wert</i>	<i>Prüfmethode nach</i>
<b>Flame properties</b>	<b>Brandeigenschaften</b>			
Free from halogens	Halogenfrei		yes / ja	DIN 53474
fire performance	Brandverhalten		1a	BS 6853
fire performance	Brandverhalten		category-/EQ/I	LUL 2-01001-002 A1
fire performance	Brandverhalten		V0	UL 94 (3.2 mm)
limited oxygen index	begrenzter Sauerstoffindex	%	> 40	ISO 4589-1
<b>Thermal properties</b>	<b>Thermische Eigenschaften</b>			
Temperature range	Temperaturbereich	°C	-25 ... +95	PMA-Norm DO 9.21-4510
<b>Application approvals/releases</b>	<b>Anwendungszulassungen/-freigaben</b>			
London Underground Limited	London Underground Limited		type approval / Typenzulassung	Metronet Rail, Tube Lines
<b>Mechanical properties</b>	<b>Mechanische Eigenschaften</b>			
Impact strength	Schlagfestigkeit	J	> 3	PMA-Norm DO 9.21-4330
Compression strength	Scheiteldruckfestigkeit	N	> 140 (50 mm) > 280 (100 mm)	PMA-Norm DO 9.21-4320
Compression deformation	Scheiteldruckverformung	%	max. 50	
Reversed bending stresses	Biegewechselfestigkeit	cycles	> 5'000 flexible	IEC EN 61386
Pull-out resistance conduit/PMAFIX:	Ausreissfestigkeit Wellrohr/PMAFIX:			
Connector type IP68	Verschraubung Typ IP68	N	> 200	PMA-Norm DO 9.21-4610
Pull-out resistance conduit/ PMA Smart Line:	Ausreissfestigkeit Wellrohr/ PMA Smart Line:			
Connector type IP66	Verschraubung Typ IP66	N	> 150	PMA-Norm DO 9.21-4610
Testing at 23°C, 50% r.h., conduit nominal width 17, unless otherwise stated	Prüftemperatur 23°C, 50% r.F., Rohr- nennweite 17, sofern nicht anders angegeben			
<b>Weathering resistance</b>	<b>Witterungsbeständigkeit</b>			
weathering (UV/humidity) for black colour	Bewitterung (UV/Feuchte) für schwarze Farbe		good / gut	
<b>Chemical properties</b>	<b>Chemische Eigenschaften</b>			
please refer to catalogue	ersichtlich in PMAFIX/PMAFLEX:			
PMAFIX/PMAFLEX or www.pma.ch	Katalog oder unter www.pma.ch			
<b>Environmental properties</b>	<b>Umwelteigenschaften</b>			
RoHS compliant	RoHS-konform	J	yes / ja	EU Directive 2002/95/EC
<b>Content of delivery</b>	<b>Lieferumfang</b>			
Conduit	Wellrohr			

In addition to the national and international standards which consider mainly material properties and general product performance, PMA applies its own internally developed standards when assessing the system suitability of cable protection products. The PMA standards are based on 30 years experience and allow a better assessment of whether a product is practically appropriate for a specific application.

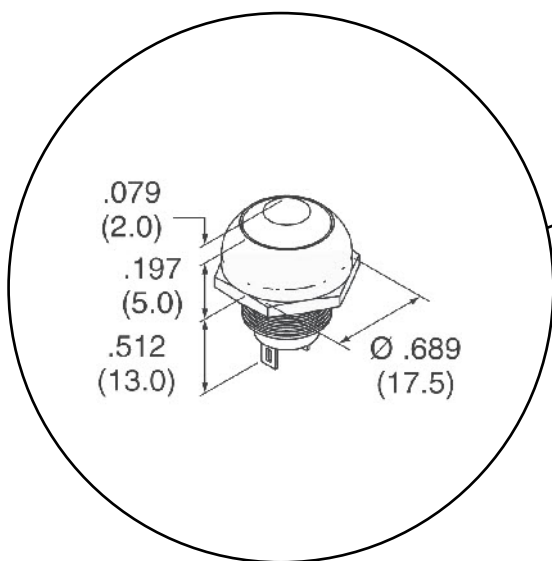
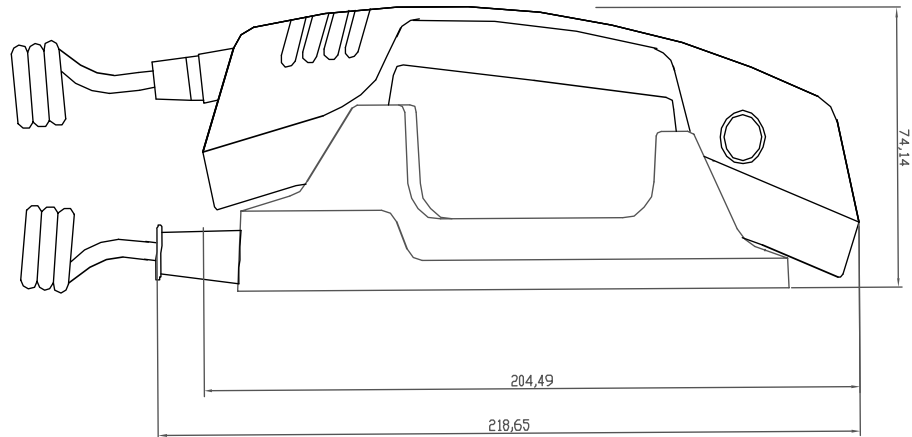
Neben internationalen und nationalen Normen, die sich vor allem auf Materialeigenschaften und allgemeine Produkteigenschaften beziehen, wendet PMA ergänzend selbst definierte Werknormen zur Beurteilung der Systemeigenschaften von Kabelschutzprodukten an. Diese erlauben auf der Basis über 30-jähriger Erfahrungen eine bessere Beurteilung der praktischen Eignung eines Produktes für spezifische Anwendungen.

The specifications and instructions for our customers in this document reflect the product engineering level at the time of manufacturing. Please consider the valid data sheet release at a time. For questions please contact the PMA customer service. PMA AG accepts no liability for damages resulting from unprofessional installation or application or misuse for a purpose. This disclaimer also includes damages to third parties. It is the customer's responsibility to check the delivered products and immediately notify PMA AG of detected faults. It is also the customer's responsibility to test the delivered product on its applicability for the intended purpose. PMA AG will accept no liability or responsibility for their products if a product or a PMA system is combined or used together with third-party products, i.e. products from other companies than PMA AG. Jurisdiction in all legal disputes concerning product liability have the courts of the canton of Zurich/Switzerland. Swiss law applies. For more information and the newest data sheet releases go to: [www.pma.ch](http://www.pma.ch)

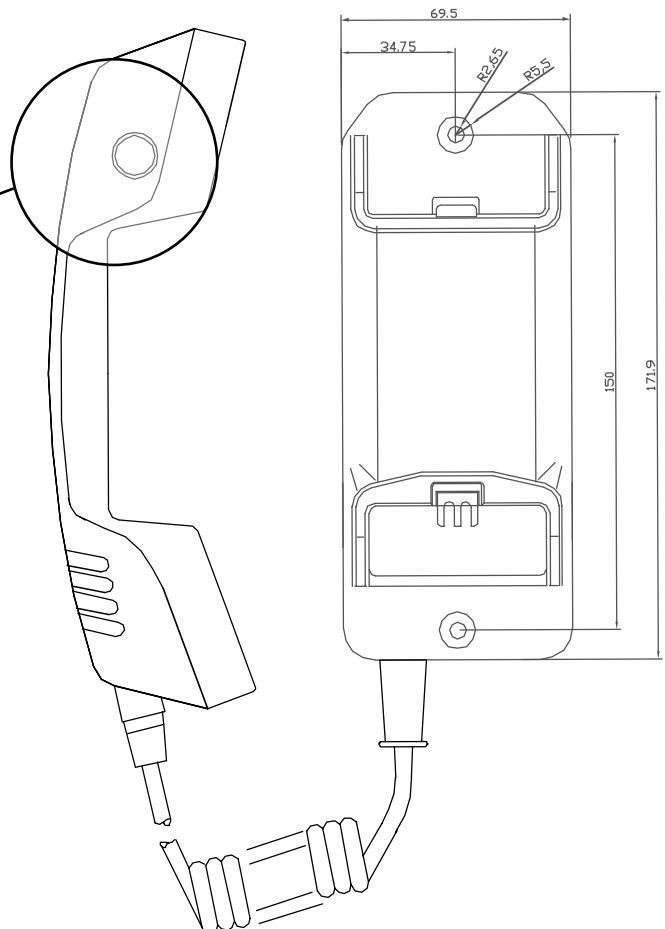
Die in diesem Dokument für unsere Kunden enthaltenen Angaben und Instruktionen entsprechen dem neuesten Stand unserer Technik zum Zeitpunkt der Herstellung des Produktes. Es ist der jeweils gültige Datenblattstand zu berücksichtigen. Bei Fragen wenden Sie sich bitte an den PMA-Kundendienst. Die PMA AG lehnt jede Haftung bei unsachgemässer Montage oder Verwendung sowie Zweckentfremdung des Produktes ab. Dieser Haftungsausschluss umfasst auch allfällige Drittschäden. Es obliegt dem Kunden, die gelieferten Werte zu prüfen und eintreffig festgestellte Mängel sofort der PMA AG anzuzeigen. Es obliegt ferner dem Kunden, die Ware auf ihre Eignung zwecks einer spezifischen Anwendung zu überprüfen. Die PMA AG lehnt jegliche Haftung für ihre Produkte ab, wenn ein einzelnes Produkt oder ein PMA-System mit Fremdprodukten, d.h. Produkten anderer Unternehmungen kombiniert bzw. verwendet wird. Gerichtsstand für Streitigkeiten bezüglich Produkthaftung sind die Gerichte des Kantons Zürich/Schweiz. Es kommt Schweizer Recht zur Anwendung. Ergänzende Informationen und neueste Datenblätter unter: [www.pma.ch](http://www.pma.ch)



**DAC Limited Handset and Stowage Assembly Part No. 505890**



Push button switch NO momentary  
IP67. Contact rated to 32v AC 0.4A





**Handset [part No. 503626] is a TPU-Ester/Ether (Thermoplastic Polyurethane Elastomer (Ester/Ether)) plastic material. Halogen Free**

## Mechanical Properties

**500 grade series, ether/ester / Shore hardness A 85 - 89**

Extrusion- and injection molding grade; improved microbial resistance; Improved hydrolysis resistance; Application; Cable sheathings; Hoses, non-reinforced; Roof lining

**ISO Shortname**

Property	Test Condition	Unit	Standard	Value		
				drying	annealed	-
(23 °C/50 % r. h.)						
C shore hardness, method A		-	ISO 868		88	
C shore hardness, method D		-	ISO 868		33	
Ultimate tensile strength	200 mm/min	MPa	DIN 53504		41,2	
Strain at break	200 mm/min	%	DIN 53504		550	
Stress at 10 % strain	200 mm/min	MPa	DIN 53504		2,2	
Stress at 50 % strain	200 mm/min	MPa	DIN 53504		5	
Stress at 100 % strain	200 mm/min	MPa	DIN 53504		6,4	
Stress at 300 % strain	200 mm/min	MPa	DIN 53504		12,4	
C Compression set	24 h; 70 °C	%	ISO 815		50	
C Compression set	72 h; 23 °C	%	ISO 815		25	
C Abrasion resistance		mm³	ISO 4649		60	
Impact resilience		%	ISO 4662		36	
Tear propagation resistance	500 mm/min	kN/m	ISO 34-1		55	

### Thermal properties

Tensile storage modulus	-20 °C	MPa	ISO 6721-1,-4		165	
Tensile storage modulus	20 °C	MPa	ISO 6721-1,-4		29	
Tensile storage modulus	60 °C	MPa	ISO 6721-1,-4		20	

### Other properties (23 °C)

C Density		kg/m³	ISO 1183-1			1150
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### Molding conditions

Injection molding-Melt temperature		°C	-	210 - 230		
Injection molding-Mold temperature		°C	-			20 - 40
Extrusion-Melt temperature		°C	-	190 - 210		
Maximum drying temperature		°C	-			80

# Material Properties & Safety Information

## SAFETY DATA SHEET

according to Regulation (EU) No. 1907/2006

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Vapour pressure:	not	applicable
Viscosity, dynamic:	not	applicable
Water solubility:	practically insoluble	
pH:	not applicable	
Ignition temperature:	> 210 °C	
Autoignition temperature:	not applicable	
Explosion limits:	not applicable	

---

### STABILITY AND REACTIVITY

**Hazardous reactions:** No hazardous reactions observed.

**Hazardous decomposition products:** Smouldering or incomplete combustion leads to the formation of toxic gas mixtures consisting mainly of CO, CO<sub>2</sub> and nitrogen oxides.

**Thermal decomposition:** Decomposition begins at 230 °C.

---

### TOXICOLOGICAL INFORMATION PRIOR TO PROCESSING

Small quantities of isocyanates may be released when drums are opened for the first time and when the product is exposed to elevated temperatures (e.g. during drying or processing). It is primarily a matter of diisopropylphenyl isocyanate.

Exceeding the recommended processing temperatures leads to a significant increase in the amount of isocyanate vapor generated.

Over-exposure entails a risk of concentration-dependent inhalatory irritation and/or sensitization by isocyanates (delayed appearance of difficult breathing, coughing, asthma is possible). Hypersensitive persons may suffer from these effects even at low isocyanate concentrations.

The regulations for the substances listed below must be observed when processing this product, particularly if processing takes place at elevated temperatures.

Substance	CAS-No.	R-phrases
Isocyanates (all, as -NCO)		R42 May cause sensitization by inhalation.
diisopropyl-phenylisocyanate	28178-42-9	R26 Very toxic by inhalation. R22 Harmful if swallowed. R42 May cause sensitization by inhalation. R34 Causes burns.
tetrahydrofuran	109-99-9	R36/37 Irritating to eyes and respiratory system.

# SAFETY DATA SHEET

according to Regulation (EU) No. 1907/2006

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## Additional information:

According to our experience and information the product has no harmful effects on health if properly handled.

---

## ECOLOGICAL INFORMATION

Do not allow to escape into waterways, wastewater or soil.

### Additional information on ecotoxicology:

The product is practically insoluble in water. In view of its consistency and insolubility in water, no ecological problems are to be expected if the product is properly handled. The product is not readily biodegradable.

---

## DISPOSAL CONSIDERATIONS

Dispose in accordance with applicable international, national and local laws, ordinances and statutes. For disposal within the EC, the appropriate code according to the European Waste Catalogue (EWC) should be used.

After containers have been emptied as thoroughly as possible (e.g. by pouring, scraping or draining until "drip-dry"), they can be sent to an appropriate collection point set up within the framework of the existing take-back scheme of the chemical industry. Containers must be recycled in compliance with national legislation and environmental regulations.

The product is suitable for mechanical recycling. After appropriate treatment it can be remelted and reprocessed into new moulded articles. Mechanical recycling is only possible if the material has been selectively retrieved and carefully segregated according to type.

---

## TRANSPORT INFORMATION

Not Dangerous good according to ADG Code

**ADR/RID** - -

**ADNR** - -

**IATA** - -

**IMDG** - -

Other information : Not dangerous cargo.  
Slight smell. Keep dry.  
Keep separated from foodstuffs.

---

## OTHER INFORMATION

### Further information

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.



Stowage [part No. 505555] is a Polyether plastic material.

## Mechanical Properties

### Polyether Block Amide (PEBA) (Conditioned)

Categories: [Polymer](#); [Thermoplastic](#); [Elastomer, TPE](#); [Polyether Block Amide \(PEBA\)](#)

**Material Notes:** POLYETHER BLOCK AMIDE(PEBA) hardness 55 shore D Non plasticized flexible Polyamide Outstanding mechanical properties at low temperature (-40.C) Applications: overmolded parts for sport good (Football shoe sole) Industrial (conveyor belts, transmission belts)

ISO data provided by the manufacturer.

**Key Words:** Thermoplastic Elastomer, TPE

Physical Properties	Metric	English	Comments
Density	1.01 g/cc	0.0365 lb/in	
Melt Flow	8.00 g/10 min	8.00 g/10 min	235 C/1 kg load
Mechanical Properties	Metric	English	Comments
Hardness, Shore D	55	55	
Tensile Strength, Yield	12.0 MPa	1740 psi	50 mm/min
Elongation at Break	>= 50.0 %	>= 50.0 %	Nominal Strain; 50 mm/min
Elongation at Yield	31.0 %	31.0 %	50 mm/min
Tensile Modulus	0.150 GPa	21.8 ksi	1 mm/min
Charpy Impact Unnotched	NB	NB	
Charpy Impact, Notched, Low Temp	NB	NB	
Charpy Impact, Unnotched Low Temp	NB	NB	
Charpy Impact, Notched	NB	NB	
Electrical Properties	Metric	English	Comments
Surface Resistance	3.00e+12 ohm	3.00e+12 ohm	
Thermal Properties	Metric	English	Comments
CTE, linear	170 m/m-C	94.4 in/in-F	Parallel to Flow
Melting Point	159 C	318 F	(Dry)
Deflection Temperature at 0.46 MPa (66 psi)	66.0 C	151 F	
Vicat Softening Point	144 C	291 F	50 C/hr; 50N
Flammability, UL94	HB	HB	1.6 mm
Optical Properties	Metric	English	Comments
Transmission, Visible	80.0 %	80.0 %	Mfr. reports 'Transparent' but doesn't quantify.

**MATERIAL SAFETY DATA SHEET**

Printed: 1/6/09

**PRODUCT IDENTIFICATION AND USE**

PRODUCT CODE: AP9678  
PRODUCT USE: ENGINEERING THERMOPLASTIC RESIN FOR EXTRUSION AND MOLDING APPLICATIONS.  
WHMIS CLASSIFICATION: NOT CONTROLLED

**HAZARDOUS INGREDIENTS**

	%W/W	CAS #	TLV
NA			

ADDITIONAL INGREDIENT INFORMATION (WHMIS NOT CONTROLLED):

POLYETHER BLOCK POLYAMIDE COPOLYMER

**PHYSICAL DATA**

PHYSICAL STATE: SOLID  
ODOUR AND APPEARANCE: YELLOW PELLETS; MINIMAL ODOUR.  
ODOUR THRESHOLD: NE  
SPECIFIC GRAVITY/DENSITY (G/ML): 1.01 – 1.1  
VAPOUR PRESSURE: NE  
VAPOUR DENSITY (AIR=1): NE  
VOLATILITY/VOL(%): NE  
SOLUBILITY IN H2O: NEGLIGIBLE  
EVAPORATION RATE: NE  
BOILING POINT: NE  
FREEZING POINT: 130-175°C (MELTING POINT)  
PH: NE  
LOG KOW: NE

**SHIPPING INFORMATION**

THIS PRODUCT IS NOT TDG REGULATED.

**FIRE AND EXPLOSION HAZARD**

FLAMMABILITY: NOT FLAMMABLE.  
CONDITIONS: WILL BURN AT ELEVATED TEMPERATURES.  
MEANS OF EXTINCTION: WATER SPRAY, CARBON DIOXIDE, FOAM, DRY CHEMICALS.  
FLASHPOINT: NE UPPER EXPLOSION LIMIT (% V):  
NA LOWER EXPLOSION LIMIT (%V):  
NA AUTO-IGNITION TEMPERATURE:  
NE HAZARDOUS COMBUSTION  
PRODUCTS: OXIDES OF CARBON, NITROGEN OXIDES.  
EXPLOSION DATA: NE  
SENSITIVITY TO IMPACT: NO

NA - NOT APPLICABLE

NE - NOT ESTABLISHED

# MATERIAL SAFETY DATA SHEET

Printed: 1/6/09

SENSITIVITY TO STATIC DISCHARGE: NO

## REACTIVITY

CHEMICAL STABILITY: STABLE  
 INCOMPATIBLE MATERIALS: ACIDS, STRONG OXIDIZING AGENTS.  
 CONDITIONS OF REACTIVITY: NE  
 HAZARDOUS DECOMPOSITION PRODUCTS: NE

## HEALTH HAZARD INFORMATION

ROUTE OF ENTRY  
 SKIN CONTACT: PROCESS VAPOURS MAY CAUSE IRRITATION.  
 SKIN ABSORPTION: NE  
 EYE: PROCESS VAPOURS MAY CAUSE IRRITATION.  
 INGESTION: NOT EXPECTED TO BE HARMFUL.  
 INHALATION: PROCESS VAPOURS MAY CAUSE IRRITATION.  
 ACUTE OVER EXPOSURE EFFECTS: NE  
 CHRONIC OVER EXPOSURE EFFECTS: NE  
 SENSITIZATION: DOES NOT MEET WHMIS CRITERIA.  
 CARCINOGENICITY: DOES NOT MEET WHMIS CRITERIA.  
 TERATOGENICITY: DOES NOT MEET WHMIS CRITERIA.  
 MUTAGENICITY: DOES NOT MEET WHMIS CRITERIA.  
 REPRODUCTIVE TOXICITY: DOES NOT MEET WHMIS CRITERIA.

## PREVENTIVE MEASURES

PERSONAL PROTECTIVE EQUIPMENT: WEAR SAFETY GLASSES AND USE IMPERVIOUS GLOVES  
 SPECIFIC ENGINEERING CONTROLS: LOCAL EXHAUST IS RECOMMENDED.  
 LEAK AND SPILL PROCEDURES: SWEEP OR SCOOP UP AND REMOVE TO SUITABLE CONTAINER.  
 WASTE DISPOSAL: CONSULT FEDERAL OR LOCAL AUTHORITIES.  
 HANDLING PROCEDURES AND EQUIPMENT: WASH BEFORE EATING, DRINKING, USING TOBACCO PRODUCTS OR REST ROOMS  
 STORAGE REQUIREMENTS: KEEP IN A CLOSED, LABELED CONTAINER IN A VENTILATED AREA.

## FIRST AID MEASURES

EYE FLUSH EYES WITH LARGE AMOUNT OF WATER FOR 15 MINUTES WHILE HOLDING EYELIDS OPEN. SEEK MEDICAL ATTENTION IF IRRITATION OCCURS OR PERSISTS.  
 SKIN WASH SKIN WITH WATER AND SOAP. SEEK MEDICAL ATTENTION IF IRRITATION OCCURS OR PERSISTS.  
 INGESTION NONE REQUIRED  
 INHALATION REMOVE PERSON TO FRESH AIR IMMEDIATELY. IF BREATHING HAS STOPPED, APPLY ARTIFICIAL RESPIRATION AND ADMINISTER OXYGEN IF NECESSARY. SEEK MEDICAL ATTENTION.

## PREPARATION DATE

PREPARED BY: TECHNICAL DEPARTMENT.  
 PHONE NUMBER OF PREPARER: 905-827-9841  
 DATE PREPARED (MM/DD/YY): 10/15/92  
 DATE REVISED (MM/DD/YY): 01/06/09

MINIMUM CONTACT WITH THIS AND ALL CHEMICALS IS RECOMMENDED AS A GOOD GENERAL POLICY

NA - NOT APPLICABLE

NE - NOT ESTABLISHED



## **MATERIAL SAFETY DATA SHEET**

Printed: 1/6/09

FOLLOW.

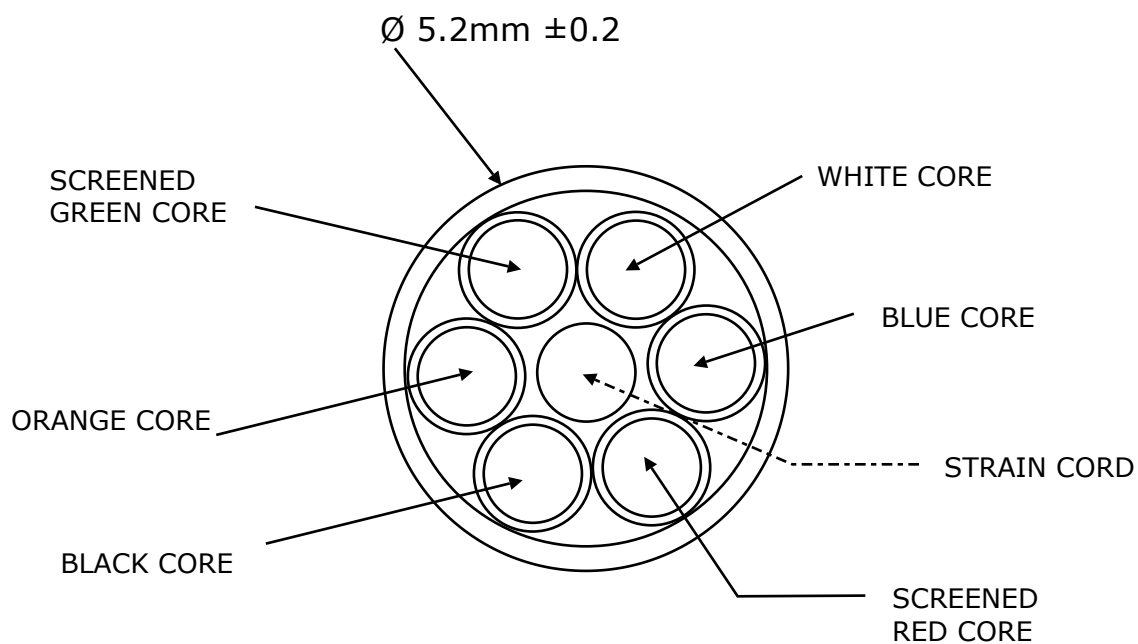
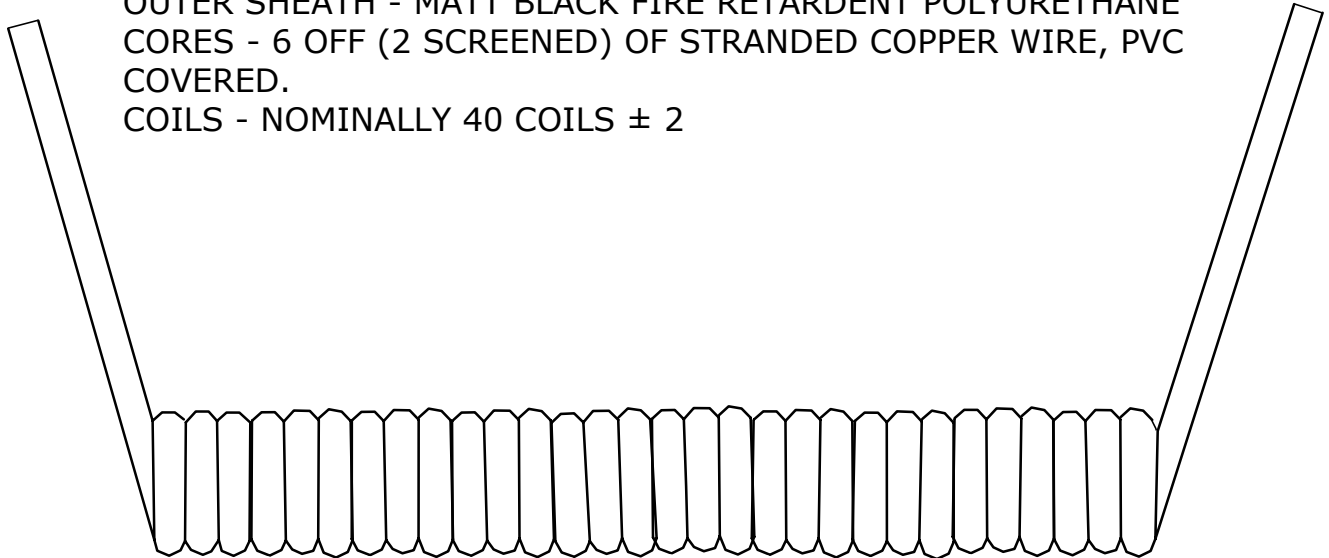
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DAC extensible cable - Part No. 4019/DAC/40COIL

**GENERAL DESCRIPTION**

OUTER SHEATH - MATT BLACK FIRE RETARDENT POLYURETHANE  
CORES - 6 OFF (2 SCREENED) OF STRANDED COPPER WIRE, PVC  
COVERED.

COILS - NOMINALLY 40 COILS  $\pm$  2



# Traction Cable

## Radox GKW-LW/S



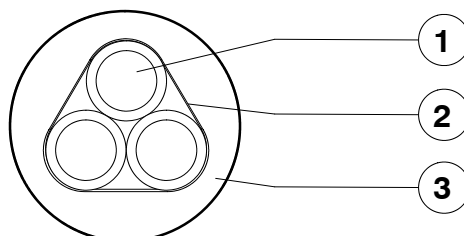
### General Properties :

Excellent high temperature, low temperature, ozone, diesel oil and weathering resistance, zero halogen, flame retardant, easily strippable, flexible.

### Application :

For permanent protected installation inside equipment, on cable trays etc. inside and outside of railway rolling stock, buses and other vehicles.

### General composition of cable :



#### 1. Cores GKW-LW

Conductor : flexible tin plated copper  
Dual wall insulation : GKW P / GKW HP  
Colour : n x white : all cores sequentially numbered [ e.g. 4x1.5 mm<sup>2</sup>]  
or (n-1) x white numbered, last core yellowgreen [ e.g. 4G1.5 mm<sup>2</sup>]

#### 2. Covering

Plastic tape

#### 3. Jacket

Radox GKW S, colour : black

Cable marking H + S 125zzzzz-zzzzzz Radox GKW-LW/ S n x ... mm<sup>2</sup>  
except 1.0 mm<sup>2</sup> : Production lot number

Cable marking H + S 125zzzzz-zzzzzz Radox GKW-LW/S n x 1.0 mm<sup>2</sup> ( 18 AWG )  
only 1.0 mm<sup>2</sup> : Production lot number

### Technical Data :

Voltage rating cond.-earth  
Voltage rating cond.-cond.  
maximum permissible Voltage rating cond.-earth  
maximum permissible Voltage rating cond.-cond.  
maximum permissible Voltage rating cond.-earth  
maximum permissible Voltage rating cond.-cond.

U <sub>0</sub>	600	V rms
U	1000	V rms
	720	V rms
U <sub>m</sub>	1200	V rms
V <sub>0</sub>	900	V dc
	1500	V dc

Test voltage, 5 min

	3500	V rms
	8400	V dc

Max. conductor temperature continuous

+ 120 °C

Min. operating temperature ...

- 40 °C

Min. bending radius free installation

D ≤ 10 mm 5 x D

D > 10 mm 6 x D

D ≤ 10 mm 3 x D

D > 10 mm 4 x D

fixed installation

where D : cable diameter ( see table )

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**HUBER+SUHNER**  
Wire+Cable Division

CH-8330 Pfäffikon



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www.hubersuhner.com

# Traction Cable

## Radox GKW-LW/S



### The cables are in conformity with:

Fire protection on railway vehicles, category ..... int. Ia, Ib, II, ext. Ia, Ib, II. BS 6853

**Fire protection on railway vehicles, level ..... 1 - 4 ..... DIN 5510**

Vertical flame spread .....  $50 < L \leq 540$  mm ..... EN 60332-1-2

Vertical flame spread, bunched,  $D \leq 6$  mm .....  $L \leq 1.5$  m ..... EN 50305, 9.1.2

Vertical flame spread, bunched,  $6 < D < 12$  mm .....  $L \leq 2.5$  m ..... EN 50266-2-5 (EN 50305, 9.1.1)

Vertical flame spread, bunched,  $D \geq 12$  mm .....  $L \leq 2.5$  m ..... EN 50266-2-4

Smoke density .....  $T \geq 60$  % ..... EN 61034-2

Corrosivity of combustion gases .....  $pH \geq 4.3$ ,  $C \leq 10 \mu S/mm$  ..... EN 50267-2-2

Amount of halogen acid gas .....  $HCl + HBr \leq 0.5$  % ..... EN 50267-2-1

Content of fluorine .....  $HF \leq 0.1$  % ..... EN 60684-2, 45.2

Toxicity .....  $ITC \leq 5$  ..... EN 50305, 9.2

**Fire protection on railway vehicles, category ..... A1, A2, B ..... NF E16-101**

Fire protection on railway vehicles, class ..... C / F0 ..... NF E16-101

Vertical flame spread .....  $50 < L \leq 540$  mm ..... NF C32-070, 2.1

Vertical flame spread, bunched .....  $L \leq 300$  mm ..... NF C32-070, 2.2

Smoke index .....  $I.F. \leq 5$  ..... X10-702-2, NF X70-100-1

**Fire protection on railway vehicles ..... Fulfilled ..... NFPA 130**

Vertical flame spread, bunched .....  $L \leq 1.5$  m ..... UL 1685, 12 (FT4 exp.)

Smoke density .....  $TSR \leq 150 m^2$ ,  $PSRR \leq 0.40 m^2/s$  ..... UL 1685, 12 (FT4 exp.)

**Fire protection on railway vehicles, class ..... B ..... UIC 564-2**

Vertical flame spread .....  $L \leq 300$  mm,  $t \leq 30$  s ..... UIC 895 An. 6

**Fire protection on railway vehicles, hazard level ..... LR1 - LR3 ..... UNI CEI 11170**

Vertical flame spread .....  $50 < L \leq 540$  mm ..... EN 60332-1-2

Vertical flame spread, bunched,  $D \leq 6$  mm .....  $L \leq 1.5$  m ..... EN 50305, 9.1.2

Vertical flame spread, bunched,  $6 < D < 12$  mm .....  $L \leq 2.5$  m ..... EN 50266-2-5 (EN 50305, 9.1.1)

Vertical flame spread, bunched,  $D \geq 12$  mm .....  $L \leq 2.5$  m ..... EN 50266-2-4

Smoke density .....  $T \geq 70$  % ..... EN 61034-2

Corrosivity of combustion gases .....  $pH \geq 4.3$ ,  $C \leq 10 \mu S/mm$  ..... EN 50267-2-2

Amount of halogen acid gas .....  $HCl + HBr \leq 0.5$  % ..... EN 50267-2-1

Toxicity .....  $ITC \leq 5$  ..... EN 50305, 9.2

### Applicable standards :

H+S : 563078 (e) : Technical Datasheet : Traction cable Radox GKW-LW Current rating for multicore cables

H+S : 97382-0701(e)1.doc : Technical Specification GKW-LW Thin Wall Single Core Cables

# Traction Cable

## Radox GKW-LW/S



Table 1:

Cable type n x mm <sup>2</sup>	Conductor <sup>nom</sup> construction* n x mmD		Core dia nom mm	Cable dia mm	R <sub>20</sub> max Ω/km	C <sub>max</sub> core/core pF/m	Fire load nom kJ/m	Weight <sup>nom</sup> Cu kg / 100m	H + S Part No.
12 x 2 x 0.25	19 x 0.13	0.60	1.02	8.9 ± 0.3	88.5	100	1000	5.5	10.8
2 x 0.50	19 x 0.18	0.90	1.30	4.0 ± 0.2	40.1	105	250	1.0	2.7
3 x 0.50	19 x 0.18	0.90	1.30	4.2 ± 0.2	40.1	105	275	1.4	3.1
4 x 0.50	19 x 0.18	0.90	1.30	4.5 ± 0.2	40.1	105	310	1.9	3.7
5 x 0.50	19 x 0.18	0.90	1.30	5.0 ± 0.2	40.1	105	385	2.3	4.6
5 G 0.50	19 x 0.18	0.90	1.30	5.0 ± 0.2	40.1	105	385	2.3	4.6
6 x 0.50	19 x 0.18	0.90	1.30	5.4 ± 0.2	40.1	105	450	2.8	5.3
7 x 0.50	19 x 0.18	0.90	1.30	5.8 ± 0.3	40.1	105	530	3.2	6.2
9 x 0.50	19 x 0.18	0.90	1.30	6.7 ± 0.3	40.1	105	570	4.2	7.6
10 x 0.50	19 x 0.18	0.90	1.30	6.7 ± 0.3	40.1	105	605	4.6	8.0
12 x 0.50	19 x 0.18	0.90	1.30	6.9 ± 0.3	40.1	105	665	5.5	9.0
15 x 0.50	19 x 0.18	0.90	1.30	7.8 ± 0.3	40.1	105	885	6.9	11.5
16 x 0.50	19 x 0.18	0.90	1.30	7.8 ± 0.3	40.1	105	875	7.4	11.9
18 x 0.50	19 x 0.18	0.90	1.30	8.2 ± 0.3	40.1	105	970	8.3	13.2
24 x 0.50	19 x 0.18	0.90	1.30	9.5 ± 0.3	40.1	105	1190	11.1	16.9
25 x 0.50	19 x 0.18	0.90	1.30	9.5 ± 0.3	40.1	105	1190	11.5	17.2
27 x 0.50	19 x 0.18	0.90	1.30	9.7 ± 0.3	40.1	105	1260	12.5	18.4
30 x 0.50	19 x 0.18	0.90	1.30	10.1 ± 0.4	40.1	105	1390	13.8	20.3
36 x 0.50	19 x 0.18	0.90	1.30	11.2 ± 0.4	40.1	105	1740	16.6	24.8
2 x 2 x 0.50	19 x 0.18	0.90	1.30	5.8 ± 0.3	41.4	105	490	1.9	4.7

# Traction Cable

## Radox GKW-LW/S



Cable type n x mm <sup>2</sup>	Conductor <sup>nom</sup> construction* n x mmD	Conductor <sup>nom</sup> dia mm	Core dia nom mm	Cable dia mm	R <sub>20</sub> max Ω/km	C <sub>max</sub> core/core pF/m	Fire load nom kJ/m	Weight <sup>nom</sup> Cu kg / 100m	H + S Part No.
2 x 0.75	19 x 0.22	1.12	1.52	4.4 ± 0.2	26.7	110	290	1.4	12 566 767
3 x 0.75	19 x 0.22	1.12	1.52	4.6 ± 0.2	26.7	110	310	2.1	12 556 768
3 G 0.75	19 x 0.22	1.12	1.52	4.6 ± 0.2	26.7	110	310	2.1	12 562 758
4 x 0.75	19 x 0.22	1.12	1.52	5.0 ± 0.2	26.7	110	355	2.8	12 556 769
5 x 0.75	19 x 0.22	1.12	1.52	5.7 ± 0.3	26.7	110	465	3.5	12 556 770
6 x 0.75	19 x 0.22	1.12	1.52	6.0 ± 0.3	26.7	110	525	4.3	12 556 771
7 x 0.75	19 x 0.22	1.12	1.52	6.8 ± 0.3	26.7	110	680	5.0	12 556 772
8 x 0.75	19 x 0.22	1.12	1.52	7.4 ± 0.3	26.7	110	820	5.7	12 561 829
9 x 0.75	19 x 0.22	1.12	1.52	7.7 ± 0.3	26.7	110	750	6.4	12 581 701
9 G 0.75	19 x 0.22	1.12	1.52	7.7 ± 0.3	26.7	110	750	6.4	12 581 833
10 x 0.75	19 x 0.22	1.12	1.52	7.7 ± 0.3	26.7	110	740	7.1	12 556 773
12 x 0.75	19 x 0.22	1.12	1.52	7.9 ± 0.3	26.7	110	810	8.5	12 556 673
14 x 0.75	19 x 0.22	1.12	1.52	8.4 ± 0.3	26.7	110	920	9.9	12 561 830
16 x 0.75	19 x 0.22	1.12	1.52	9.0 ± 0.3	26.7	110	1060	11.3	12 556 774
18 x 0.75	19 x 0.22	1.12	1.52	9.4 ± 0.3	26.7	110	1180	12.7	12 556 775
20 x 0.75	19 x 0.22	1.12	1.52	10.2 ± 0.4	26.7	110	1390	14.2	12 561 831
24 x 0.75	19 x 0.22	1.12	1.52	11.1 ± 0.4	26.7	110	1490	17.1	12 556 776
27 x 0.75	19 x 0.22	1.12	1.52	11.3 ± 0.4	26.7	110	1550	19.1	12 556 812
30 x 0.75	19 x 0.22	1.12	1.52	11.7 ± 0.4	26.7	110	1690	21.2	12 556 813



# Traction Cable

## Radox GKW-LW/S



Cable type n x mm <sup>2</sup>	Conductor* construction* n x mmD	Conductor nom dia mm	Core dia nom mm	Cable dia mm	R <sub>20</sub> max Ω/km	C <sub>max</sub> core/core pF/m	Fire load nom kJ/m	Weight <sub>nom</sub> Cu kg / 100m	H + S Part No.
36 x 0.75	19 x 0.22	1.12	1.52	12.8 ± 0.4	26.7	110	2060	25.5	12 556 814
41 x 0.75	19 x 0.22	1.12	1.52	14.5 ± 0.4	26.7	110	2520	29.1	12 568 482

# Traction Cable

## Radox GKW-LW/S



Cable type n x mm <sup>2</sup>		Conductor <sup>nom</sup> construction* n x mmD		Core dia nom mm	Cable dia mm	R <sub>20</sub> max Ω/km	C <sub>max</sub> core/core pF/m	Fire load nom kJ/m	Weight <sub>nom</sub> Cu kg / 100m	H + S Part No.
2 x 1.0	2 x 18	19 x 0.26	1.23	1.67	4.7 ± 0.2	20.0	115	330	1.8	12 556 777
3 x 1.0	3 x 18	19 x 0.26	1.23	1.67	5.0 ± 0.2	20.0	115	360	2.7	12 556 778
4 x 1.0	4 x 18	19 x 0.26	1.23	1.67	5.5 ± 0.2	20.0	115	415	3.6	12 556 779
5 x 1.0	5 x 18	19 x 0.26	1.23	1.67	6.0 ± 0.3	20.0	115	515	4.5	12 556 780
5 G 1.0	5 G 18	19 x 0.26	1.23	1.67	6.0 ± 0.3	20.0	115	515	4.5	12 563 051
6 x 1.0	6 x 18	19 x 0.26	1.23	1.67	6.6 ± 0.3	20.0	115	625	5.4	12 556 781
7 x 1.0	7 x 18	19 x 0.26	1.23	1.67	7.3 ± 0.3	20.0	115	775	6.3	12 556 475
10 x 1.0	10 x 18	19 x 0.26	1.23	1.67	8.3 ± 0.3	20.0	115	890	9.0	12 556 782
12 x 1.0	12 x 18	19 x 0.26	1.23	1.67	8.6 ± 0.3	20.0	115	940	10.9	12 556 783
14 x 1.0	14 x 18	19 x 0.26	1.23	1.67	9.1 ± 0.3	20.0	115	1060	12.7	12 582 064
16 x 1.0	16 x 18	19 x 0.26	1.23	1.67	9.6 ± 0.3	20.0	115	1200	14.5	12 556 784
18 x 1.0	18 x 18	19 x 0.26	1.23	1.67	10.3 ± 0.4	20.0	115	1420	16.3	12 556 785
20 x 1.0	20 x 18	19 x 0.26	1.23	1.67	11.2 ± 0.4	20.0	115	1640	18.1	12 556 476
22 x 1.0	22 x 18	19 x 0.26	1.23	1.67	11.6 ± 0.4	20.0	115	1750	20.0	12 583 631
24 x 1.0	24 x 18	19 x 0.26	1.23	1.67	12.1 ± 0.4	20.0	115	1730	21.7	12 556 815
27 x 1.0	27 x 18	19 x 0.26	1.23	1.67	12.4 ± 0.4	20.0	115	1800	24.5	12 556 816
30 x 1.0	30 x 18	19 x 0.26	1.23	1.67	12.8 ± 0.4	20.0	115	1940	27.2	12 556 477
36 x 1.0	36 x 18	19 x 0.26	1.23	1.67	14.0 ± 0.4	20.0	115	2410	32.7	12 556 817
50 x 1.0	50 x 18	19 x 0.26	1.23	1.67	16.8 ± 0.5	20.0	115	3270	45.4	12 565 314

# Traction Cable

## Radox GKW-LW/S



Cable type n x mm <sup>2</sup>	Conductor <sup>nom</sup> construction* n x mmD	Core dia nom mm	Cable dia mm	R <sub>20</sub> max Ω/km	C <sub>max</sub> core/core pF/m	Fire load nom kJ/m	Weight <sup>nom</sup> Cu kg / 100m	H + S Part No.
2 x 1.5	37 x 0.22	2.04	5.4 ± 0.3	13.7	120	430	2.9	12 556 786
3 x 1.5	37 x 0.22	2.04	5.8 ± 0.3	13.7	120	470	4.3	12 555 404
3 G 1.5	37 x 0.22	2.04	5.8 ± 0.3	13.7	120	470	4.3	12 559 973
4 x 1.5	37 x 0.22	2.04	6.5 ± 0.3	13.7	120	575	5.8	12 556 787
4 G 1.5	37 x 0.22	2.04	6.5 ± 0.3	13.7	120	575	5.8	12 562 759
5 x 1.5	37 x 0.22	2.04	7.1 ± 0.3	13.7	120	660	7.2	12 555 405
5 G 1.5	37 x 0.22	2.04	7.1 ± 0.3	13.7	120	660	7.2	12 559 974
6 x 1.5	37 x 0.22	2.04	7.9 ± 0.3	13.7	120	880	8.7	12 556 788
6 G 1.5	37 x 0.22	2.04	7.9 ± 0.3	13.7	120	880	8.7	12 563 990
7 x 1.5	37 x 0.22	2.04	8.4 ± 0.3	13.7	120	1030	10.1	12 556 789
7 G 1.5	37 x 0.22	2.04	8.4 ± 0.3	13.7	120	1030	10.1	12 559 975
8 x 1.5	37 x 0.22	2.04	9.3 ± 0.3	13.7	120	1280	11.6	12 559 717
10 x 1.5	37 x 0.22	2.04	9.9 ± 0.3	13.7	120	1160	14.5	12 556 791
12 x 1.5	37 x 0.22	2.04	10.3 ± 0.4	13.7	120	1340	17.4	12 555 406
14 x 1.5	37 x 0.22	2.04	11.1 ± 0.4	13.7	120	1560	20.3	12 562 572
16 x 1.5	37 x 0.22	2.04	11.7 ± 0.4	13.7	120	1780	23.2	12 556 792
18 x 1.5	37 x 0.22	2.04	12.4 ± 0.4	13.7	120	1980	26.0	12 556 793
20 x 1.5	37 x 0.22	2.04	13.3 ± 0.4	13.7	120	2280	29.1	12 582 062
24 x 1.5	37 x 0.22	2.04	14.3 ± 0.4	13.7	120	2370	34.9	12 556 818
25 x 1.5	37 x 0.22	2.04	14.7 ± 0.4	13.7	120	2540	36.4	12 555 407
25 G 1.5	37 x 0.22	2.04	14.7 ± 0.4	13.7	120	2460	36.4	12 564 477
27 x 1.5	37 x 0.22	2.04	14.7 ± 0.4	13.7	120	2530	39.1	12 556 819
30 x 1.5	37 x 0.22	2.04	15.6 ± 0.5	13.7	120	2890	43.6	12 556 820
36 G 1.5	37 x 0.22	2.04	17.1 ± 0.5	13.7	120	3510	52.1	12 568 635

**Traction Cable**



**Radox GKW-LW/S**

Cable type n x mm <sup>2</sup>	Conductor <sup>nom</sup> construction* n x mmD		Core dia nom mm	Cable dia mm	R <sub>20</sub> max Ω/km	C <sub>max</sub> core/core pF/m	Fire load nom kJ/m	Weight <sub>nom</sub> Cu kg / 100m		H + S Part No.
36 x 1.5	37 x 0.22	1.54	2.04	16.9 ± 0.5	13.7	120	3470	52.4	68.9	12 555 408
50 x 1.5	37 x 0.22	1.54	2.04	20.1 ± 0.5	13.7	120	4580	72.7	94.1	12 565 315

# Traction Cable

## Radox GKW-LW/S



Cable type		Conductor* construction* n x mmD		Core dia nom mm	Cable dia mm	R <sub>20</sub> max Ω/km	C <sub>max</sub> core/core pF/m	Fire load nom kJ/m	Weight <sub>nom</sub> Cu kg / 100m		H + S part No.
n x mm <sup>2</sup>	n x AWG										
2 x 2.0	2 x 14	19 x 0.35		1.64	2.29	6.1 ± 0.3	180	555	3.4	6.6	Y2 566 059

# Traction Cable

## Radox GKW-LW/S



Cable type n x mm <sup>2</sup>	Conductor <sup>nom</sup> construction* n x mmD	Core dia nom mm	Cable dia mm	R <sub>20</sub> max Ω/km	C <sub>max</sub> core/core pF/m	Fire load nom kJ/m	Weight <sup>nom</sup> Cu kg / 100m	H + S Part No.
2 x 2.5	37 x 0.29	2.54	6.6 ± 0.3	8.21	125	625	4.3	12 556 794
3 x 2.5	37 x 0.29	2.54	7.0 ± 0.3	8.21	125	670	6.5	12 556 415
3 G 2.5	37 x 0.29	2.54	7.0 ± 0.3	8.21	125	670	6.5	12 564 478
4 x 2.5	37 x 0.29	2.54	7.9 ± 0.3	8.21	125	840	8.6	12 556 795
4 G 2.5	37 x 0.29	2.54	7.9 ± 0.3	8.21	125	840	8.6	12 562 760
5 x 2.5	37 x 0.29	2.54	8.8 ± 0.3	8.21	125	1050	10.8	12 556 796
5 G 2.5	37 x 0.29	2.54	8.8 ± 0.3	8.21	125	1050	10.8	12 567 459
6 x 2.5	37 x 0.29	2.54	9.6 ± 0.3	8.21	125	1260	12.9	12 556 797
7 x 2.5	37 x 0.29	2.54	10.5 ± 0.4	8.21	125	1560	15.1	12 556 798
7 G 2.5	37 x 0.29	2.54	10.5 ± 0.4	8.21	125	1560	15.1	12 566 649
8 x 2.5	37 x 0.29	2.54	11.6 ± 0.4	8.21	125	1940	17.3	12 568 739
10 x 2.5	37 x 0.29	2.54	12.3 ± 0.4	8.21	125	1740	21.6	12 556 800
12 x 2.5	37 x 0.29	2.54	12.6 ± 0.4	8.21	125	1890	25.9	12 556 416
14 x 2.5	37 x 0.29	2.54	13.6 ± 0.4	8.21	125	2230	30.2	12 582 063
16 x 2.5	37 x 0.29	2.54	14.5 ± 0.4	8.21	125	2570	34.6	12 556 801
18 x 2.5	37 x 0.29	2.54	15.4 ± 0.5	8.21	125	2930	38.9	12 556 802
20 x 2.5	37 x 0.29	2.54	16.2 ± 0.5	8.21	125	3280	43.1	12 562 080
24 x 2.5	37 x 0.29	2.54	17.8 ± 0.5	8.21	125	3540	52.0	12 555 975



# Traction Cable

## Radox GKW-LW/S



Cable type n x mm <sup>2</sup>	Conductor <sup>nom</sup> construction* n x mmD		Core dia nom mm	Cable dia mm	R <sub>20</sub> max Ω/km	C <sub>max</sub> core/core pF/m	Fire load nom kJ/m	Weight <sub>nom</sub> Cu kg / 100m	H + S Part No.
25 x 2.5	37 x 0.29	1.93	2.54	18.2 ± 0.5	8.21	125	3790	54.1	12 556 803
25 G 2.5	37 x 0.29	1.93	2.54	18.2 ± 0.5	8.21	125	3790	54.1	12 568 634
27 x 2.5	37 x 0.29	1.93	2.54	18.3 ± 0.5	8.21	125	3690	58.5	12 556 821
30 x 2.5	37 x 0.29	1.93	2.54	19.3 ± 0.5	8.21	125	4140	65.0	12 556 417
33 x 2.5	37 x 0.29	1.93	2.54	20.1 ± 0.5	8.21	125	4590	71.5	12 563 721
35 x 2.5	37 x 0.29	1.93	2.54	21.1 ± 0.5	8.21	125	5200	75.7	12 562 081
36 x 2.5	37 x 0.29	1.93	2.54	21.0 ± 0.5	8.21	125	5070	77.8	12 556 822

\* (typical value x single wire nominal diameter, conductor resistance according to IEC 60228)



# Traction Cable

## Radox GKW-LW/S EMC

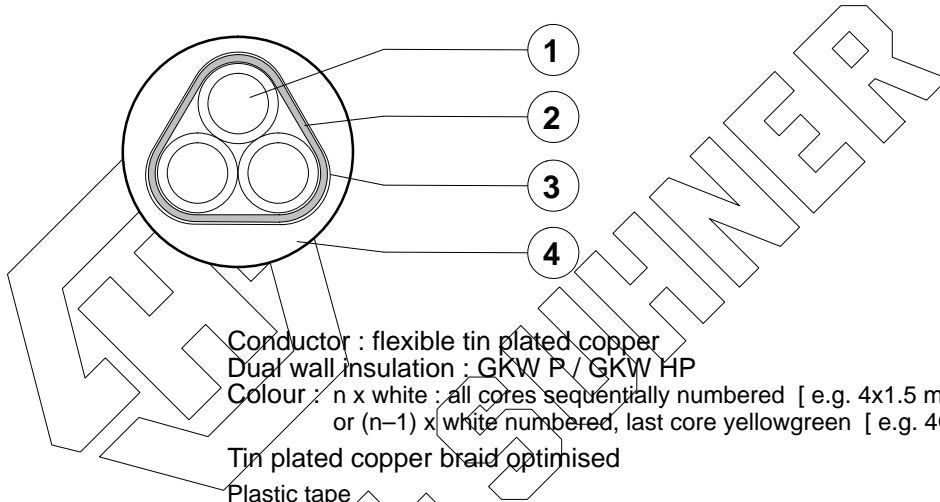
### General Properties :

Excellent high temperature, low temperature, ozone, diesel oil and weathering resistance, zero halogen, flame retardant, easily strippable, flexible; excellent screening properties.

### Application :

For permanent protected installation inside equipment, on cable trays etc. inside and outside of railway rolling stock, buses and other vehicles.

### General composition of cable :



#### 1. Cores GKW-LW

Conductor : flexible tin plated copper  
Dual wall insulation : GKW P / GKW HP  
Colour : n x white : all cores sequentially numbered [ e.g. 4x1.5 mm<sup>2</sup>]  
or (n-1) x white numbered, last core yellowgreen [ e.g. 4G1.5 mm<sup>2</sup>]

#### 2. EMC – screen

Tin plated copper braid optimised

#### 3. Wrapping (optional)

Plastic tape

#### 4. Jacket

Radox GKW,S, colour : black

Cable marking H + S 125zzzzz-zzzzzz Radox GKW-LW/ S EMC n x ... mm<sup>2</sup>

except 1.0 mm<sup>2</sup> :

Production lot number

Cable marking H + S 125zzzzz-zzzzzz Radox GKW-LW/S EMC n x 1.0 mm<sup>2</sup> ( 18 AWG )

only 1.0 mm<sup>2</sup> :

Production lot number

### Technical Data :

Voltage U <sub>0</sub> /U .....	600/1000 .....	V AC
	900/1500 .....	V DC
Test voltage 50 Hz, 5 min .....	3 500 .....	V
Max. conductor temperature continuous .....	+ 120 .....	°C
Min. operating temperature .....	- 40 .....	°C
Min. bending radius free installation ....	D ≤ 10 mm .....	5 x D
	D > 10 mm .....	6 x D
fixed installation .....	D ≤ 10 mm .....	3 x D
	D > 10 mm .....	4 x D

where D : cable diameter ( see table )

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# Traction Cable

## Radox GKW-LW/S EMC

### The cables comply with the following standards for fire protection on railway vehicles

BS 6853	Interior cables	Vehicle category	Ia, Ib, II
	Exterior cables	Vehicle category	Ia, Ib, II
DIN 5510	Level of fire protection		1, 2, 3, 4
NF F16-101	Classification		C / F0
	Interior cables	Vehicle category	A1, A2, B
	Exterior cables	Vehicle category	A1, A2, B

### The cables pass the following fire tests

Vertical flame spread of bunched cables		BS 4066-3, modified to BS 6853
Smoke density		BS 6853 annex D
Toxic fume	$R \leq 1.0$	BS 6853 annex B
Vertical flame spread of a single cable		DIN EN 50265-2-1
Vertical flame spread of bunched cables	Category C	DIN EN 50266-2-4
Vertical flame spread of bunched cables	Category D	DIN EN 50266-2-5
Smoke density		DIN EN 50268-2
Vertical flame spread of bunched cables		NF C32-070 test 2
Smoke density	smoke index $\leq 5$	NF X10-702-2
Toxic fume	smoke index $\leq 5$	NF X70-100
Vertical flame spread of a single cable		IEC 60332-1, EN 50265-2-1
Vertical flame spread of bunched cables	Category C	IEC 60332-3-24, EN 50266-2-4
Amount of halogen acid gas	0 mg/g	IEC 60754-1, EN 50267-2-1
Corrosivity of combustion gases		IEC 60754-2, EN 50267-2-3
Smoke density		IEC 61034-2, EN 50268-2

### Applicable standards :

H+S : 563078 (e) : Technical Datasheet : Traction cable Radox GKW-LW Current rating for multicore cables  
H+S : 97382-0701(e)1.doc : Technical Specification GKW-LW Thin Wall Single Core Cables



# Traction Cable

## Radox GKW-LW/S EMC

**Table :**

Cable type n x mm <sup>2</sup>	Conductor construction* D <sub>nom</sub> n x mm mm		Core-D D <sub>nom</sub> mm	Screen D <sub>max</sub> size mm mm <sup>2</sup>		Cable-D D <sub>nom</sub> mm	R <sub>20</sub> cond. screen Ω/km Ω/km		I <sub>k</sub> ** screen A	Z <sub>T</sub> max mΩ/m	C core/core core/screen pF/m pF/m		Fire load kJ/m	Weight copper cable kg/100m		H + S Part No.
2 x 2 x 0.25	19 x 0.13	0.60	1.02	4.4	1.3	5.7 ± 0.3	88.5	15.2	500	170	100	170	330	2.15	4.89	12 566 633
3 x 2 x 0.25	19 x 0.13	0.60	1.02	4.7	1.3	6.1 ± 0.3	88.5	16.2	500	150	100	170	325	2.67	5.72	12 566 634
7 x 2 x 0.25	19 x 0.13	0.60	1.02	6.2	2	7.8 ± 0.3	88.5	10.2	760	100	100	170	620	5.1	9.2	12 566 694
25 x 0.25	19 x 0.13	0.60	1.02	7.3	2.8	8.9 ± 0.3	88.5	7.8	890	80	100	170	925	8.2		12 567 868



# Traction Cable

## Radox GKW-LW/S EMC

Cable type n x mm <sup>2</sup>	Conductor construction* D <sub>nom</sub> n x mm mm		Core-D D <sub>nom</sub> mm	Screen D <sub>max</sub> size mm mm <sup>2</sup>		Cable-D D <sub>nom</sub> mm	R <sub>20</sub> cond. screen Ω/km Ω/km		I <sub>k</sub> ** screen A	Z <sub>T</sub> max mΩ/m	C core/core core/screen pF/m pF/m		Fire load kJ/m	Weight copper cable kg/100m		H + S Part No.
2 x 0.50	19 x 0.18	0.90	1.30	3.1	0.63	4.3 ± 0.3	40.1	31.1	200	200	110	190	240	1.6	3.4	12 555 592
3 x 0.50	19 x 0.18	0.90	1.30	3.3	0.75	4.5 ± 0.3	40.1	25.9	235	200	110	190	345	2.2	4.0	12 555 593
4 x 0.50	19 x 0.18	0.90	1.30	3.6	0.88	4.8 ± 0.3	40.1	22.2	275	150	110	190	370	2.8	4.7	12 555 594
5 x 0.50	19 x 0.18	0.90	1.30	4.1	0.94	5.4 ± 0.3	40.1	20.7	295	150	110	190	405	3.3	5.8	12 555 595
6 x 0.50	19 x 0.18	0.90	1.30	4.6	1.3	5.9 ± 0.3	40.1	14.7	410	100	110	190	455	4.2	7.0	12 555 596
7 x 0.50	19 x 0.18	0.90	1.30	5.0	1.5	6.3 ± 0.3	40.1	12.8	470	100	110	190	480	4.8	8.0	12 555 603
8 x 0.50	19 x 0.18	0.90	1.30	5.5	1.7	6.8 ± 0.3	40.1	11.3	530	100	110	190	500	5.3	8.6	12 561 467
9 x 0.50	19 x 0.18	0.90	1.30	5.8	1.8	7.2 ± 0.3	40.1	10.5	570	60	110	190	520	6.1	9.5	12 558 109
10 x 0.50	19 x 0.18	0.90	1.30	5.8	1.8	7.2 ± 0.3	40.1	10.5	570	60	110	190	500	6.6	10.1	12 555 597
12 x 0.50	19 x 0.18	0.90	1.30	6.0	1.8	7.4 ± 0.3	40.1	10.5	570	60	110	190	530	7.5	11.2	12 555 598
15 x 0.50	19 x 0.18	0.90	1.30	6.8	2.8	8.5 ± 0.3	40.1	6.92	880	40	110	190	590	9.9	13.5	12 558 110
16 x 0.50	19 x 0.18	0.90	1.30	6.8	2.1	8.5 ± 0.3	40.1	9.13	660	40	110	190	620	9.7	14.2	12 555 600
18 x 0.50	19 x 0.18	0.90	1.30	7.4	2.8	8.9 ± 0.3	40.1	6.92	880	40	110	190	650	11.3	16.2	12 555 601
22 x 0.50	19 x 0.18	0.90	1.30	8.3	3.3	9.9 ± 0.3	40.1	5.93	1000	25	110	190	680	13.7	19.5	12 558 111
25 x 0.50	19 x 0.18	0.90	1.30	8.5	3.5	10.3 ± 0.4	40.1	5.53	1100	25	110	190	710	15.3	21.3	12 555 602
27 x 0.50	19 x 0.18	0.90	1.30	8.8	3.7	10.5 ± 0.4	40.1	5.19	1170	25	110	190	740	16.5	23.1	12 559 007
30 x 0.50	19 x 0.18	0.90	1.30	9.4	4.8	11.3 ± 0.4	40.1	4.07	1500	25	110	190	810	18.9	26.5	12 559 008
36 x 0.50	19 x 0.18	0.90	1.30	10.1	5.1	12.1 ± 0.4	40.1	3.78	1600	25	110	190	880	22.1	30.1	12 559 009
42 x 0.50	19 x 0.18	0.90	1.30	11.0	5.9	12.9 ± 0.4	40.1	3.30	1850	25	110	190	965	25.3	36.0	12 559 010
48 x 0.50	19 x 0.18	0.90	1.30	12.1	6.9	13.6 ± 0.4	40.1	2.83	2150	60	110	190	1060	28.1	41.0	12 561 833
50 x 0.50	19 x 0.18	0.90	1.30	12.2	7.9	14.2 ± 0.4	40.1	2.45	2500	25	110	190	1100	31.6	43.0	12 559 011



# Traction Cable

## Radox GKW-LW/S EMC

Cable type n x mm <sup>2</sup>	Conductor construction* D <sub>nom</sub> n x mm mm		Core-D D <sub>nom</sub> mm	Screen D <sub>max</sub> size mm mm <sup>2</sup>		Cable-D D <sub>nom</sub> mm	R <sub>20</sub> cond. screen Ω/km Ω/km		I <sub>K</sub> ** screen A	Z <sub>T</sub> max mΩ/m	C core/core core/screen pF/m pF/m		Fire load kJ/m	Weight copper cable kg/100m		H + S Part No.
2 x 2 x 0.50	19 x 0.18	0.90	1.30	5.0	1.4	6.4 ± 0.3	41.4	13.7	440	200	110	190	560	3.3	6.9	12 555 604
3 x 2 x 0.50	19 x 0.18	0.90	1.30	5.7	1.7	6.7 ± 0.3	41.4	11.5	530	150	110	190	590	4.7	8.0	12 561 834
4 x 2 x 0.50	19 x 0.18	0.90	1.30	6.0	1.7	7.4 ± 0.3	41.4	11.4	530	150	110	190	620	5.5	9.5	12 555 605
5 x 2 x 0.50	19 x 0.18	0.90	1.30	7.8	2.8	9.3 ± 0.3	41.4	7.2	890	60	110	190	590	7.4	13.6	12 566 533
6 x 2 x 0.50	19 x 0.18	0.90	1.30	7.7	3.0	9.2 ± 0.3	41.4	6.38	950	60	110	190	645	8.7	14.8	12 557 170
8 x 2 x 0.50	19 x 0.18	0.90	1.30	7.9	3.2	9.7 ± 0.3	41.4	5.93	1000	40	110	190	720	10.8	15.5	12 555 930
10 x 2 x 0.50	19 x 0.18	0.90	1.30	9.1	3.7	10.9 ± 0.4	41.4	5.19	1170	40	110	190	825	13.2	20.0	12 555 606
12 x 2 x 0.50	19 x 0.18	0.90	1.30	10.1	5.1	12.1 ± 0.4	41.4	3.83	1600	40	110	190	1070	16.5	24.0	12 562 825
15 x 2 x 0.50	19 x 0.18	0.90	1.30	11.1	5.9	13.0 ± 0.4	41.4	3.30	1850	25	110	190	1220	20.1	30.0	12 555 607
16 x 2 x 0.50	19 x 0.18	0.90	1.30	11.1	5.9	13.0 ± 0.4	41.4	3.30	1850	40	110	190	1310	21	32.0	12 560 140
20 x 2 x 0.50	19 x 0.18	0.90	1.30	12.4	7.9	14.4 ± 0.4	41.4	2.47	2500	55	110	190	1450	26.9	36.0	12 561 619





# Traction Cable

## Radox GKW-LW/S EMC

Cable type n x mm <sup>2</sup>	Conductor construction* n x mm    D <sub>nom</sub> mm		Core—D D <sub>nom</sub> mm	Screen D <sub>max</sub> size mm    mm <sup>2</sup>		Cable—D D <sub>nom</sub> mm	R <sub>20</sub> cond.    screen Ω/km    Ω/km		I <sub>K</sub> <sup>**</sup> screen A	Z <sub>T</sub> max mΩ/m	C core/core    core/screen pF/m    pF/m		Fire load kJ/m	Weight copper cable kg/100m		H + S Part No.
2 x 0.75	19 x 0.22	1.12	1.52	3.6	0.95	4.8 ± 0.3	26.7	23.5	300	150	120	205	170	2.2	4.0	12 556 629
3 x 0.75	19 x 0.22	1.12	1.52	3.9	1.0	5.0 ± 0.3	26.7	18.7	315	150	120	205	240	3.0	5.0	12 556 636
4 x 0.75	19 x 0.22	1.12	1.52	4.3	1.1	5.5 ± 0.3	26.7	17.1	345	100	120	205	265	3.8	6.2	12 556 630
5 x 0.75	19 x 0.22	1.12	1.52	4.9	1.1	6.1 ± 0.3	26.7	17.3	345	100	120	205	325	4.4	7.5	12 556 637
6 x 0.75	19 x 0.22	1.12	1.52	5.2	1.7	6.6 ± 0.3	26.7	11.4	530	100	120	205	385	5.7	8.5	12 556 638
7 x 0.75	19 x 0.22	1.12	1.52	5.9	1.8	7.2 ± 0.3	26.7	10.5	570	100	120	205	450	6.5	10.0	12 556 639
8 x 0.75	19 x 0.22	1.12	1.52	6.4	1.9	7.8 ± 0.3	26.7	9.80	600	50	120	205	535	7.3	11.3	12 556 631
10 x 0.75	19 x 0.22	1.12	1.52	6.7	1.7	8.1 ± 0.3	26.7	11.4	530	50	120	205	555	8.3	13.0	12 556 640
12 x 0.75	19 x 0.22	1.12	1.52	6.9	2.2	8.4 ± 0.3	26.7	8.60	690	50	120	205	580	10.2	15.0	12 556 632
14 x 0.75	19 x 0.22	1.12	1.52	7.5	2.8	9.1 ± 0.3	26.7	7.25	880	80	120	205	620	12.5	17.0	12 561 835
16 x 0.75	19 x 0.22	1.12	1.52	8.1	3.2	9.7 ± 0.3	26.7	5.90	1000	25	120	205	640	13.9	20.6	12 556 419
18 x 0.75	19 x 0.22	1.12	1.52	8.4	3.5	10.2 ± 0.4	26.7	5.50	1100	25	120	205	705	15.4	23.0	12 556 641
24 x 0.75	19 x 0.22	1.12	1.52	10.3	5.5	12.0 ± 0.4	26.7	3.50	1700	25	120	205	755	21.4	29.4	12 561 836
25 x 0.75	19 x 0.22	1.12	1.52	10.3	5.5	12.3 ± 0.4	26.7	3.50	1700	25	120	205	935	22.1	30.0	12 556 480
2 x 2 x 0.75	19 x 0.22	1.12	1.52	5.8	1.7	7.1 ± 0.3	27.6	11.4	530	150	120	205	730	4.4	8.6	12 558 422
3 x 2 x 0.75	19 x 0.22	1.12	1.52	6.2	1.7	7.6 ± 0.3	27.6	11.4	530	150	120	205	770	5.7	10.9	12 558 423
5 x 2 x 0.75	19 x 0.22	1.12	1.52	8.9	3.53	10.7 ± 0.4	27.6	5.95	1115	60	120	205	785	10.4	18.2	12 562 002
6 x 2 x 0.75	19 x 0.22	1.12	1.52	9.9	5.17	11.9 ± 0.4	27.6	3.92	1640	65	120	205	1370	14.6	22.7	12 564 824
3 x 3 x 0.75	19 x 0.22	1.12	1.52	7.4	2.8	8.9 ± 0.3	27.6	10.0	880	80	120	205	790	9.1	15.1	12 562 003
5 x 4 x 0.75	19 x 0.22	1.12	1.52	10.8	5.1	12.8 ± 0.4	27.6	3.7	1600	100	120	205	860	18.5	29.0	12 564 825



# Traction Cable

## Radox GKW-LW/S EMC

Cable type		Conductor construction* n x mm D <sub>nom</sub> mm		Core-D D <sub>nom</sub> mm	Screen D <sub>max</sub> mm size mm <sup>2</sup>		Cable-D D <sub>nom</sub> mm	R <sub>20</sub> cond. Ω/km screen Ω/km		I <sub>k</sub> ** screen A	Z <sub>T</sub> max mΩ/m	C core/core core/screen pF/m		Fire load kJ/m	Weight copper cable kg/100m		H + S Part No.
n x mm <sup>2</sup>	n x AWG	n x mm	D <sub>nom</sub> mm	D <sub>nom</sub> mm	D <sub>max</sub> mm	size mm <sup>2</sup>	D <sub>nom</sub> mm	cond. Ω/km	screen Ω/km	I <sub>k</sub> ** screen A	Z <sub>T</sub> max mΩ/m	core/core	core/screen pF/m	Fire load kJ/m	copper	cable kg/100m	H + S Part No.
2 x 1.0	2 x 18	19 x 0.25	1.22	1.67	3.8	0.75	5.0 ± 0.3	20.0	25.9	235	200	125	215	270	2.5	5.0	12 555 875
3 x 1.0	3 x 18	19 x 0.25	1.22	1.67	4.1	1.14	5.5 ± 0.3	20.0	18.6	345	150	125	215	305	3.8	6.0	12 555 688
4 x 1.0	4 x 18	19 x 0.25	1.22	1.67	4.5	1.04	5.8 ± 0.3	20.0	20.2	315	150	125	215	335	3.7	7.2	12 555 877
5 x 1.0	5 x 18	19 x 0.25	1.22	1.67	5.2	1.2	6.6 ± 0.3	20.0	15.9	380	100	125	215	405	5.7	8.8	12 555 878
5 G 1.0	5 x 18	19 x 0.25	1.22	1.67	5.2	1.2	6.6 ± 0.3	20.0	15.9	380	100	125	215	405	5.7	8.8	12 563 051
6 x 1.0	6 x 18	19 x 0.25	1.22	1.67	5.9	1.8	7.3 ± 0.3	20.0	10.5	570	100	125	215	490	7.2	11.4	12 555 879
7 x 1.0	7 x 18	19 x 0.25	1.22	1.67	6.4	2.1	7.9 ± 0.3	20.0	9.15	660	60	125	215	600	8.4	13.4	12 555 880
8 x 1.0	8 x 18	19 x 0.25	1.22	1.67	7.0	2.2	8.5 ± 0.3	20.0	8.60	690	40	125	215	670	9.4	15.0	12 556 373
9 x 1.0	8 x 18	19 x 0.25	1.22	1.67	7.4	3.0	8.9 ± 0.3	20.0	6.40	950	40	125	215	660	11.1	16.0	12 559 976
10 x 1.0	10 x 18	19 x 0.25	1.22	1.67	7.4	3.0	8.9 ± 0.3	20.0	6.40	950	40	125	215	610	12.0	16.8	12 555 881
12 x 1.0	12 x 18	19 x 0.25	1.22	1.67	7.7	3.3	9.2 ± 0.3	20.0	5.95	1000	25	125	215	710	14.0	18.8	12 555 882
16 x 1.0	16 x 18	19 x 0.25	1.22	1.67	8.8	3.7	10.5 ± 0.4	20.0	5.20	1150	25	125	215	850	18.0	25.0	12 555 883
18 x 1.0	18 x 18	19 x 0.25	1.22	1.67	9.4	3.8	11.2 ± 0.4	20.0	5.05	1200	20	125	215	1020	19.9	27.5	12 555 884
25 x 1.0	25 x 18	19 x 0.25	1.22	1.67	10.8	4.5	12.7 ± 0.4	20.0	4.30	1400	20	125	215	1220	26.9	35.7	12 555 885
27 x 1.0	27 x 18	19 x 0.25	1.22	1.67	11.2	5.9	13.3 ± 0.4	20.0	3.30	1850	20	125	215	1300	30.0	39.5	12 559 012
30 x 1.0	30 x 18	19 x 0.25	1.22	1.67	11.8	7.9	13.8 ± 0.4	20.0	2.45	2500	20	125	215	1395	34.8	45.0	12 559 013
36 x 1.0	36 x 18	19 x 0.25	1.22	1.67	13.0	8.5	15.2 ± 0.5	20.0	2.30	2650	20	125	215	910	40.7	53.0	12 559 014
42 x 1.0	42 x 18	19 x 0.25	1.22	1.67	14.0	9.1	16.3 ± 0.5	20.0	2.15	2850	20	125	215	1040	46.6	60.5	12 559 015
50 x 1.0	50 x 18	19 x 0.25	1.22	1.67	15.3	9.4	17.8 ± 0.5	20.0	2.10	3000	15	125	215	1230	54.0	69.0	12 559 016
2x2x1.0	2x2x18	19 x 0.25	1.22	1.67	6.4	2.3	7.9 ± 0.3	20.7	8.30	730	60	125	215	800	5.9	10.7	12 558 112
4x2x1.0	4x2x18	19 x 0.25	1.22	1.67	7.8	3.0	9.4 ± 0.3	20.7	6.40	950	40	125	215	850	10.2	12.8	12 555 886
6x2x1.0	6x2x18	19 x 0.25	1.22	1.67	9.7	3.8	11.6 ± 0.3	20.7	5.0	1200	60	125	215	860	15.0	24.0	12 564 826



# Traction Cable

## Radox GKW-LW/S EMC

Cable type		Conductor		Core-D	Screen		Cable-D	R <sub>20</sub>		I <sub>K</sub> **	Z <sub>T</sub>	C		Fire	Weight		H + S
n x mm <sup>2</sup>	n x AWG	construction* n x mm	D <sub>nom</sub> mm	D <sub>nom</sub> mm	D <sub>max</sub> mm	size mm <sup>2</sup>	D <sub>nom</sub> mm	cond. Ω/km	screen Ω/km	screen A	max mΩ/m	core/core pF/m	core/screen pF/m	load kJ/m	copper kg/100m	cable kg/100m	Part No.
12x2x1.0	12x2x18	19 x 0.25	1.22	1.67	12.1	5.9	14.3 ± 0.5	20.7	3.3	1850	60	125	215	1160	30.0	40.0	12 564 827
4x3x1.0	3x4x18	19 x 0.25	1.22	1.67	9.6	3.7	11.5 ± 0.4	20.7	5.6	1420	65	125	215	960	14.7	23.0	12 566 800
3x4x1.0	3x4x18	19 x 0.25	1.22	1.67	9.4	4.4	11.3 ± 0.4	20.7	4.40	1390	45	125	215	980	15.2	24.5	12 555 887
4x4x1.0	4x4x18	19 x 0.25	1.22	1.67	10.6	5.1	12.5 ± 0.4	20.7	3.80	1600	25	125	215	1000	19.5	26.7	12 558 113



# Traction Cable

## Radox GW-LW/S EMC

Cable type n x mm <sup>2</sup>	Conductor construction* n x mm		D <sub>nom</sub> mm	Core-D D <sub>nom</sub> mm	Screen D <sub>max</sub> mm	size mm <sup>2</sup>	Cable-D D <sub>nom</sub> mm	R <sub>20</sub> cond. Ω/km		screen Ω/km	I <sub>K</sub> ** screen A	Z <sub>T</sub> max mΩ/m	C core/core core/screen pF/m		Fire load kJ/m	Weight copper cable kg/100m	H + S Part No.
2 x 1.5	37 x 0.22	1.54	2.04	4.5	0.95		5.8 ± 0.3	13.7	20.7	300	150	125	215	365	3.7	7.0	12 555 888
3 x 1.5	37 x 0.22	1.54	2.04	4.8	1.1		6.1 ± 0.3	13.7	17.3	345	150	125	215	410	5.3	8.1	12 555 889
4 x 1.5	37 x 0.22	1.54	2.04	5.4	1.3		6.7 ± 0.3	13.7	14.8	410	100	125	215	460	6.9	10.0	12 555 890
5 x 1.5	37 x 0.22	1.54	2.04	6.3	1.8		7.7 ± 0.3	13.7	10.5	570	80	125	215	555	8.8	13.5	12 555 891
6 x 1.5	37 x 0.22	1.54	2.04	6.8	2.1		8.3 ± 0.3	13.7	9.1	660	60	125	215	635	10.5	15.5	12 555 892
7 x 1.5	37 x 0.22	1.54	2.04	7.6	3.0		9.1 ± 0.3	13.7	6.3	950	60	125	215	780	12.8	18.4	12 555 893
8 x 1.5	37 x 0.22	1.54	2.04	8.5	3.3		10.3 ± 0.4	13.7	6.2	1040	50	125	215	1120	14.0	22.2	12 567 260
9 x 1.5	37 x 0.22	1.54	2.04	8.8	3.7		10.5 ± 0.4	13.7	5.2	1150	40	125	215	910	16.3	23.4	12 558 115
10 x 1.5	37 x 0.22	1.54	2.04	8.8	3.7		10.5 ± 0.4	13.7	5.2	1150	40	125	215	860	17.7	24.0	12 555 894
12 x 1.5	37 x 0.22	1.54	2.04	9.2	3.7		10.9 ± 0.4	13.7	5.2	1150	25	125	215	970	20.5	26.8	12 555 895
16 x 1.5	37 x 0.22	1.54	2.04	10.6	5.5		12.5 ± 0.4	13.7	3.5	1730	20	125	215	1290	27.5	36.4	12 555 896
18 x 1.5	37 x 0.22	1.54	2.04	11.7	5.9		13.2 ± 0.4	13.7	3.3	1860	20	125	215	1440	31.0	40.5	12 555 897
25 x 1.5	37 x 0.22	1.54	2.04	13.3	9.1		15.8 ± 0.5	13.7	2.3	2880	55	125	215	1780	47.7	56.2	12 555 898
48 x 1.5	37 x 0.22	1.54	2.04	17.9	12.0		20.7 ± 0.5	13.7	1.8	3780	40	125	215	2950	77.1	98.9	12 565 317
2 x 2 x 1.5	37 x 0.22	1.54	2.04	7.6	2.8		9.2 ± 0.3	14.2	6.9	880	70	125	215	780	8.6	15.3	12 558 114
3 x 2 x 1.5	37 x 0.22	1.54	2.04	8.2	3.1		9.8 ± 0.3	14.2	6.2	980	70	125	215	870	11.3	20.5	12 561 927
7 x 2 x 1.5	37 x 0.22	1.54	2.04	10.6	5.4		12.6 ± 0.4	14.2	3.6	1700	60	125	215	1250	22.2	33.0	12 561 928



# Traction Cable

## Radox GKW-LW/S EMC

Cable type n x mm <sup>2</sup>	Conductor construction* n x mm		Core-D D <sub>nom</sub> mm	Screen D <sub>max</sub> mm size mm <sup>2</sup>		Cable-D D <sub>nom</sub> mm	R <sub>20</sub> cond. Ω/km screen Ω/km		I <sub>K</sub> ** screen A	Z <sub>T</sub> max mΩ/m	C core/core core/screen pF/m		Fire load kJ/m	Weight copper cable kg/100m		H + S Part No.
2 x 2.5	37 x 0.29	1.93	2.54	5.7	1.5	7.0 ± 0.3	8.21	12.8	470	60	125	215	530	6.2	10.5	12 557 233
3 x 2.5	37 x 0.29	1.93	2.54	6.2	1.7	7.6 ± 0.3	8.21	11.4	530	60	125	215	580	8.7	13.0	12 554 750
4 x 2.5	37 x 0.29	1.93	2.54	6.9	2.8	8.4 ± 0.3	8.21	6.92	880	60	125	215	650	12.1	17.0	12 557 234
5 x 2.5	37 x 0.29	1.93	2.54	7.8	3.3	9.4 ± 0.3	8.21	5.93	1000	40	125	215	880	15.0	19.0	12 557 235
6 x 2.5	37 x 0.29	1.93	2.54	8.6	3.7	10.4 ± 0.4	8.21	5.19	1170	40	125	215	945	17.8	22.5	12 557 236
7 x 2.5	37 x 0.29	1.93	2.54	9.6	5.2	11.4 ± 0.4	8.21	3.78	1640	40	125	215	1180	21.5	27.0	12 557 237
10 x 2.5	37 x 0.29	1.93	2.54	11.1	5.9	13.2 ± 0.4	8.21	3.30	1860	25	125	215	1220	29.0	37.0	12 557 238
12 x 2.5	37 x 0.29	1.93	2.54	11.5	5.9	13.6 ± 0.4	8.21	3.30	1860	25	125	215	1255	34.0	42.0	12 557 239
16 x 2.5	37 x 0.29	1.93	2.54	13.3	8.6	15.7 ± 0.5	8.21	2.28	2700	20	125	215	1730	46.0	56.0	12 557 240
18 x 2.5	37 x 0.29	1.93	2.54	14.1	9.1	16.6 ± 0.5	8.21	2.14	2850	20	125	215	2060	51.0	62.0	12 557 241
25 x 2.5	37 x 0.29	1.93	2.54	16.5	10.3	19.3 ± 0.5	8.21	2.05	3240	40	125	215	2690	64.5	83.5	12 557 242
27 x 2.5	37 x 0.29	1.93	2.54	17.5	11.1	20.5 ± 0.5	8.21	1.75	3500	40	125	215	2395	74.0	87.0	12 563 351
48 x 2.5	37 x 0.29	1.93	2.54	22.2	17.8	25.7 ± 0.6	8.21	1.15	5620	25	125	215	4780	122.0	156.0	12 565 318

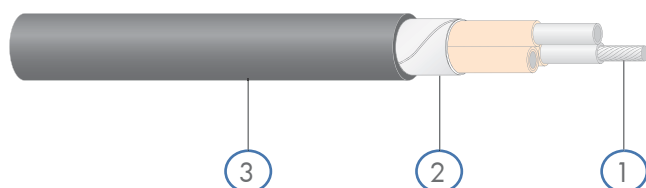
\* (typical value x single wire diameter)

\*\* (Short-circuit currents of screen are based on the following assumptions : duration of short circuit 0.1 s, initial temperature 90°C, final temperature 160°C)

# RADOX® GKW-LW/S

multi core

Conductor	according to EN 50306-2	Voltage rating	600/1000V AC
Number of conductors	2 - ...		900/1500V DC
Cross section	0.25 - 4.0 mm <sup>2</sup>	Temperature range	-40 °C to +120 °C



## Composition of cable

1. Cores	GKW-LW colour standard: white numbered, others on request
2. Separator	tape
3. Sheath	RADOXGKW S, colour: black

## Characteristics and specialities

- Resistance to oil, ozone and weathering
- Broad product range
- Space saving constructions

## Application

- Typical applications include carriage wiring, terminal boxes, power supply to various systems and ground connections inside railway rolling stock at fixed installations.
- Guidelines for selection and the installation are described in the standards EN 50355 and EN 50343.

## Standards

Standard	Fire protection on railway vehicles	
BS 6853	category	int. Ia, Ib, II / ext. Ia, Ib, II
prEN 45545-2		
DIN 5510-2	protection level	1, 2, 3, 4
NF F 16-101	class, category	C / F0, int. A1, A2, B / ext. A1, A2, B
UNI CEI 11170-3		

For further technical details please refer to our data sheet.

Con- struction	Conductor	Core	Cable	Conductor resistance	Capacitance	Fire load	Weight		Item no.
n x mm <sup>2</sup>	d <sub>nom.</sub> mm	d <sub>nom.</sub> mm	d mm	R <sub>20</sub> max. Ω/km	C <sub>H2O</sub> pF/m	kJ/m	copper kg/100 m	cable kg/100 m	
2 x 0.5	0.90	1.30	4.0 ± 0.2	40.1	105	248	0.95	2.4	12556756
5 x 0.5	0.90	1.30	5.0 ± 0.2	40.1	105	386	2.30	4.3	12556759
9 x 0.5	0.90	1.30	6.7 ± 0.3	40.1	105	612	4.20	6.6	12561299
12 x 0.5	0.90	1.30	6.9 ± 0.3	40.1	105	645	5.70	8.9	12556763
16 x 0.5	0.90	1.30	7.8 ± 0.3	40.1	105	876	7.40	11.5	12556764
25 x 0.5	0.90	1.30	9.5 ± 0.3	40.1	105	1186	11.60	17.0	12561301
30 x 0.5	0.90	1.30	10.1 ± 0.4	40.1	105	1372	14.00	20.5	12556810
2 x 2 x 0.5	0.90	1.30	5.8 ± 0.3	41.4	105	508	1.90	5.0	12561618
2 x 0.75	1.10	1.52	4.4 ± 0.2	26.7	110	294	1.40	3.2	12556767
4 x 0.75	1.10	1.52	5.0 ± 0.2	26.7	110	361	2.80	4.9	12556769
9 x 0.75	1.10	1.52	7.7 ± 0.3	26.7	110	755	6.30	10.6	12581701
14 x 0.75	1.10	1.52	8.4 ± 0.3	26.7	110	903	9.70	14.0	12561830
27 x 0.75	1.10	1.52	11.3 ± 0.4	26.7	110	1619	18.60	27.0	12556812
36 x 0.75	1.10	1.52	12.8 ± 0.4	26.7	110	2138	24.90	36.0	12556814
3 x 1	1.25	1.67	5.0 ± 0.2	20.0	115	360	2.7	4.7	12556778
6 x 1	1.25	1.67	6.6 ± 0.3	20.0	115	660	5.4	8.8	12556781
14 x 1	1.25	1.67	9.1 ± 0.3	20.0	115	1062	11.7	17.4	12582064
20 x 1	1.25	1.67	11.2 ± 0.4	20.0	115	1650	16.7	25.6	12556476
50 x 1	1.25	1.67	16.8 ± 0.5	20.0	115	3468	44.6	62.0	12565314
2 x 1.5	1.50	2.02	5.4 ± 0.3	13.7	120	433	2.80	5.5	12556786
5 x 1.5	1.50	2.02	7.1 ± 0.3	13.7	120	718	7.00	11.0	12555405
7 x 1.5	1.50	2.02	8.4 ± 0.3	13.7	120	1083	9.80	15.0	12556789
10 x 1.5	1.50	2.02	9.9 ± 0.3	13.7	120	1160	14.00	17.0	12556791
18 x 1.5	1.50	2.02	12.4 ± 0.4	13.7	120	2019	25.20	35.0	12556793
30 x 1.5	1.50	2.02	15.6 ± 0.5	13.7	120	2961	42.00	56.0	12556820
50 x 1.5	1.50	2.02	20.1 ± 0.5	13.7	120	4767	70.00	87.0	12565315
3 x 2.5	1.95	2.60	7.0 ± 0.3	8.21	125	692	6.70	10.5	12556415
6 x 2.5	1.95	2.60	9.6 ± 0.3	8.21	125	1343	13.50	20.0	12556797
12 x 2.5	1.95	2.60	12.6 ± 0.4	8.21	125	1969	27.00	36.0	12556416
18 x 2.5	1.95	2.60	15.3 ± 0.5	8.21	125	2962	40.50	54.5	12556802
24 x 2.5	1.95	2.60	17.8 ± 0.5	8.21	125	3653	54.00	69.5	12555975
30 x 2.5	1.95	2.60	19.3 ± 0.5	8.21	125	4401	67.50	87.0	12556417
36 x 2.5	1.95	2.60	21.0 ± 0.5	8.21	125	5236	81.00	105	12556822

Capacity in water typical value.

S = RADOX GKW S sheath





## Nomad Digital Cables Fire Compliance Assessment

Prepared for

Nomad Digital Ltd

By

A handwritten signature in black ink, appearing to read "P. Butler", written over a horizontal line.

Paul Butler CEng, BEng, DMS, MIMechE  
Rolling Stock Fire Technical Competent Authority  
**Radical International Ltd**

**REVISION RECORD**

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## TABLE OF CONTENTS

<b>1. Introduction .....</b>	<b>4</b>
<b>2. Cables Reaction to Fire Performance Assessment .....</b>	<b>4</b>
2.1 Compliance Assessment of Huber & Suhner Radox Railcat Cat5e .....	4
2.2 Compliance Assessment of Leoni BETAtrans® DATA Cat 7 FOAM .....	4
2.3 Compliance Assessment of Huber & Suhner 3GKW .....	4
2.4 Compliance Assessment of Huber & Suhner EF142 .....	4
2.5 Compliance Assessment of Huber & Suhner SPUMA 400 FR .....	5
2.6 Compliance Assessment of Huber & Suhner SX 04172-B60 .....	6
2.7 Compliance Assessment of Hellermann Tyton Helagaine HEGP Cable Sleeving .....	8
<b>3. Conclusions .....</b>	<b>9</b>

Appendix A - Cable Compliance Assessment Matrix

## 1. Introduction

Nomad Digital Ltd has commissioned Radical International Ltd to undertake a comparative study of fire compliance assessment for typical rail vehicle cable types used on WiFi contracts. The basis for the fire compliance assessment is the highest vehicle category of. NF F 16101/102 (Category A1), BS6853 (Category 1a), and GM/RT2130 (Category B Operating Category 3).

## 2. Cables Reaction to Fire Performance Assessment

The following cables are included within this assessment:

- Ethernet Type: Huber Suhner Radox Railcat Cat5e
- Ethernet Type: Leoni BETAtrans DATA C-flex 100  $\Omega$  Giga Cat 7 FOAM
- Power Type: Huber Suhner 3GKW
- RF Type: Huber Suhner EF142
- RF Type: Huber Suhner SPUMA 400 FR
- RF Type: Huber Suhner SX 04172-B60
- Cable Sleeving: Helagaine HEGP

A summary of the assessment of the cables and sleeving is shown in Appendix A.

### 2.1 Compliance Assessment of Huber & Suhner Radox Railcat Cat5e

Ethernet cable type Huber Suhner Radox Railcat Cat5e is demonstrated to be fully compliant with the requirements of all vehicle categories of NF F 16101, BS6853:1999 and GM/RT 2130. The evidence is provided by the test reports and data sheet from the well-known cable supplier Huber Suhner as referenced in Appendix A.

### 2.2 Compliance Assessment of Leoni BETAtrans® DATA Cat 7 FOAM

Ethernet cable type Leoni BETAtrans DATA C-flex 100  $\Omega$  Giga Cat 7 FOAM is demonstrated to be fully compliant with the requirements of all vehicle categories of NF F 16101, BS6853:1999 and GM/RT 2130. The evidence is provided by the test reports and data sheet from the well-known cable supplier Leoni as referenced in Appendix A.

### 2.3 Compliance Assessment of Huber & Suhner 3GKW

Power cable type Huber Suhner 3GKW is demonstrated to be fully compliant with the requirements of all vehicle categories of NF F 16101, BS6853:1999 and GM/RT 2130. The evidence is provided by the test reports and data sheet from the well-known cable supplier Huber Suhner as referenced in Appendix A.

### 2.4 Compliance Assessment of Huber & Suhner EF142

RF cable type Huber Suhner EF142 has not been tested for fire performance in accordance with NF F 16101, BS6853:1999 and GM/RT 2130. The cable has been tested and found compliant with alternative cable tests EN 60332-1-2, IEC 60332-2, EN 61034-2 and IEC 60754. However, this cable type has previously only been used within the fire resistant cubicles and thus does not require qualification against NF F 16101, BS6853:1999 and GM/RT 2130.

## 2.5 Compliance Assessment of Huber & Suhner SPUMA 400 FR

### Compliance with Norm NF F 16101

Huber and Suhner have provided Nomad Digital Ltd with NF F 16101 test reports (not listed on the data sheet), as listed in Appendix A against the test methods for NF F 16-101 as follows:

- Flammability: NF C 32-070
- Toxicity: NF X 70-100
- Smoke Density: NF X 10-702

With the following test results:

- NF C 32-070 test method results in a Class D
- NF X 70-100 NF X 10-702 combined test result results in a Class F1

The requirements of NF F 16101 for vehicle category A1 requires a minimum classification of C,F1 and thus the smoke and toxicity test result is compliant but the flammability performance is not. However, the test report Repport D'Essais 973-1/2010 shows a degraded portion above the chimney of 41cm. This value is only marginally over the requirements for Class C of 30cm, and only 22% into the Class D range of 30cm to 80cm. Considering the protected position within the vehicles, and low voltage RF type application, it is considered that this marginal fail is acceptable when used within category A1 vehicles.

### Compliance with Norms BS6853:1999 and GM/RT 2130

The SPUMA 400 FR cable has not been specifically tested in accordance with the requirements of GM/RT 2130 and BS6853:1999. In the case of this cable, the manufacturer has aimed the fire performance qualification at the newer European standardisation EN 45545 (see Appendix A), by compliance with the following tests:

- Vertical Flame Spread: EN 60332-1-2
- Vertical Flame Spread, Bunched: EN 50266-2-5
- Smoke Density: EN 61034-2
- Toxicity: EN 45545 part 2, C.16.4

In addition, the fire performance accreditation is currently claimed on the data sheet for DIN 5510 by compliance with the following tests:

- Flame spread, single cable EN 60332-1-2
- Smoke density EN 61034-2
- Toxicity EN 50305, 9.1.2

The reaction to fire test results for EN 45545 are particularly valid in this project as this will soon be the mandatory fire performance standard for Europe. As such the supplier has demonstrated compliance against EN 45545 in advance and is thus ahead of many other similar suppliers. Although some of the test methods are different to those specified in BS6853 and GM/RT 2130, they are equally valid and stringent.

Although it is considered that EN 45545 and DIN 5510 are valid alternatives to BS6853 and GM/RT 2130 test methods, and this is supported by these standards having equal status as applicable options under technical specification of interoperability (TSI) regulations, it is proposed to make comparisons to the UK standards as far as is possible.

In terms of flammability, BS6853 calls up BS4066-3 which is recognised as equivalent to EN 60332-1, and GM/RT 2130 now calls up BS6853 directly. Thus, the declaration of conformity for EN 60332-1 as referenced in Appendix A (applicable to EN 45545 and DIN 5510 compliance) for the SPUMA 400 FR cable is judged to be compliant with the BS6853 and GM/RT 2130 flammability requirements.

In terms of toxicity, BS6853 calls up the test method and weighted summation 'R value' calculation method in Annex B. Using other test method results, it is possible to calculate the 'R' weighted values in accordance with the BS6853 method. The gas concentration reference values from BS6853 Table B.2 and the NF X 70-100 test report results are shown in Table 1 below.

Gas	BS6853 Annex B	NF X 70-100 Test Value	Weighting
	Ref Value		
CO <sub>2</sub>	14000	505	0.036
CO	280	41	0.146
HF	4.9	0	0.000
HCl	15	0	0.000
HBr	20	0	0.000
HCN	11	0	0.000
NO <sub>x</sub>	7.6	0	0.000
SO <sub>x</sub>	53	0	0.000
<b>R Value</b>			<b>0.183</b>
<b>R<sub>max</sub> (Cat 1a)</b>			<b>1.0</b>
<b>Margin</b>			<b>81.8%</b>

**Table 1 – Conversion of SPUMA 400 FR Toxicity Results to BS6853 Equivalent**

Using the BS6853 Annex B calculation the 'R' value was 0.183 which is considerably lower than the appropriate BS6853 criteria of R<sub>max</sub> of 1.0 for category 1a vehicles (Table 13 of BS6853 – for interior cables). GM/RT 2130 calls up BS6853 for toxicity requirements and thus the SPUMA 400 FR cable is judged to be compliant with BS6853 and GM/RT 2130.

In terms of smoke density, the standards called up in EN 45545 and DIN 5510 are not directly comparable with BS6853. However, it can be seen from the EN 61034-2 fire test report that the result light transmittance was 92% compared with the pass criteria of 60%. On the basis of this excellent result (53% margin), it is highly likely that the smoke performance against the BS6853 method would also be compliant. Again, GM/RT 2130 calls up BS6853 for smoke density requirements and thus the SPUMA 400 FR cable is judged to be compliant with BS6853 and GM/RT 2130.

## 2.6 Compliance Assessment of Huber & Suhner SX 04172-B60

### Compliance with Norm NF F 16101

Test reports in accordance with NF F 16-101 are listed in Appendix A for the following test methods:

- Flammability: NF C 32-070
- Toxicity: NF X 70-100
- Smoke Density: NF X 10-702

With the following test results:

- NF C 32-070 test method results in a Class D
- NF X 70-100 NF X 10-702 combined test result results in a Class F1

The requirements of NF F 16101 for vehicle category A1 requires a minimum classification of C,F1 and thus the smoke and toxicity test result is compliant but the flammability performance is not. However, the test report Rapt 07.0600 shows two results of a degraded portion above the chimney of 51.5 and 74.5cm. The average value of 63cm is only marginally over the requirements for Class C of 30cm, and only 66% into the Class D range of 30cm to 80cm. Considering this cable is normally situated in protected positions within railway vehicles, and low voltage RF type application, it is considered that this marginal fail is acceptable when used within category A1 vehicles.

### Compliance with Norms BS6853:1999 and GM/RT 2130

The SX 04172-B60 cable has not been specifically tested in accordance with the requirements of GM/RT 2130 and BS6853:1999. In the case of this cable, the manufacturer has aimed the fire performance qualification at the newer European standardisation EN 45545 (see Appendix A), by compliance with the following tests:

- Vertical Flame Spread: EN 60332-1-2
- Vertical Flame Spread, Bunched: EN 50266-2-2
- Smoke Density: EN 61034-2
- Toxicity: EN 45545 part 2, C.16.4

In addition, the fire performance accreditation is currently claimed on the data sheet for DIN 5510 by compliance with the following tests:

- Flame spread, single cable EN 60332-1-2
- Smoke density EN 61034-2
- Toxicity EN 50305, 9.1.2

The reaction to fire test results for EN 45545 are particularly valid in this project as this will soon be the mandatory fire performance standard for Europe. As such the supplier has demonstrated compliance against EN 45545 in advance and is thus ahead of many other similar suppliers. Although some of the test methods are different to those specified in BS6853 and GM/RT 2130, they are equally valid and stringent.

Although it is considered that EN 45545 and DIN 5510 are valid alternatives to BS6853 and GM/RT 2130 test methods, and this is supported by these standards having equal status as applicable options under technical specification of interoperability (TSI) regulations, it is proposed to make comparisons to the UK standards as far as is possible.

In terms of flammability, BS6853 calls up BS4066-3 which is recognised as equivalent to EN 60332-1, and GM/RT 2130 calls up BS6853 directly. Thus, the declaration of conformity for EN 60332-1 as referenced in Appendix A (applicable to EN 45545 and DIN 5510 compliance) for the SX 04172-B60 cable is judged to be compliant with the BS6853 and GM/RT 2130 flammability requirements.

In terms of toxicity, BS6853 calls up the test method and weighted summation 'R value' calculation method in Annex B. Using other test method results, it is possible to calculate the 'R' weighted values in accordance with the BS6853 method. The gas concentration reference values from BS6853 Table B.2 and the NF X 70-100 test report results are shown in Table 2 below.

Gas	BS6853 Annex B	NF X 70-100 Test Value	Weighting
	Ref Value		
CO <sub>2</sub>	14000	1021.25	0.073
CO	280	46.28	0.165
HF	4.9	0	0.000
HCl	15	0	0.000
HBr	20	0	0.000
HCN	11	0	0.000
NO <sub>x</sub>	7.6	0	0.000
SO <sub>x</sub>	53	0	0.000
		<b>R Value</b>	<b>0.238</b>
		<b>R<sub>max</sub> (Cat 1a)</b>	<b>1</b>
		<b>Margin</b>	<b>76.2%</b>

**Table 2 – Conversion of SX 04172-B60 Toxicity Results to BS6853 Equivalent**

Using the BS6853 Annex B calculation the 'R' value was 0.238 which is considerably lower than the appropriate BS6853 criteria of  $R_{max}$  of 1.0 for category 1a vehicles (Table 13 of BS6853 – for interior



cables). GM/RT 2130 calls up BS6853 for toxicity requirements and thus the SX 04172-B60 cable is judged to be compliant with BS6853 and GM/RT 2130.

In terms of smoke density, the NF X 70-100 is not directly comparable with BS6853. However, it can be seen from the fire test report that the combined VOF4, Dm and CIT was F1 and thus compliant with the pass criteria in NF F 16101 for vehicle category A1. On the basis of this excellent result against a strict performance requirement, it is highly likely that the smoke performance against the BS6853 method would also be compliant. Again, GM/RT 2130 calls up BS6853 for smoke density requirements and thus the SX 04172-B60 cable is judged to be compliant with BS6853 and GM/RT 2130.

## 2.7 Compliance Assessment of Hellermann Tyton Helagaine HEGP Cable Sleeving

### Compliance with Norm NF F 16101

The Hellermann Tyton HEGP Helagaine cable sleeving datasheet referenced in Appendix A states full fire compliance against the NF F 16101 grid 10 (for small dimension parts) of class F2, I2.

### Compliance with Norms BS6853:1999 and GM/RT 2130

Following a discussion with the cable sleeving manufacture Hellermann Tyton, the following detailed toxicity and oxygen index for the HEGP Helagaine product.

#### Résultats :

Gases released in mg per g of material

				average	100 Ci / CCi	
CO	:	145,3	155,6	173,1	158,0	9,0
CO <sub>2</sub>	:	966,4	1010,4	927,6	968,1	1,1
HCl	:	NQ	NQ	NQ	0,0	0,0
HBr	:	NQ	NQ	NQ	0,0	0,0
HF	:	NQ	NQ	NQ	0,0	0,0
HCN	:	NQ	NQ	NQ	0,0	0,0
SO <sub>2</sub>	:	NQ	NQ	NQ	0,0	0,0
NQ = No Quantifiable.						

ITC = 10,1

In terms of toxicity, BS6853 calls up the test method and weighted summation 'R value' calculation method in Annex B. Using other test method results above, it is possible to calculate the 'R' weighted values in accordance with the BS6853 method. The gas concentration reference values from BS6853 Table B.2 and the NF X 70-100 test report results are shown in Table 3 below.

Gas	BS6853 Annex B	NF X 70-100 Test Value	Weighting
	Ref Value		
CO <sub>2</sub>	14000	968.1	0.069
CO	280	158	0.564
HF	4.9	0	0.000
HCl	15	0	0.000
HBr	20	0	0.000
HCN	11	0	0.000
NO <sub>x</sub>	7.6	0	0.000
SO <sub>x</sub>	53	0	0.000
R Value			<b>0.633</b>
BS6853 Table 7 R <sub>max</sub> (Cat 1a)			<b>1.0</b>
Margin			<b>36.7%</b>

**Table 3 – Conversion of HEGP Helagaine Toxicity Results to BS6853 Equivalent**

Using the BS6853 Annex B calculation the 'R' value was 0.633 which is considerably lower than the appropriate BS6853 criteria of R<sub>max</sub> of 1.0 for category 1a vehicles (Table 13 of B6853 – for interior cables). GM/RT 2130 calls up BS6853 for toxicity requirements and thus the HEGP Helagaine cable sleeving is judged to be compliant with BS6853 and GM/RT 2130.

For interior minor use materials in Table 7 of BS6853 the oxygen index is used as the flammability criteria. From the datasheet referenced in Appendix A the OI value is 39%. The comparison of the test result and BS6853 Table 7 criteria is shown in Table 4 below.

Test (BS6853 - Table 7)	Result	Cat 1a Criteria	Margin
Oxygen Index (ISO 4589-2) =	39%	34%	<b>14.7%</b>

**Table 4 – Conversion of HEGP Helagaine Toxicity Results to BS6853 Equivalent**

The comparison demonstrates that the cable sleeving is compliant with the interior minor materials requirements of BS6853. For GM/RT2130, the limit of OI is called up as BS6853, and thus the cable sleeving is compliant.

In terms of smoke density, the NF X 70-100 is not directly comparable with BS6853. However, it can be seen from the fire test report that the combined VOF<sub>4</sub>, D<sub>m</sub> and C<sub>IT</sub> was F1 and thus compliant with the pass criteria in NF F 16101 for vehicle category A1. On the basis of this excellent result against a strict performance requirement, it is highly likely that the smoke performance against the BS6853 method would also be compliant. Again, GM/RT 2130 calls up BS6853 for smoke density requirements and thus the HEGP Helagaine cable sleeving is judged to be compliant with BS6853 and GM/RT 2130.

### 3. Conclusions

The demonstration of the reaction to fire performance of the cables used is via fire test reports and/or data sheets provided by the cable manufacturers. The fire performance and evidence document references for each cable type are presented in Appendix A. In most cases the cables have been tested in accordance with NF F 16101. Where the cables are not fully compliant with NF F 16101, they have been reviewed and judged to be only marginal failures with mitigation judged to allow them to be acceptable for use in the highest vehicle category of NF F 16101. Where the cables have not been tested in accordance with BS6853 and GM/RT 2130, an equivalence comparison has been undertaken that has proved them compliant with the highest vehicle categories.

### Appendix a – Cable Compliance Assessment Matrix

Cable Name	Reference Documents	Compliance and Vehicle Category						Comments
		NF F 16-101		BS6853		GM/RT2130		
H+S Radox Railcat (Cat5e) Cable	<ul style="list-style-type: none"><li>• Ratp Report 07.1165A</li><li>• ISSeP Report 6652-1/2010 to 6652-6/2010</li><li>• H+S Datasheet 12 585 489 B (e)</li></ul>	✓	A1 (C,F0)	✓	1a	✓	B	Fully compliant.
Leoni BETAtrans DATA C-flex 100 Ω Giga Cat 7 FOAM	<ul style="list-style-type: none"><li>• SSeP Classification C 2130-2/2011 NF F 16-101</li><li>• ISSeP Classification F 2130-5/2011 NF F 16-101</li><li>• MPA 2011-B-1909-10 Vertical flame BS 6853</li><li>• ISSeP BS6853 Annex B 2130-4/2012</li><li>• MPA 2011-B-1909-09 smoke density BS 6853</li><li>• Leoni Datasheet 'BETAtrans DATA C-flex 100 Ω GigaCAT 7 FOAM' 30015e rev date 09.05.12</li></ul>	✓	A1 (C,F1)	✓	1a	✓	B	Fully compliant.
H+S 3GKW Cable	<ul style="list-style-type: none"><li>• ISSeP Report 2596-1/2008 to 2596-6/2008</li><li>• ISSeP Report 256-1/2001 to 256-3/2001</li><li>• H+S Datasheet 05 2003/1000e</li></ul>	✓	A1 (C,F1)	✓	1a	✓	B	Fully compliant.
H+S EF142	<ul style="list-style-type: none"><li>• H+S Datasheet DOC-0000197322 AG</li></ul>	Not applicable – only used inside the fire resistant cubicles.						Passed alternative tests EN 60332-1-2, IEC 60332-2, EN 61034-2 and IEC 60754
H+S SPUMA 400 FR	<ul style="list-style-type: none"><li>• Repport D'Essais 978/2010</li><li>• Repport D'Essais 973-1/2010</li><li>• VDE Report FG41-hz</li><li>• H+S Datasheet 84078173/01.2009</li><li>• H+S CoC 11-17050-000039</li><li>• Currenta 110013de</li><li>• Currenta 110023de</li></ul>	Compliant by marginal result case (41cm burn length)	D,F1	Compliant by ustification case (see main text)	1a	Compliant by ustification case (see main text)	B	Compliance to NF F 16101 by marginally over (11cm) the C class flammability requirements.  Compliance with BS6853 GM/RT2130 by comparison w ith other test results (DIN5510 EN45545).
H+S SX04172-B60 Cable	<ul style="list-style-type: none"><li>• Ratp Report 07.0600</li><li>• Cofrac Report E09/01</li><li>• H+S CoC 11-17050-000040</li><li>• H+S Datasheet DOC-0000246581AA</li></ul>	Compliant by marginal result case (51.5/74.5cm burn length)	D,F1	Compliant by ustification case (see main text)	1a	✓	B	Compliance to NF F 16101 by marginally over (11cm) the C class flammability requirements.  Compliance with BS6853 by comparison with other test results (based on DIN5510 EN45545 test results).
Helagaine HEGP Cable Sleeving	<ul style="list-style-type: none"><li>• HEGP Datasheet Issue 9</li><li>• Rapt Report HEGP 08-0847</li></ul>	✓	F2,I2	Compliant by ustification case (see main text)	1a	Compliant by ustification case (see main text)	B	Compliance with BS6853 GM/RT2130 by comparison w ith other test results (based on DIN5510 test results)



# Traction cable

## RADOX 4 GKW-AX 1800V M

### Product description:

**RADOX 4 GKW-AX 1800V M**

Nominal voltage:

Single core cables with reduced wall thickness

1800 / 3000 V AC

Hazard level:

M (extra low temperature, extra oil and extra fuel resistant)

### General Properties :

Halogen free, electron-beam cross-linked cables with improved behaviour in case of fire, easy to strip, soldering resistant and flexible. The cables are in accordance to EN 50264-3-1, but significantly thinner until 25 mm<sup>2</sup>.

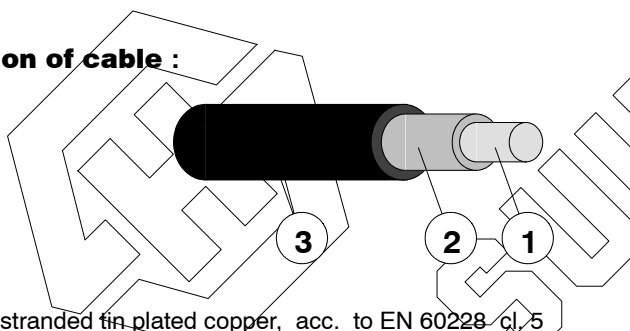
### Application :

The cables are intended for permanent installation in rail vehicles or for applications in which a limited alternating bending stress occur during service.

Guidelines for selection and installation are described in the standards EN 50355 and EN 50343.

For unscreened cables the guidelines of EN 50153 shall be followed.

### General composition of cable :



1. Conductor : stranded tin plated copper, acc. to EN 60228 cl. 5
  2. Insulation : inner layer RADOX EI 110, colour: white
  3. outer layer RADOX EI 109, colour : black (see Table 1), coloured (see Table 2)
- Cable marking : HUBER+SUHNER RADOX 4 GKW-AX 1800V 1X[cross section] M [part No. + batch No.]

### Technical Data :

Voltage rating cond.-earth	U <sub>0</sub>	1800	V AC
Voltage rating cond.-cond.	U	3000	V AC
maximum permissible Voltage rating AC cond.-earth		2100	V AC
maximum permissible Voltage rating AC cond.-cond.	U <sub>m</sub>	3600	V AC
maximum permissible Voltage rating DC cond.-earth	V <sub>0</sub>	2700	V DC
maximum permissible Voltage rating DC cond.-cond.		4500	V DC
Test voltage.		6500	V AC
Temperature range		- 50 ... + 120	°C

### Min. bending radius

fixed	D ≤ 12 mm	3 x D
	D > 12 mm	4 x D
sporadic movement	D ≤ 12 mm	4 x D
	D > 12 mm	5 x D

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The product fulfils the test and specification requirements described in this document for the stated areas of application and operating conditions. HUBER+SUHNER AG does not expressly or implicitly guarantee performance under additional or changed conditions. Deviations are to be agreed upon in writing.

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# Traction cable

## RADOX 4 GWK-AX 1800V M

### NB:

The upper temperature limit is determined by long term ageing according to EN 50305 Par. 7 and extrapolation to 20,000 hours.

The lower temperature limit is determined by bending and elongation tests according to EN 60811-1-4 Par. 8, respectively low temperature behaviour tests for static conditions, e.g. for fixed installation according to GOST 20.57.406-81 – method 204-1 and GOST 17491-80.

The specified bending radii require a careful and proper handling using proven fastening technologies.

### The cables are in conformity with:

<b>Fire protection on railway vehicles, hazard level</b>	<b>HL1 - HL3</b>	<b>EN 45545</b>
Vertical flame spread	$50 < L \leq 540 \text{ mm}$	EN 60332-1-2
Vertical flame spread, bunched, $D \leq 6 \text{ mm}$	$L \leq 1.5 \text{ m}$	EN 50305, 9.1.2
Vertical flame spread, bunched, $6 < D < 12 \text{ mm}$	$L \leq 2.5 \text{ m}$	EN 50305, 9.1.1 (EN 60332-3-25)
Vertical flame spread, bunched, $D \geq 12 \text{ mm}$	$L \leq 2.5 \text{ m}$	EN 60332-3-24
Smoke density	$T \geq 70 \%$	EN 61034-2
Toxicity	$ITC \leq 6$	EN 50305, 9.2
<b>Fire protection on railway vehicles, level of protection</b>	<b>1 - 4</b>	<b>DIN 5510</b>
Vertical flame spread	$50 < L \leq 540 \text{ mm}$	EN 60332-1-2
Vertical flame spread, bunched, $D \leq 6 \text{ mm}$	$L \leq 1.5 \text{ m}$	EN 50305, 9.1.2
Vertical flame spread, bunched, $6 < D < 12 \text{ mm}$	$L \leq 2.5 \text{ m}$	EN 60332-3-25
Vertical flame spread, bunched, $D \geq 12 \text{ mm}$	$L \leq 2.5 \text{ m}$	EN 60332-3-24
Smoke density	$T \geq 60 \%$	EN 61034-2
Corrosivity of combustion gases	$\text{pH} \geq 4.3, C \leq 10 \mu\text{S/mm}$	EN 50267-2-2
Amount of halogen acid gas	$\text{HCl} + \text{HBr} \leq 0.5 \%$	EN 50267-2-1
Content of fluorine	$\text{HF} \leq 0.1 \%$	EN 60684-2, 45.2
Toxicity	$ITC \leq 3$	EN 50305, 9.2
<b>Fire protection on railway vehicles, category</b>	<b>A1, A2, B</b>	<b>NF F16-101</b>
Fire protection on railway vehicles, class	C / F1	NF F16-101
Vertical flame spread	$50 < L \leq 540 \text{ mm}$	NF C32-070, 2.1
Vertical flame spread, bunched	$L \leq 300 \text{ mm}$	NF C32-070, 2.2
Smoke index	$\text{I.F.} \leq 5$	X10-702-2, NF X70-100-1
<b>Fire protection on railway vehicles, hazard level</b>	<b>LR1 - LR4</b>	<b>UNI CEI 11170</b>
Vertical flame spread	$50 < L \leq 540 \text{ mm}$	EN 60332-1-2
Vertical flame spread, bunched, $D \leq 6 \text{ mm}$	$L \leq 1.5 \text{ m}$	EN 50305, 9.1.2
Vertical flame spread, bunched, $6 < D < 12 \text{ mm}$	$L \leq 2.5 \text{ m}$	EN 60332-3-25
Vertical flame spread, bunched, $D \geq 12 \text{ mm}$	$L \leq 2.5 \text{ m}$	EN 60332-3-24
Smoke density	$T \geq 70 \%$	EN 61034-2
Corrosivity of combustion gases	$\text{pH} \geq 4.3, C \leq 10 \mu\text{S/mm}$	EN 50267-2-2
Amount of halogen acid gas	$\text{HCl} + \text{HBr} \leq 0.5 \%$	EN 50267-2-1
Toxicity	$ITC \leq 3$	EN 50305, 9.2
<b>Fire protection on railway vehicles, category</b>	<b>Ia, Ib, II</b>	<b>BS 6853, GM/RT 2130</b>
Vertical flame spread	$50 < L \leq 540 \text{ mm}$	EN 60332-1-2
Vertical flame spread, bunched	$L \leq 2.5 \text{ m}$	EN 50266, BS 6853 An. D.8.7
Smoke density	$A_0 \leq \text{BS 6853}$	BS 6853 An. D.8.7
Toxicity	$R \leq 1.0$	BS 6853 An. B.1
<b>Fire protection on railway vehicles</b>	<b>Fulfilled</b>	<b>NFPA 130</b>
Vertical flame spread, bunched	$L \leq 1.5 \text{ m}$	UL 1685, 12 (FT4 exp.)
Smoke density	$\text{TSR} \leq 150 \text{ m}^2, \text{PSRR} \leq 0.40 \text{ m}^2/\text{s}$	UL 1685, 12 (FT4 exp.)



# **Traction cable**

## **RADOX 4 GKW-AX 1800V M**

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**Requirement of hazard level code M** (acc. to EN 50264-1 or EN 50306-1)

Extra low temperature .....	- 40 °C
Extra oil resistance .....	IRM 902, 72h, 100°C
Extra fuel resistance .....	IRM 903, 168h, 70°

### **Applicable documents :**

EN 50355	Guide to use
H+S 557 578	Current rating for single core cables
Doc.No. 0000356416	Technical Specification RADOX 4/9 GKW-AX



# Traction cable

## RADOX 4 GKW-AX 1800V M

**Table 1 :**

Cable type mm <sup>2</sup>	Conductor construction n x mm	Conductor nom D mm	Cable dia. mm	R <sub>20</sub> <sup>1)</sup> max Ω / km	C <sub>H2O</sub> <sup>2)</sup> nom pF/m	Fireload nom kJ / m	Weight copper kg / 100m	Weight cable kg / 100m	H+S Part. Nr.
0.5	19x0.18	0.88	2.45±0.10	38.5	236	91	0.44	1.1	84 118 052
0.75	24x0.18	1.10	2.65±0.10	26.7	276	102	0.70	1.4	84 118 059
1	37x0.18	1.22	3.00±0.10	20.0	266	132	0.88	1.8	12 555 986
1.5	37x0.23	1.52	3.35±0.10	13.7	307	157	1.4	2.5	12 536 686
2.5	61x0.23	1.94	3.75±0.10	8.21	362	187	2.2	3.5	12 536 692
4	61x0.29	2.40	4.50±0.10	5.09	396	257	3.5	5.2	12 536 694
6	84x0.30	2.93	5.20±0.15	3.39	419	334	5.2	7.4	12 536 696
10	80x0.40	3.89	6.40±0.15	1.95	488	467	9.1	12	12 545 527
16	119x0.40	5.30	8.40±0.20	1.24	535	801	13	19	12 545 528
25	182x0.40	6.60	10.2±0.3	0.795	565	1125	21	28	12 545 529
35	266x0.40	7.80	11.7±0.3	0.565	607	1457	30	40	12 545 530
50	378x0.40	9.30	13.5±0.3	0.393	660	1737	43	54	12 545 531
70	348x0.50	11.4	15.8±0.3	0.277	755	2178	61	75	12 545 532
95	444x0.50	12.9	17.5±0.3	0.210	808	2549	78	95	12 545 533
120	570x0.50	14.9	19.8±0.3	0.164	862	3118	100	120	12 544 522
150	722x0.50	16.8	22.1±0.3	0.132	894	3474	127	150	12 545 534
185	874x0.50	18.3	24.0±0.3	0.108	903	4432	153	182	12 544 523
240	1147x0.50	21.1	27.0±0.3	0.0817	994	5225	201	235	12 547 684
300	1443x0.50	23.7	29.9±0.4	0.0654	1060	6106	251	291	12 552 906
400	1952x0.50	27.3	34.1±0.5	0.0495	1115	7639	342	392	12 555 997

- 1) conductor resistance according to EN 60228  
2) capacity in water





# Traction cable

## RADOX 4 GW-AX 1800V M

Table 2 :

Cable type mm <sup>2</sup>	Conductor construction n x mm	nom D mm	Cable dia. mm	R <sub>20</sub> <sup>1)</sup> max Ω / km	C <sub>H2O</sub> <sup>2)</sup> nom pF/m	Fireload nom kJ / m	Weight copper kg / 100m	nom cable	Colour	H+S Part. Nr.
0.5	19x0.18	0.88	2.45±0.10	38.5	236	91	0.44	1.1	bn	84 118 053
									bu	84 118 056
									gy	84 118 058
									rd	84 118 057
1	37x0.18	1.22	3.00±0.10	20.0	266	132	0.88	1.8	ye	12 586 321
1.5	37x0.23	1.52	3.35±0.10	13.7	307	157	1.4	2.5	ye	12 562 189
									bu	12 543 842
									gy	12 567 226
									rd	12 555 769
2.5	61x0.23	1.94	3.75±0.10	8.21	362	187	2.2	3.5	bn	12 584 664
									gy	84 091 279
									rd	12 554 310
4	61x0.29	2.40	4.50±0.10	5.09	396	257	3.5	5.2	rd	12 559 555
6	84x0.30	2.93	5.20±0.15	3.39	419	334	5.2	7.4	wh	84 090 550
									bu	12 568 594
									rd	12 582 984
10	80x0.40	3.89	6.40±0.15	1.95	488	467	9.1	12	rd	12 582 985
16	119x0.40	5.30	8.40±0.20	1.24	535	801	13	19	rd	12 566 008
25	182x0.40	6.60	10.2±0.3	0.795	565	1125	21	28	rd	12 568 968
35	266x0.40	7.80	11.7±0.3	0.565	607	1457	30	40	rd	12 568 008
50	378x0.40	9.30	13.5±0.3	0.393	660	1737	43	54	rd	12 582 459
70	348x0.50	11.4	15.8±0.3	0.277	755	2178	61	75	rd	12 566 010
95	444x0.50	12.9	17.5±0.3	0.210	808	2549	78	95	rd	12 582 460
185	874x0.50	18.3	24.0±0.3	0.108	903	4432	153	182	rd	12 559 659

1) conductor resistance according to EN 60228

2) capacity in water



# Bahnkabel RADOX® TENUIS-TW/S EMC

## Allgemeine Eigenschaften :

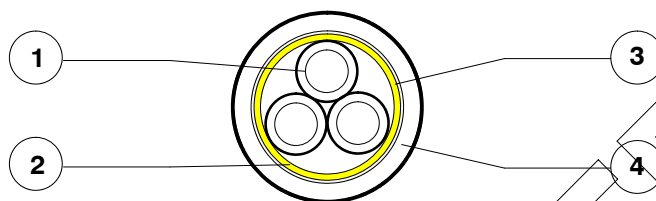
Zweischichtige Isolation aus Hightech-Polymeren mit ausgezeichneten elektrischen Eigenschaften; hohe Wärme-, Kälte-, Öl-, Säure-, Alkalien-, Ozon- und Wetterbeständigkeit; mit verbessertem Verhalten im Brandfall, raucharm, halogenfrei, flammwidrig, geringe Toxizität, lötbeständig, flexibel, gut abisolierbar.

## Verwendung :

Für geschützte permanente Verlegung innerhalb und ausserhalb von Schienenfahrzeugen, Bussen und ähnlichen Verkehrsmitteln, zum Anschluss fester und sporadisch bewegter Teile in Gleich- und Wechselspannungstechnologie.

Aufgrund der dünnwandigen Isolation und der umfassend guten Eigenschaften ist die Aderleitung besonders gut als kompakte System-Verdrahtungsleitung geeignet.

Bei Applikationen mit sehr häufiger Bewegung (z. B. Wagenübergangskabel) wird empfohlen speziell dafür konstruierte Huber+Suhrner Kabelfamilien einzusetzen.



### 1. Adern TENUIS-TW

Leiter : Cu - Litze verzinkt  
Zweischichtige Isolation : GKW TP / GKW TS  
Aderfarbe : n x weiss, fortlaufend nummeriert

### 2. Standard EMV-Abschirmung

Cu-Drahtgeflecht verzinkt

### 3. Zwischenlage

Kunststoffband

### 4. Schutzmantel

Radox GKW S, Farbe : schwarz

Kennzeichnung : H + S xxxxxxxx-zzzzzz RADOX TENUIS-TW/S EMC 600/1000 V n x ... mm<sup>2</sup>

Laufende - Auftragsnummer  
Artikelnummer

## Technische Daten :

Nennspannung Leiter-Erde	U <sub>0</sub>	600	V AC
Nennspannung Leiter-Leiter	U	1000	V AC
höchste zulässige Betriebsspannung AC Leiter-Erde		720	V AC
höchste zulässige Betriebsspannung AC Leiter-Leiter	U <sub>m</sub>	1200	V AC
höchste zulässige Betriebsspannung DC Leiter-Erde	V <sub>0</sub>	900	V DC
höchste zulässige Betriebsspannung DC Leiter-Leiter		1500	V DC
Prüfspannung an der vollständigen Leitung, 50 Hz, 5 Min		3 500	V AC
		8 400	V DC
Temperaturbereich			
fixierte Installation		- 40 ... + 120	°C
freie Installation / sporadisch bewegt / bei Verlegung		- 25 ... + 90	°C
Min. Biegeradius*)			
fixierte Installation	bei Biegewinkel ≤ 90°	alle D	2 x D
	bei Biegewinkel > 90°	D ≤ 12 mm	3 x D
	bei Biegewinkel > 90°	D > 12 mm	4 x D
freie Installation / sporadisch bewegt		D ≤ 12 mm	6 x D
		D > 12 mm	8 x D

\*) bei sorgfältiger, fachgerechter Handhabung unter Anwendung von erprobten Befestigungstechniken

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## Die Kabel sind konform mit:

Brandschutz in Schienenfahrzeugen, Kategorie	int. Ia, Ib, II, ext. Ia, Ib, II.	BS 6853
Brandschutz in Schienenfahrzeugen, Brandschutzstufe	1, 2, 3, 4	DIN 5510-2
Brandschutz in Schienenfahrzeugen, Klasse	C / F0	NF F16-101
Brandschutz in Schienenfahrzeugen, Kategorie	int. A1, A2, B, ext. A1, A2, B	NF F16-101
Senkrechte Flammenausbreitung, gebündelt	$L \leq 2.5 \text{ m}$	EN 50266, mod. durch BS 6853
Rauchdichte	$A_0 \leq \text{BS 6853}$	BS 6853 Anhang D
Toxizität	$R \leq 1.0$	BS 6853 Anhang B
Senkrechte Flammenausbreitung	$50 < L \leq 540 \text{ mm}$	EN 60332-1-2, IEC 60332-1-2
Senkrechte Flammenausbreitung, gebündelt, $D \geq 12 \text{ mm}$	$L \leq 2.5 \text{ m}$	EN 50266-2-4, IEC 60332-3-24
Senkrechte Flammenausbreitung, gebündelt, $D < 12 \text{ mm}$	$L \leq 2.5 \text{ m}$	EN 50266-2-5, IEC 60332-3-25
Rauchdichte	$T \geq 70\%$	EN 50268-2, IEC 61034-2
Senkrechte Flammenausbreitung, gebündelt	$L \leq 300 \text{ mm}$	NF C32-070 # 2.2
Rauchdichte	$I.F. \leq 5$	NF X10-702-2
Toxizität	$I.F. \leq 5$	NF X70-100-1
Gehalt an Halogenwasserstoffsäure	$\text{HCl} + \text{HBr} \leq 0.5\%$	EN 50267-2-1, IEC 60754-1
Korrosivität von Brandgasen	$\text{pH} \geq 4.3, \sigma \leq 10 \mu\text{S/mm}$	EN 50267-2-2, IEC 60754-2
Gehalt an Fluor	$\text{HF} \leq 0.1\%$	EN 60684-2, # 45.2
Toxizität	$\text{ITC} \leq 10$	EN 50305 # 9.2
Brandschutz in Schienenfahrzeugen, Klasse	B	UIC 564-2 Anhang 9
Senkrechte Flammenausbreitung	$L \leq 300 \text{ mm}, t \leq 30 \text{ s}$	UIC 895 Anhang 6

## Mitgeltende Normen:

H+S: 567 046 Thin wall - RADOX® TENUIS-TW Part 1 - General requirements  
RADOX® TENUIS-TW Part 2 - Single core cables  
RADOX® TENUIS-TW Part 3 - Multi core cables

H+S: 581 998 Bahnkabel TENUIS-TW/S Strombelastbarkeit für mehradrige Kabel

H+S: 582 716 Zusätze zu Datenblatt 568 354

Allgemeine Eigenschaften, Aufbau in Anlehnung an EN 50306

EN 50355 Guide to Use



# Bahnkabel RADOX®TENUIS-TW/S EMC

Kabeltyp n x mm <sup>2</sup>	Leiter <sup>nom</sup> Aufbau* n x mm		D mm	Ader D <sub>nom</sub> mm	Kabel-D mm	R <sub>20</sub> * max Ω/km	Brandlast nom kJ/m	Gewicht <sup>nom</sup> Kupfer kg / 100m		H + S Art. Nr.
2 x 0.50	19 x 0.18	0.89	1.43	1.43	4.8 ± 0.3	40.1	323	1.8	4.2	12568117
3 x 0.50	19 x 0.18	0.89	1.43	1.43	5.3 ± 0.3	40.1	383	2.3	5.1	12568118
4 x 0.50	19 x 0.18	0.89	1.43	1.43	5.4 ± 0.3	40.1	390	2.9	5.6	12568119
5 x 0.50	19 x 0.18	0.89	1.43	1.43	6.2 ± 0.3	40.1	495	4.4	7.0	12581351
6 x 0.50	19 x 0.18	0.89	1.43	1.43	6.5 ± 0.3	40.1	526	4.8	8.2	12568120
7 x 0.50	19 x 0.18	0.89	1.43	1.43	7.2 ± 0.3	40.1	700	5.0	9.8	12583138
8 x 0.50	19 x 0.18	0.89	1.43	1.43	7.5 ± 0.3	40.1	798	6.7	10.5	12581352
9 x 0.50	19 x 0.18	0.89	1.43	1.43	7.9 ± 0.3	40.1	730	7.3	10.9	12581450
12 x 0.50	19 x 0.18	0.89	1.43	1.43	8.1 ± 0.3	40.1	770	9.1	12.5	12581353
15 x 0.50	19 x 0.18	0.89	1.43	1.43	9.0 ± 0.3	40.1	1226	9.6	16.7	12582036
16 x 0.50	19 x 0.18	0.89	1.43	1.43	9.1 ± 0.3	40.1	1020	9.8	15.8	12583727
25 x 0.50	19 x 0.18	0.89	1.43	1.43	11.3 ± 0.4	40.1	1828	15.3	25.4	12582037
30 x 0.50	19 x 0.18	0.89	1.43	1.43	12.3 ± 0.4	40.1	2210	19.6	31.7	12582909
36 x 0.50	19 x 0.18	0.89	1.43	1.43	13.3 ± 0.4	40.1	2571	22.6	36.8	12582038
42 x 0.50	19 x 0.18	0.89	1.43	1.43	14.7 ± 0.4	40.1	3061	26.2	42.4	12582039



# Bahnkabel RADOX®TENUIS-TW/S EMC

Kabeltyp n x mm <sup>2</sup>	Leiter <sup>nom</sup> Aufbau* n x mm		D mm	Ader D <sub>nom</sub> mm	Kabel-D mm	R <sub>20</sub> * max Ω/km	Brandlast nom kJ/m	Gewicht <sup>nom</sup> Kupfer kg / 100m		H + S Art. Nr.
2 x 2 x 0.50	19 x 0.18		0.89	1.43	7.2 ± 0.3	40.1	662	3.6	8.0	12568121
3 x 2 x 0.50	19 x 0.18		0.89	1.43	8.1 ± 0.3	40.1	765	4.8	9.8	12581451
4 x 2 x 0.50	19 x 0.18		0.89	1.43	9.3 ± 0.3	40.1	950	6.1	13.1	12568122
5 x 2 x 0.50	19 x 0.18		0.89	1.43	10.3 ± 0.4	40.1	1155	7.9	16.3	12582041
6 x 2 x 0.50	19 x 0.18		0.89	1.43	11.1 ± 0.4	40.1	1370	9.2	18.8	12582042
8 x 2 x 0.50	19 x 0.18		0.89	1.43	13.5 ± 0.4	40.1	2130	13.8	27.2	12583728
12 x 2 x 0.50	19 x 0.18		0.89	1.43	13.0 ± 0.3	40.1	1680	20.6	27.6	12581358
2 x (2 x 0.50)	19 x 0.18		0.89	1.43	11.8 ± 0.4	40.1	1950	8.7	22.4	12582040



# Bahnkabel RADOX®TENUIS-TW/S EMC

Kabeltyp n x mm <sup>2</sup>	Leiter <sup>nom</sup> Aufbau* n x mm		D mm	Ader D <sub>nom</sub> mm	Kabel-D mm	R <sub>20</sub> * max Ω/km	Brandlast nom kJ/m	Gewicht <sup>nom</sup> Kupfer kg / 100m		H + S Art. Nr.
2 x 0.75	19 x 0.22		1.10	1.63	5.0 ± 0.3	26.7	345	2.6	4.8	12568514
3 x 0.75	19 x 0.22		1.10	1.63	5.4 ± 0.3	26.7	380	3.6	5.8	12568515
3 G 0.75	19 x 0.22		1.10	1.63	5.4 ± 0.3	26.7	380	3.6	5.8	12583993
4 x 0.75	19 x 0.22		1.10	1.63	6.0 ± 0.3	26.7	441	4.8	7.2	12568516
4 G 0.75	19 x 0.22		1.10	1.63	6.0 ± 0.3	26.7	441	4.8	7.2	12583994
5 x 0.75	19 x 0.22		1.10	1.63	6.7 ± 0.3	26.7	570	5.4	9.1	12582044
6 x 0.75	19 x 0.22		1.10	1.63	7.2 ± 0.3	26.7	675	5.9	10.3	12568517
7 x 0.75	19 x 0.22		1.10	1.63	8.0 ± 0.3	26.7	863	6.8	12.0	12581578
8 x 0.75	19 x 0.22		1.10	1.63	8.4 ± 0.3	26.7	962	8.2	14.1	12582045
10 x 0.75	19 x 0.22		1.10	1.63	8.7 ± 0.3	26.7	896	9.6	15.2	12582046
12 x 0.75	19 x 0.22		1.10	1.63	9.0 ± 0.3	26.7	910	12.3	16.5	12581354
14 x 0.75	19 x 0.22		1.10	1.63	9.8 ± 0.3	26.7	1700	13.1	19.7	12584333
16 x 0.75	19 x 0.22		1.10	1.63	10.5 ± 0.4	26.7	1236	14.8	22.1	12582047
18 x 0.75	19 x 0.22		1.10	1.63	11.0 ± 0.4	26.7	1397	16.2	24.4	12582048
24 x 0.75	19 x 0.22		1.10	1.63	12.8 ± 0.4	26.7	1761	22.8	33.1	12582049
2 x 2 x 0.75	19 x 0.22		1.10	1.63	8.2 ± 0.3	26.7	841	4.8	10.5	12582050
3 x 2 x 0.75	19 x 0.22		1.10	1.63	9.0 ± 0.3	26.7	978	6.7	12.7	12581579
4 x 2 x 0.75	19 x 0.22		1.10	1.63	10.5 ± 0.4	26.7	1140	8.9	16.8	12584787
6 x 2 x 0.75	19 x 0.22		1.10	1.63	12.8 ± 0.4	26.7	1680	11.7	22.6	12584411
6 x (2 x 0.75)	19 x 0.22		1.10	1.63	19.1 ± 0.5	26.7	4150	24.5	57.4	12584429
8 x 2 x 0.75	19 x 0.22		1.10	1.63	15.2 ± 0.5	26.7	2600	18.4	34.8	12585078



# Bahnkabel RADOX®TENUIS-TW/S EMC

Kabeltyp n x mm <sup>2</sup>	Leiter <sup>nom</sup> Aufbau* n x mm		D mm	Ader D <sub>nom</sub> mm	Kabel-D mm	R <sub>20</sub> * max Ω/km	Brandlast nom kJ/m	Gewicht <sup>nom</sup> Kupfer kg / 100m		H + S Art./Nr. Kabel
2 x 1.0	19 x 0.25	1.21	1.21	1.78	5.6 ± 0.3	20.0	430	2.7	6.0	12568162
3 x 1.0	19 x 0.25	1.21	1.21	1.78	6.0 ± 0.3	20.0	460	3.9	7.6	12568163
4 x 1.0	19 x 0.25	1.21	1.21	1.78	6.5 ± 0.3	20.0	527	4.9	8.8	12568164
5 x 1.0	19 x 0.25	1.21	1.21	1.78	7.0 ± 0.3	20.0	615	6.1	9.9	12583729
6 x 1.0	19 x 0.25	1.21	1.21	1.78	7.8 ± 0.3	20.0	795	7.1	11.4	12568165
7 x 1.0	19 x 0.25	1.21	1.21	1.78	8.5 ± 0.3	20.0	930	8.3	13.9	12583999
8 x 1.0	19 x 0.25	1.21	1.21	1.78	8.9 ± 0.3	20.0	1120	10.8	17.1	12581449
12 x 1.0	19 x 0.25	1.21	1.21	1.78	9.9 ± 0.3	20.0	1070	15.6	20.5	12581355
16 x 1.0	19 x 0.25	1.21	1.21	1.78	11.2 ± 0.4	20.0	1440	18	25.9	12584811
22 x 1.0	19 x 0.25	1.21	1.21	1.78	13.3 ± 0.3	20.0	2064	24.5	37.0	12581356
25 x 1.0	19 x 0.25	1.21	1.21	1.78	13.8 ± 0.4	20.0	2110	27.0	39.2	12582051
50 x 1.0	19 x 0.25	1.21	1.21	1.78	19.1 ± 0.5	20.0	3970	52.2	74.9	12582052
2 x 2 x 1.0	19 x 0.25	1.21	1.21	1.78	8.3 ± 0.3	20.0	877	5.5	11.7	12581357
5 x 2 x 1.0	19 x 0.25	1.21	1.21	1.78	12.7 ± 0.4	20.0	1620	15.0	24.7	12584697
6 x 2 x 1.0	19 x 0.25	1.21	1.21	1.78	14.0 ± 0.4	20.0	2020	17.9	30.8	12584412
6 x (2 x 1.0)	19 x 0.25	1.21	1.21	1.78	19.8 ± 0.5	20.0	4540	27.2	63.2	12584430
8 x 2 x 1.0	19 x 0.25	1.21	1.21	1.78	16.7 ± 0.5	20.0	3120	23.7	41.7	12585378
4 x (3 x 1.0)	19 x 0.25	1.21	1.21	1.78	17.9 ± 0.5	20.0	3950	25.0	52.5	12585384
3 x 4 x 1.0	19 x 0.25	1.21	1.21	1.78	12.4 ± 0.4	20.0	1700	15.8	26.8	12583002





# Bahnkabel RADOX®TENUIS-TW/S EMC

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Kabeltyp n x mm <sup>2</sup>	Leiter <sup>nom</sup> Aufbau* n x mm		D <sup>nom</sup> mm	Kabel-D mm	R <sub>20</sub> * max Ω/km	Brandlast nom kJ/m	Gewicht <sup>nom</sup> Kupfer kg / 100m		H + S Art. Nr.
2 x 1.5	19 x 0.31	1.52	2.17	6.5 ± 0.3	13.7	563	4.2	8.6	12568172
3 x 1.5	19 x 0.31	1.52	2.17	6.8 ± 0.3	13.7	580	5.5	9.5	12568173
3 G 1.5	19 x 0.31	1.52	2.17	6.8 ± 0.3	13.7	585	5.6	9.6	12583730
4 x 1.5	19 x 0.31	1.52	2.17	7.4 ± 0.3	13.7	665	6.9	11.8	12568174
4 G 1.5	19 x 0.31	1.52	2.17	7.4 ± 0.3	13.7	675	7.0	11.5	12583731
5 x 1.5	19 x 0.31	1.52	2.17	8.3 ± 0.3	13.7	890	8.6	14.2	12582053
5 G 1.5	19 x 0.31	1.52	2.17	8.3 ± 0.3	13.7	850	8.6	14.1	12583732
6 x 1.5	19 x 0.31	1.52	2.17	9.0 ± 0.3	13.7	1020	12.0	16.8	12581465
6 G 1.5	19 x 0.31	1.52	2.17	9.0 ± 0.3	13.7	1010	10.3	16.5	12583733
7 x 1.5	19 x 0.31	1.52	2.17	10.0 ± 0.3	13.7	1270	12.5	20.3	12583734
7 G 1.5	19 x 0.31	1.52	2.17	10.0 ± 0.3	13.7	1270	12.5	20.3	12583735
12 x 1.5	19 x 0.31	1.52	2.17	12.1 ± 0.4	13.7	1700	21.0	31.4	12582054
16 x 1.5	19 x 0.31	1.52	2.17	13.6 ± 0.4	13.7	2190	27.1	40.1	12582055
18 x 1.5	19 x 0.31	1.52	2.17	14.4 ± 0.4	13.7	2490	30.5	45.2	12582056
27 x 1.5	19 x 0.31	1.52	2.17	17.0 ± 0.5	13.7	3240	43.6	62.1	12582057
3 x 4 x 1.5	19 x 0.31	1.52	2.17	14.8 ± 0.4	13.7	2460	23	39	12584953



# Bahnkabel RADOX®TENUIS-TW/S EMC

Kabeltyp n x mm <sup>2</sup>	Leiter <sup>nom</sup> Aufbau* n x mm		D mm	Ader D <sub>nom</sub> mm	Kabel-D mm	R <sub>20</sub> * max Ω/km	Brandlast nom kJ/m	Gewicht <sup>nom</sup> Kupfer kg / 100m		H + S Art. Nr.
2 x 2.5	19 x 0.40		1.96	2.75	7.8 ± 0.3	8.21	806	6.3	12.2	12568175
3 x 2.5	19 x 0.40		1.96	2.75	8.2 ± 0.3	8.21	860	8.45	14.2	12582658
3 G 2.5	19 x 0.40		1.96	2.75	8.2 ± 0.3	8.21	860	8.6	14.3	12583736
4 x 2.5	19 x 0.40		1.96	2.75	9.1 ± 0.3	8.21	1050	11.4	18.1	12582058
4 G 2.5	19 x 0.40		1.96	2.75	9.1 ± 0.3	8.21	1050	11.1	17.7	12583737
5 x 2.5	19 x 0.40		1.96	2.75	10.3 ± 0.4	8.21	1278	14.3	22.4	12584926
6 x 2.5	19 x 0.40		1.96	2.75	11.4 ± 0.4	8.21	1650	16.5	26.8	12582059
7 x 2.5	19 x 0.40		1.96	2.75	12.5 ± 0.4	8.21	1950	20.9	32.9	12584927
2 x 2 x 2.5	19 x 0.40		1.96	2.75	13.2 ± 0.4	8.21	2035	15	28.6	12583449
2 x 4.0	56 x 0.31		2.46	3.35	8.9 ± 0.3	5.09	1005	9.28	15.9	12583873
3 x 4.0	56 x 0.31		2.46	3.35	9.7 ± 0.3	5.09	1140	12.9	20.6	12584361

\* (Richtwert x max. Einzeldraht-Durchmesser, ohmscher Widerstand gemäss IEC 60228)

# Railway Cables

HUBER+SUHNER is your professional partner for the development and manufacture of cables, harnesses and sophisticated cable systems, specifically designed for the railway market.

All our RADOX® cables have the following characteristics:

- low smoke
- halogen free
- compact
- light weight
- wide operating temperature range
- corona resistant

HUBER+SUHNER can provide a wide range of products, meeting the requirements of today's modern railway industry. Contact us for advice as to which solution best suits your needs.

**RADOX® Power cables for**

- traction motors
- converters
- braking systems

**RADOX® Control cables for**

- compact wiring systems where critical space conditions exist as well as signal and control circuits

**RADOX® Jumper cables for**

- Power and Control system cables for intervehicle connections

**RADOX® databus cables for**

- Data transmission for high frequency applications

**RADOX® system solutions for**

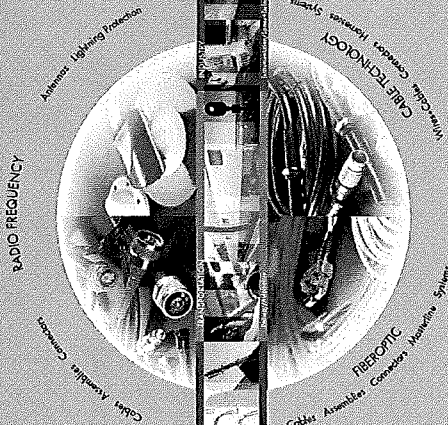
- all rolling stock and individual harness requirements



HUBER+SUHNER railway solutions

## HUBER+SUHNER – Excellence in Connectivity Solutions

HUBER+SUHNER is a leading global supplier of components and systems for electrical and optical connectivity in communications, industrial and transportation markets. HUBER+SUHNER can draw on core competences in the areas of high frequency technology, fibre optics, cables and polymers. Working in close collaboration with our customers around the globe, we strive for excellence in the development and manufacturing of high quality products.



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**RADOX® TENUIS-TW**  
 SIGNAL AND CONTROL CABLES  
 FOR RAIL AND MASS TRANSIT

**RADOX®**  
**TENUIS-TW**

HUBER+SUHNER

Excellence in Connectivity Solutions

# The Lightweight Thin-wall Railway Cables

## Light, flexible and compact

With the railway cable family RADOXTENUISW HUBER-SÜHNER offers a new generation of control and signal cables. Its characteristic achieves new dimensions of lightness and flexibility. RADOXTENUISW is smaller, lighter and more flexible than previous products on the railway market. As a thin-wall cable, it is particularly suitable for the wiring of cable looms, control panels and electrical cabinets and meets the requirements of the most important European Safety Standards for railways.

Unique characteristics of the cable improve its processability making it easier to strip without the need for special tooling. Therefore, greatly improving installation time and reducing costs.

RADOXTENUISW cables are available in single core as well as in multi core screened and unscreened versions. The cable cores are manufactured using a dual-wall insulation system made from high-tech polymers and have excellent electrical and mechanical characteristics.

Especially developed for rolling stock the cables are recognised for their high resistance to all types of media, UV rays, ozone and humidity as well as harsh environmental conditions. The cables are halogen free and do not release any corrosive gases in the event of fire. They are flame retardant and do not propagate fire, generate low smoke emissions and have an extremely low toxicity index.

Railway cable  
RADOXTENUISW single core

Cable type Type	Conductor Nominal cross-section mm <sup>2</sup>	Outer dia. mm	Cable Ø mm	120 pos. mm	Weight kg/100m	H-S mm
0.50	19 x 0.18	0.89 ± 0.05	1.40 ± 0.05	40.1	0.58	12.56/039
0.75	19 x 0.22	1.10 ± 0.05	1.60 ± 0.05	26.7	0.83	12.56/038
1.0	19 x 0.25	1.21 ± 0.05	1.75 ± 0.05	20.0	0.99	12.56/030
1.5	19 x 0.31	1.52 ± 0.05	2.15 ± 0.05	13.7	1.52	12.56/031
2.5	19 x 0.40	1.95 ± 0.05	2.70 ± 0.10	8.21	2.53	12.56/032
4.0	56 x 0.31	2.48 ± 0.10	3.55 ± 0.05	5.09	3.90	12.56/035

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## Applications

Today, cabinets, control panels and driver desks for modern cabling requirements where weight and space conditions are limited. Some of the characteristics include:

- lightweight
- compact
- excellent flexibility
- easy to strip
- easy to install

Cable conductors (striking and cabinets for rail cars) RADOXTENUISW cables are recognised for their high wall insulation and reduced weight.

Meeting the most important railway safety standards RADOXTENUISW single and multi-core cables meet the most important national fire protection regulations

- BS 6859 (Cat. A, B, C)
- DIN 55102 (Cat. A, B, C)
- NFPA 1601 (Classification C/RO, Cat. A, A2, B)

Railway cable  
RADOXTENUISW/S Multi core, unscreened

Cable type Type	Conductor Nominal cross-section mm <sup>2</sup>	Outer dia. mm	Cable Ø mm	120 pos. mm	Weight kg/100m	H-S mm
2 x 0.50	19 x 0.18	0.90	1.40	44 ± 0.2	40.1	3.1
3 x 0.50	19 x 0.18	0.90	1.40	44 ± 0.2	40.1	3.6
4 x 0.50	19 x 0.18	0.90	1.40	50 ± 0.2	40.1	4.3
5 x 0.50	19 x 0.18	0.90	1.40	55 ± 0.2	40.1	5.3
6 x 0.50	19 x 0.18	0.90	1.40	60 ± 0.2	40.1	6.2
2 x 2 x 0.50	19 x 0.18	0.90	1.40	65 ± 0.3	40.1	5.8
4 x 2 x 0.50	19 x 0.18	0.90	1.40	67 ± 0.3	40.1	9.9
2 x 0.75	19 x 0.22	1.10	1.60	47 ± 0.3	26.7	3.5
3 x 0.75	19 x 0.22	1.10	1.60	51 ± 0.3	26.7	4.7
4 x 0.75	19 x 0.22	1.10	1.60	56 ± 0.3	26.7	5.7
6 x 0.75	19 x 0.22	1.10	1.60	67 ± 0.3	26.7	8.3
2 x 2 x 0.75	19 x 0.22	1.10	1.60	77 ± 0.3	26.7	9.1
2 x 1.0	19 x 0.25	1.21	1.75	51 ± 0.3	20.0	4.5
3 x 1.0	19 x 0.25	1.21	1.75	54 ± 0.3	20.0	5.4
4 x 1.0	19 x 0.25	1.21	1.75	58 ± 0.3	20.0	6.4
6 x 1.0	19 x 0.25	1.21	1.75	73 ± 0.3	20.0	9.8
2 x 1.5	19 x 0.31	1.52	2.15	63 ± 0.3	13.7	6.3
3 x 1.5	19 x 0.31	1.52	2.15	63 ± 0.3	13.7	7.6
4 x 1.5	19 x 0.31	1.52	2.15	67 ± 0.3	13.7	9.4
2 x 2.5	19 x 0.40	1.96	2.70	73 ± 0.3	8.21	9.8
4 x 2.5	19 x 0.40	1.96	2.70	87 ± 0.3	8.21	15.2

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Railway cable  
RADOXTENUISW/S EMC Multi core, screened

Cable type Type	Conductor Nominal cross-section mm <sup>2</sup>	Outer dia. mm	Cable Ø mm	120 pos. mm	Weight kg/100m	H-S mm
2 x 0.50	19 x 0.18	0.90	1.40	48 ± 0.3	40.1	4.2
3 x 0.50	19 x 0.18	0.90	1.40	53 ± 0.3	40.1	5.1
4 x 0.50	19 x 0.18	0.90	1.40	54 ± 0.3	40.1	5.6
6 x 0.50	19 x 0.18	0.90	1.40	65 ± 0.3	40.1	8.2
2 x 2 x 0.50	19 x 0.18	0.90	1.40	72 ± 0.3	40.1	8.0
4 x 2 x 0.50	19 x 0.18	0.90	1.40	93 ± 0.3	40.1	13.1
2 x 1.0	19 x 0.25	1.21	1.75	56 ± 0.3	20.0	6.0
3 x 1.0	19 x 0.25	1.21	1.75	60 ± 0.3	20.0	7.6
4 x 1.0	19 x 0.25	1.21	1.75	65 ± 0.3	20.0	8.8
6 x 1.0	19 x 0.25	1.21	1.75	78 ± 0.3	20.0	11.4
2 x 1.5	19 x 0.31	1.52	2.15	63 ± 0.3	13.7	8.6
3 x 1.5	19 x 0.31	1.52	2.15	68 ± 0.3	13.7	9.5
4 x 1.5	19 x 0.31	1.52	2.15	74 ± 0.3	13.7	11.8
2 x 2.5	19 x 0.40	1.96	2.70	78 ± 0.3	8.21	12.2

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Multi core cables are available in a selected range of core counts.