

**Heat-shrinkable joints for halogen-free,
flame-retardant and fire-resistant cables
up to 1 kV**



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The choice of suitable materials for electrical systems is an important factor in preventive fire safety measures. In recent years, considerable attention has been paid to the fire risks associated with cable insulation polymers. While high halogen content materials, for example, have been regarded as being barely inflammable, it has been recognized that they may possess undesirable properties such as smoke and acid gas emission in fire conditions. Intensive development work has resulted in a new generation of halogen-free fire-resistant cables. A jointing system meeting comparable requirements is available from Tyco Electronics Energy Division.

Flame-retardancy

As primary insulation and cable oversheath replacement, we developed a heat-shrinkable material, Zerohal tubing, that is halogen-free and flame-retardant. A range of established tests, such as Limiting Oxygen Index and Temperature Index, have been carried out to assess the flame-retardancy of this material. The results below show that the performance of Zerohal tubing compares favorably with that of modern flame-retardant cable insulations.

Absence of halogens

Corrosion damage depends on the amount of acid gases generated when a material is burned, and therefore on the level of halogens and other acidic components in the insulation material. Pyrolytic analyses show only trace quantities of these substances in Zerohal tubing.

The low toxicity index rating (NES 713) derived from measurements of these and further combustion products provides additional evidence of the material's suitability for jointing cables meeting special requirements of this kind.

Low smoke generation

The optical smoke density produced by Zerohal tubing in fire conditions has been studied over a range of heat fluxes. The graph allows comparison of visibility with that of the smoke from other polymeric compounds.



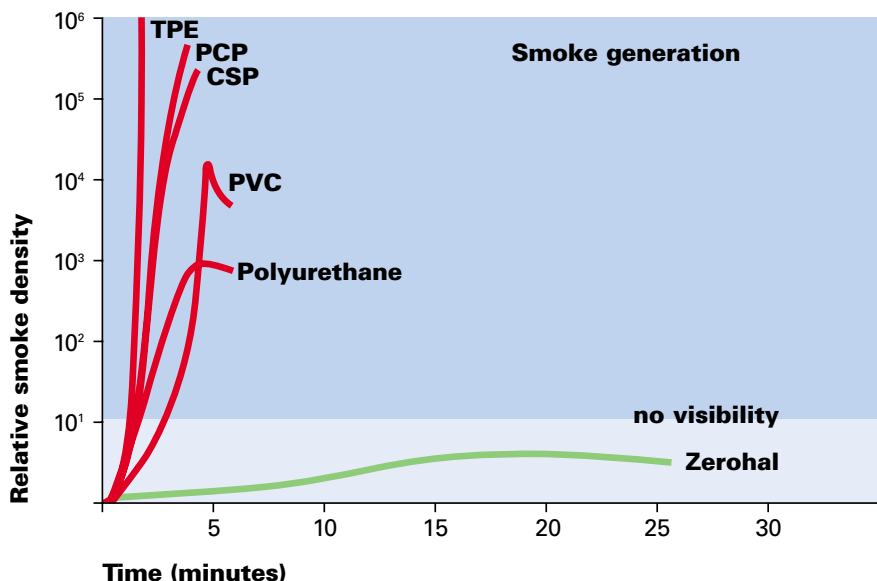
Photo 1 Public transport systems now make increasing use of halogen-free, flame-retardant and fire-resistant cables and accessories.



Photo 2 Raychem joints for halogen-free, fire-resistant cables were developed in the course of the company's experience in supplying jointing systems for special cables used in North Sea oil and gas exploration.

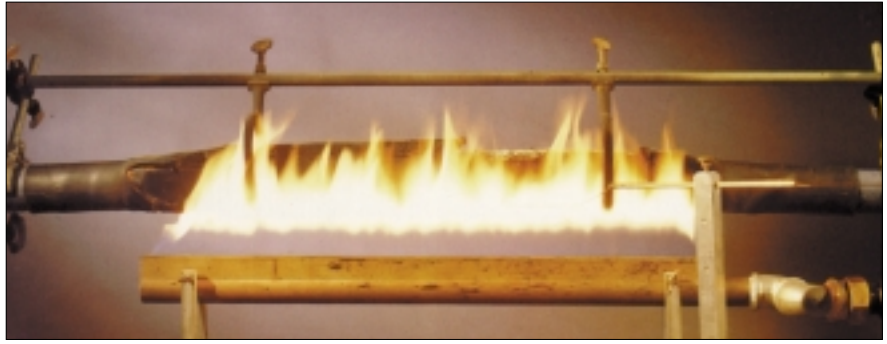
Properties of Zerohal tubing

Test	Method	Typical Results
Flame Retardancy	ASTM D635	burn time 60 secs extent of burn 15 mm
Limiting Oxygen Index	ASTM D2863	33.0
Temperature Index	NES 715	280 °C
Acid Gas Generation	RK 6717C12.14	0.9 %
Smoke Index	NES 711CI07.01	32
Toxicity Index	NES 713	1.6

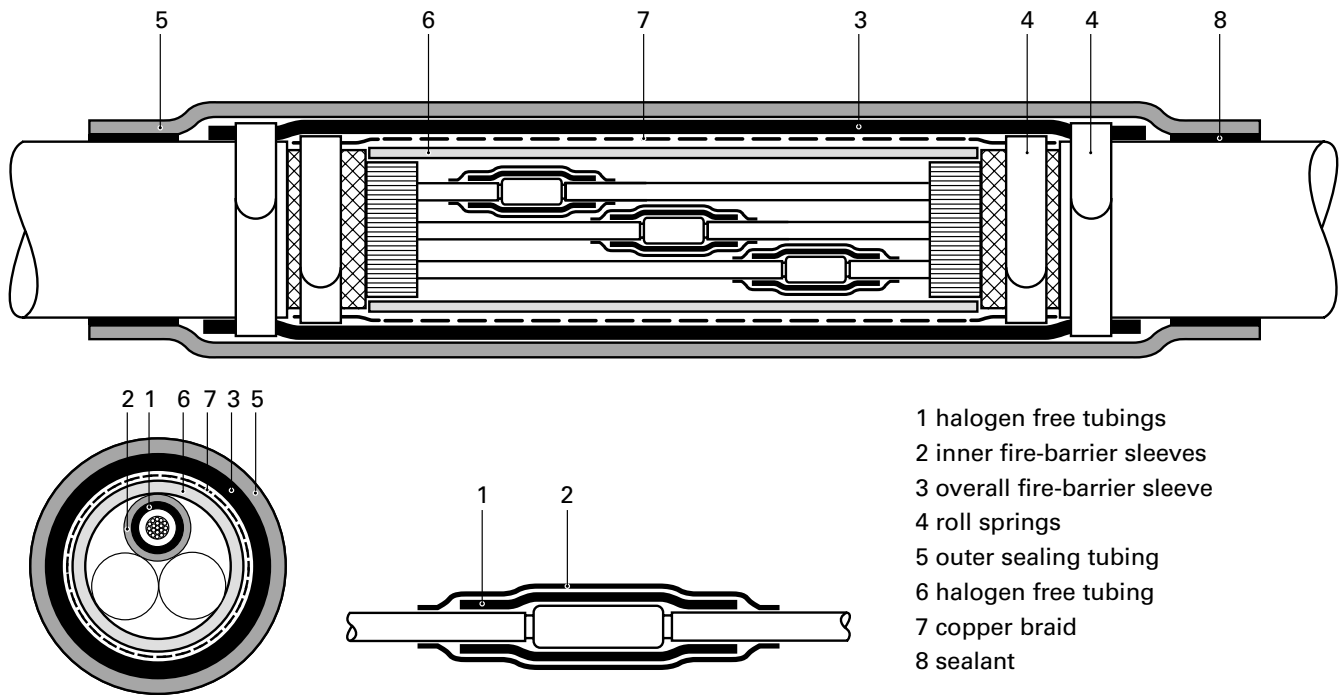


Fire-resistance

To withstand temperatures of 1000°C occurring in fires, the Raychem cable joint employs a combination of Zerohal tubing and fire-resistant glass-fibre/silicone sleeves over the connector insulation and the whole joint area. These ensure that electrical insulation is maintained for at least 3 hours during the fire test. This joint construction has been tested in accordance with IEC 60331-21 and VDE 0472-814. An independent report is available on request.



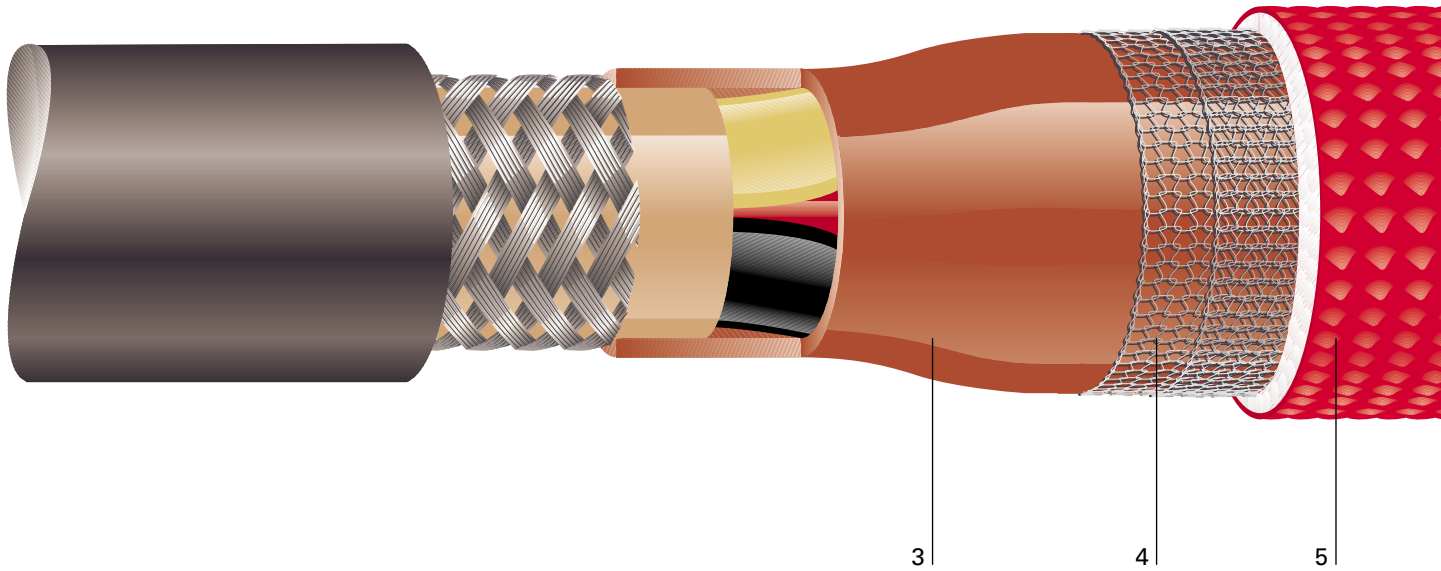
Halogen-free fire-resistant cable joint construction



Performance in Fire Conditions

Test	Test Method	Result
Flame Retardancy	in acc. with IEC 60332-1 and VDE 0482-265-2-1.	pass (ABS approval Reg.No.84-MU19468)
	material test on FCSM outer sealing tubing in acc. with IEEE 383 and IECA S-19-81	pass
Fire Resistance	functional test in acc. with IEC 60331-21 and VDE 0472-814	pass (FMFA report Subj. 1.6-75054)

Design and construction of Raychem fire-resistant joints



Advantages of heat-shrinkable joint design

Compact design

The use of halogen-free flame-retardant material in the form of heat-shrinkable tubing leads to a slim and compact joint design. This simplifies installation in confined areas such as tunnels and vertical shafts, and in all locations where space-saving is of importance.

Ease of installation

As insulation, sealing and outer protection of the joint are provided by heat-shrinkable tubings, there is no mixing or pouring involved in installation. The curing delays and shelf-life restrictions associated with resins are eliminated.

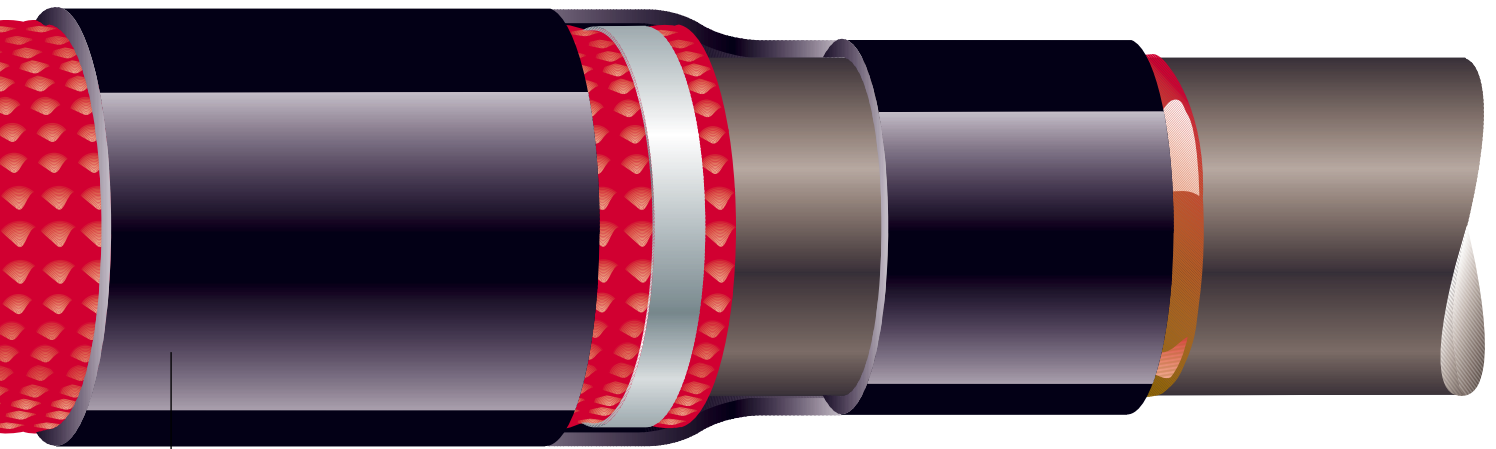
Flame-retardant halogen-free cable joints

For applications which do not require retention of electrical insulating properties in fire conditions, Raychem halogen-free cable joints are available without glass fibre/silicone sleeves.

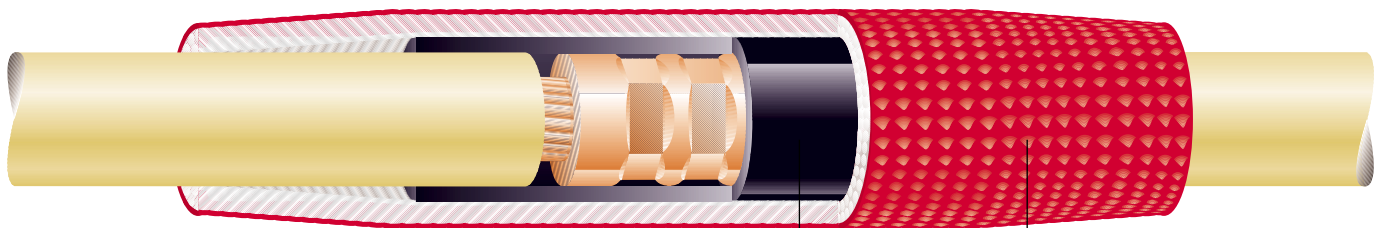
Ordering information

Raychem halogen-free, flame-retardant and fire-resistant joints are available for all common types of shielded and unshielded power and control cable for voltages up to 1 kV. They are supplied in kit form with detailed installation instructions.

Please contact your local sales representative for cable joints specific to your application.



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1 Connector insulation

The heat-shrinkable insulating tubings are of Zerohal (halogen-free), flame-retardant material. The correct insulation thickness round the connectors is provided automatically.

2 Inner fire-barrier sleeves

To ensure continued electrical functioning of the joint during fire tests, high-temperature resistant sleeves made of glass-fibre and silicone are employed over each connector area.

3 Cable bedding replacement

A tubing of halogen-free material is shrunk over the joint to restore the cable bedding in this area.

4 Shielding

Copper mesh wrapped round the joint area provides electrical continuity and restores the functions of the cable shield.

5 Overall fire barrier

The joint area is further protected from flames by an overall glass-fibre/silicone barrier. The roll springs that secure the ends of the sleeve to the cable oversheath prevent lateral penetration of flames into the joint.

6 Outer protection and sealing

To replace the cable oversheath, an outer sleeve is shrunk down over the completed joint. The shrinking action causes sealant applied to the oversheath ends to melt and flow, sealing out moisture.

Minimum performance for Raychem joints for halogen-free, flame-retardant and fire-resistant cables up to 1 kV

Test Sequence		Result
Insulation Resistance	between conductor and grounded water bath	$\geq 1000 \text{ M}\Omega$
A.C. Voltage Withstand	4 kV for 15 min	no breakdown and no flashover
Impulse Voltage Withstand	10 positive and 10 negative, 1.2/50 μs , 8 kV peak, between conductor and grounded water bath	no breakdown and no flashover
Insulation Resistance	repeat	$\geq 1000 \text{ M}\Omega$
Load Cycling	63 cycles 5 h heating, 3 h cooling Conductor temperature: 95°C	pass
Thermal Short Circuit	1 s symmetrical fault with conductor temperature as for cable specification	no visible signs of damage
Load Cycling	as above with cable in 1 m water, oversheath removed	pass
Insulation Resistance	repeat	$\geq 1000 \text{ M}\Omega$
Impulse Voltage Withstand	repeat	no breakdown and no flashover
D.C. Voltage Withstand	10 kV for 5 min	no breakdown and no flashover
Notes:	1. All voltages are phase to ground. 2. Further details are given in Raychem specification PPS 3013.	

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