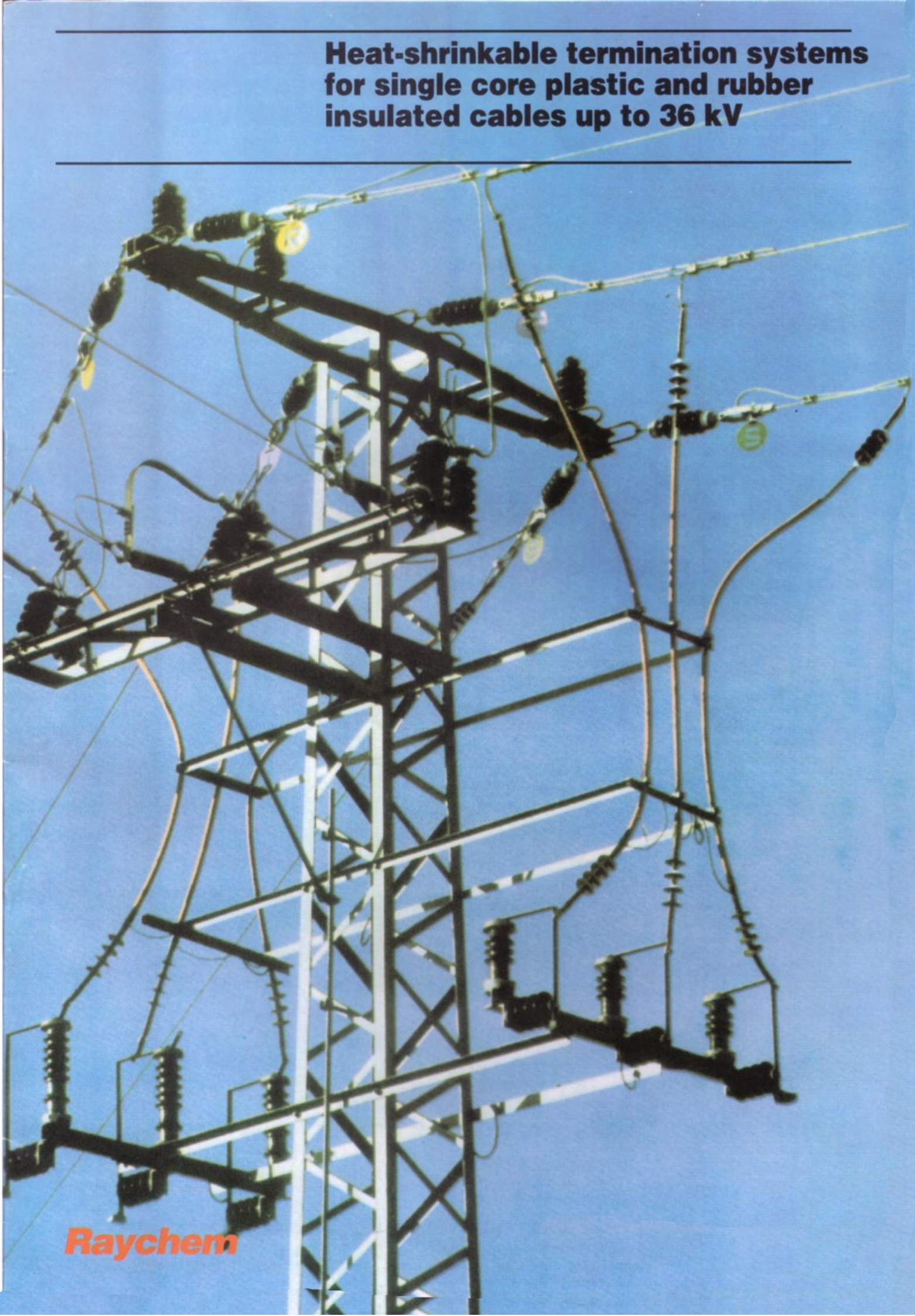
Heat-shrinkable termination systems for single core plastic and rubber insulated cables up to 36 kV



Raychem

Heat-shrinkable termination systems for single core plastic and rubber insulated cables up to 36 kV

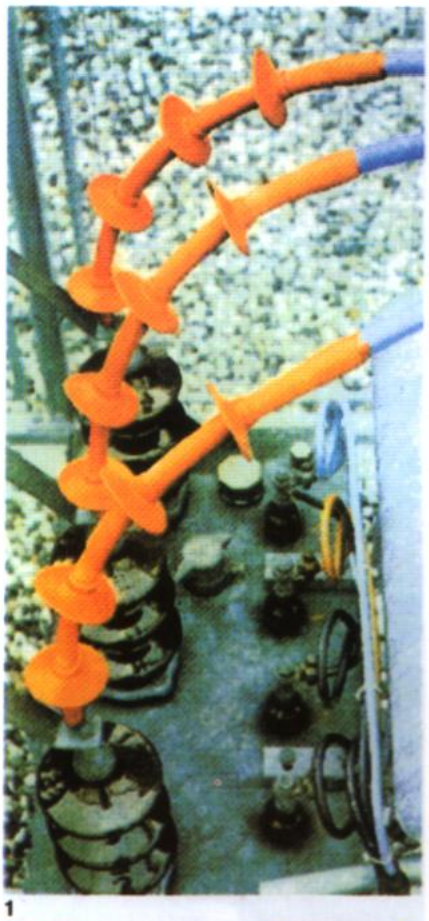
Since the late nineteen sixties, the electricity supply industry has installed over a million Raychem heat-shrinkable cable terminations throughout the world at medium voltages up to 36 kV.

The long-term performance of these numerous installations in some of the most demanding conditions led to widespread acknowledgement of the reliability and ease of application of the Raychem termination technique.

Recognition of Raychem heat-shrinkable material's advantages for cable jointing was the starting point for the development of special polymers for use at medium voltages. The resulting materials possess exceptional resistance to prolonged electrical stress and weathering, but are also capable of being shrunk down quickly to fit and seal a cable, using only a commonly available gas torch.

This technology is the basis of the Raychem termination system; a versatile and dependable link in the world's electricity networks proven in over ten years' extensive service in the field.

Raychem terminations are a universal system supplied in kit form for each specific application. The heat-shrinkable components enable one kit to accommodate varying cable tolerances and to be installed on a range of conductor sizes with the usual skills required for standard cable preparation. They are part of a wide range of Raychem cable accessories, joints, corrosion protection and sealing systems, all installed with the same heat-shrinking technique and specially developed for the power distribution industry.



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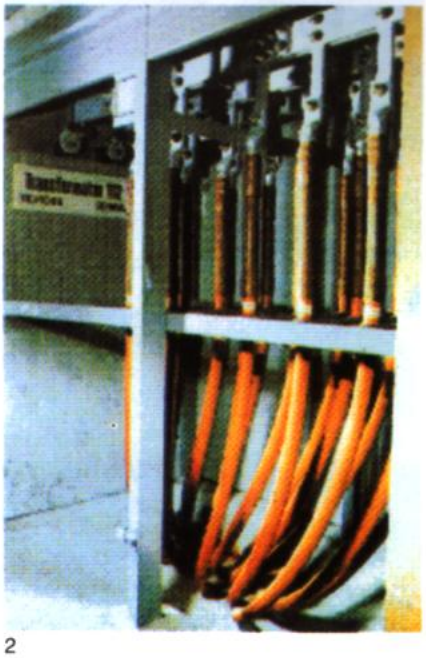

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System benefits

The advantages of the system arise from the electrical and heat-shrinkable properties of the Raychem termination components. No skill-sensitive taping, curing delays, special tools or equipment are involved. As each termination covers a range of conductor sizes, all parts can be easily slipped over and shrunk down to fit cables with varying insulation thickness tolerances and different types of screen. Reversed installation is achieved simply by turning round the heat-shrinkable sheds used to extend the creepage path. The slim design allows easier fitting into confined spaces.

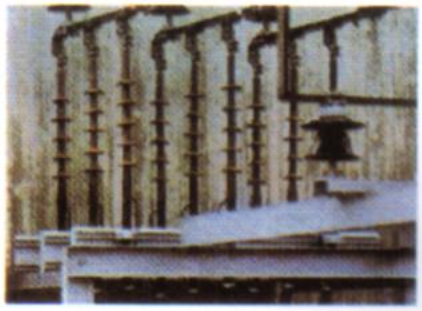
Moisture sealing

Durable sealing is achieved by special Raychem sealants on the inside of the non-tracking, weather-resistant components. At the same time as the cable fitter heats the tubing to install it, the shrinking action causes the sealant to melt and flow into place. A sealed, non-tracking and weather-resistant termination is obtained quickly with a minimum of effort.

Cover photo: Raychem 24 kV terminations for single core plastic cables used by a utility in southern Germany for a complex installation in their distribution network. The fully sealed design and easily reversed heat-shrinkable sheds of the Raychem system made possible this elegantly simple solution.

1 An inverted installation at a Danish utility made with a Raychem kit for 24 kV cables.

2 Indoor connections to a 12 kV transformer in northern Germany.



Electrical and environmental performance

Non-tracking service

The superior non-tracking characteristics and long-term erosion resistance of Raychem terminations have been exhaustively demonstrated in comparative tests at major independent laboratories and Raychem's own extensive development facilities.

These results are born out by the continuing performance of over a million units installed in tropical, desert, arctic and industrially polluted climates, confirming that Raychem terminations do not track even in severe service conditions and verifying their exceptional erosion resistance and reliability.

Test	Results
ASTM D2303 Inclined plane	Non-tracking under all test conditions including addition of 1% sugar to the contaminant. The material erodes only.
IEC 112 Comparative tracking index	No tracking or erosion observed, even on specimens thermally aged at 130°C for 7 days.

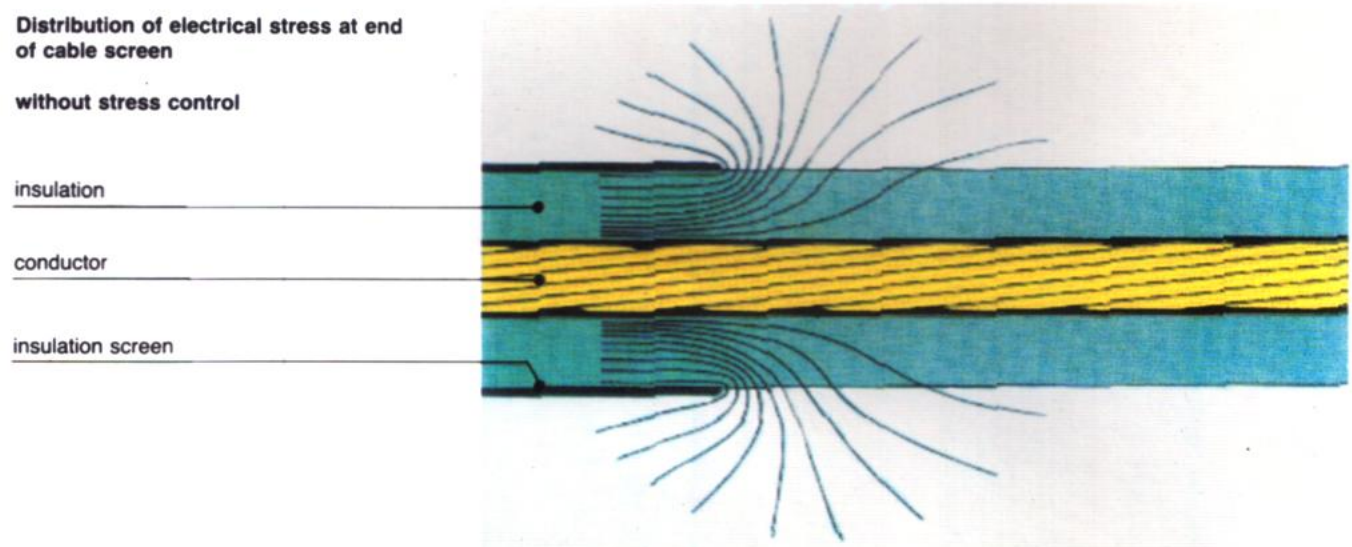
Compact and versatile stress control

To meet the need for a space-saving, flexible termination design, adaptable to different types of compact equipment, Raychem developed a material with a carefully controlled volume resistivity and permittivity, which is applied in the form of a heat-shrinkable tubing.

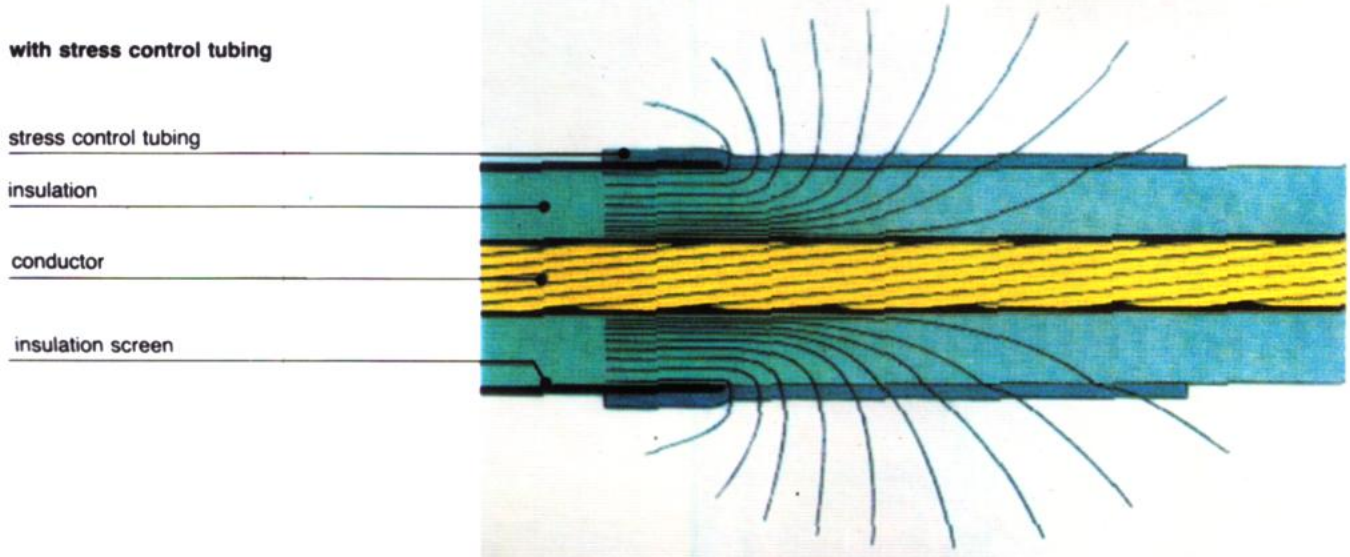
Stress at the end of the insulation screen is controlled by the tubing's defined impedance characteristic, suppressing discharges and preventing damage to the cable in service. The heat-shrinkable feature simplifies installation and allows the system to be used on different cable constructions, easily accommodating varying tolerances.

Distribution of electrical stress at end of cable screen

without stress control



with stress control tubing



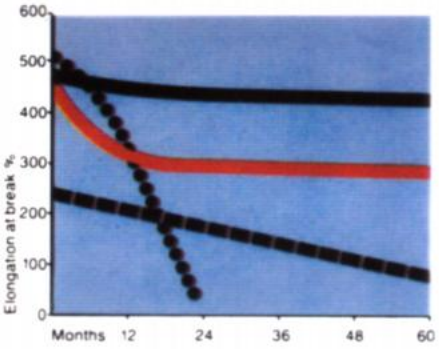
Long-term weather-resistance

Ongoing natural and accelerated weathering tests have closely monitored Raychem terminations' resistance to the combined effects of ultra-violet light, humidity, chemicals and rain. The retention of elongation and electric strength shown in these investigations is more than sufficient justification of long service life expectation.

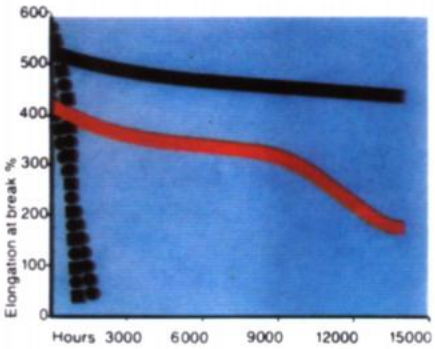
Retention of elongation is a measure of resistance to cracking by ultra-violet light.

= Raychem HVTM
= Typical black PE cable oversheath material
= Typical PE cable dielectric material
= Typical red PVC cable oversheath material
= Commercial grey EPDM

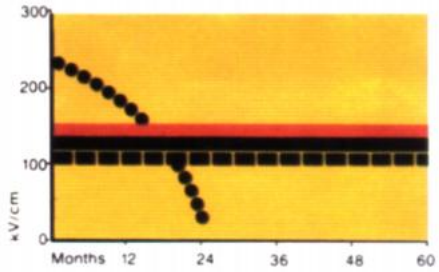
Elongation after natural weathering



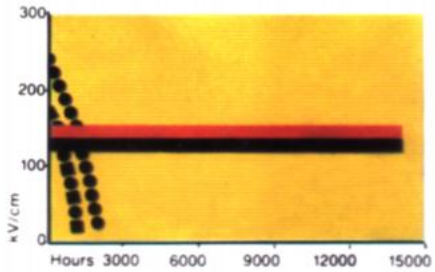
Elongation after accelerated weathering



Electric strength after natural weathering



Electric strength after accelerated weathering



Natural weathering conditions

Samples mounted at 45° facing south in Swindon, England.

Accelerated weathering conditions

Atlas Weatherometer

Relative humidity	Xenon arc on	50 ± 2%
	Xenon arc off	98 ± 2%
Black panel temperature	Xenon arc on	50 ± 2°C
	Xenon arc off	25 ± 2°C
Contaminant Concentration	Ozone	20 pphm
	Sulphur dioxide	20 pphm

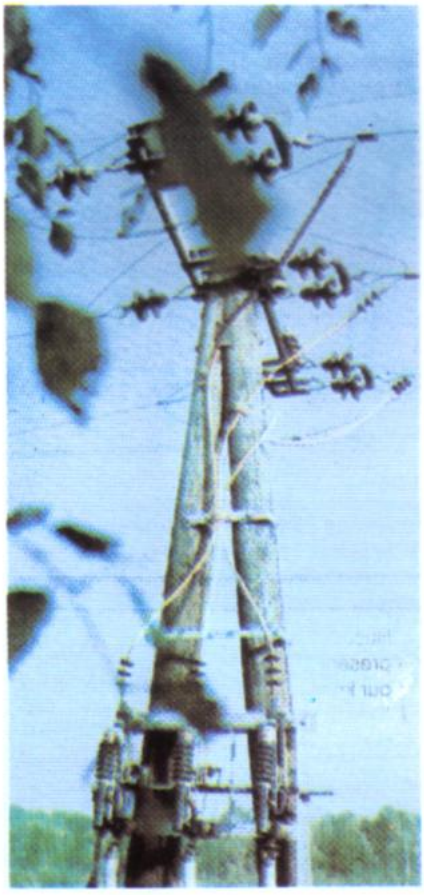
Programmed 24 hour cycle consisting of:
(a) 9 periods of 102 minutes of U.V. light only, each period followed by 18 minutes of light plus water spray. Total: 18 hours
(b) 6 hours dark only
400 hours in a weatherometer is accepted to be equivalent to one year's natural exposure.

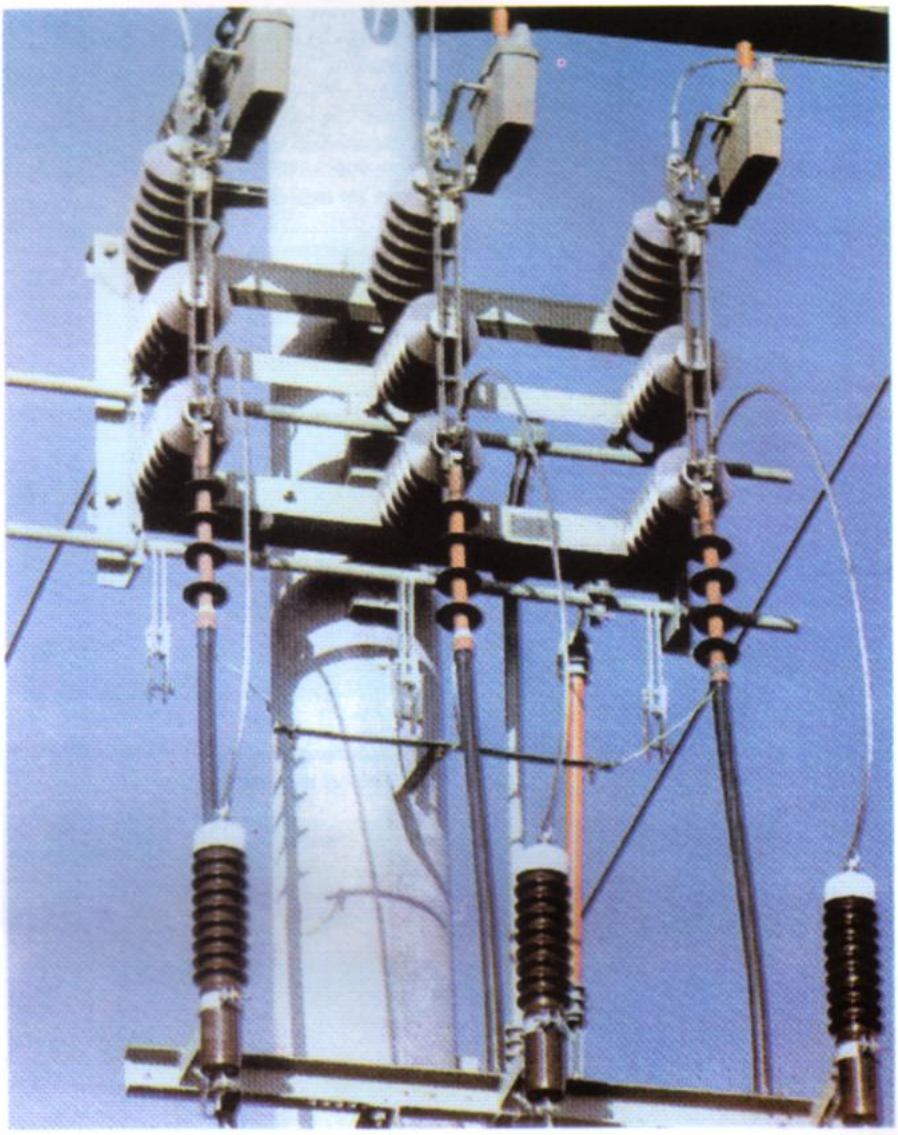
Specifications and test reports

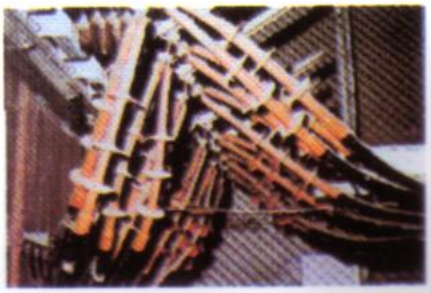
Raychem terminations meet Raychem specification PPS 3013, which encompasses the requirements of BS, VDE and other major national standards, and the IEC and IEEE international norms.

The electrical and environmental performance of Raychem terminations is documented in a continually updated list of test reports from Raychem and many independent national laboratories' field test sites, copies of which are available on request.

Indoor and outdoor application







1 Raychem 36 kV outdoor terminations installed by a Swedish utility.

2 A 12 kV Raychem termination installation in Germany.

3 Raychem terminations for single core plastic insulated cables up to 24 kV in an electrical utility's network near the Alps.

4 24 kV Raychem plastic cable terminations at a coastal site in Spain.

5 Raychem 24 kV terminations in a crowded installation in a highly polluted area of a Scandinavian steel mill.

6 36 kV single core plastic cables at an outdoor switchyard in Austria protected with Raychem heat-shrinkable terminations.

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Technical service

Raychem supports its products with technical advice and assistance from customer service engineers keenly aware of local operating conditions. Specific product development, on-site supervision, and training of fitters in cable preparation and installation are all part of Raychem's determination to fulfil its customers' total requirements.

Ordering information

Raychem terminations are available for single core plastic insulated cables with extruded or graphite screens and wire or metal tape shields with all standard conductor cross-sections and for voltages up to 36 kV. A full selection table is available on request.

Raychem terminations are supplied complete with detailed installation instructions.

For further details on this or any other Raychem products please contact your local Raychem sales engineer.

All the above information, including drawings, illustrations and graphic displays, reflects our present understanding and is to the best of our knowledge and belief correct and reliable. It does, however, under no circumstance constitute an assurance of any particular qualities. Such an assurance is only provided in the context of our product specifications.

Our liability for this product is set forth in our standard terms and conditions of sale.

At Raychem we are committed to continuous quality improvement in every aspect of our business.

Minimum performance for Raychem terminations for single core plastic and rubber insulated cables up to 36 kV

Test Sequence		Test Voltage					Result
		Highest Voltage for Cable U_m [kV]					
		7.2	12	17.5	24	36	
A.C. Voltage Withstand	1 min	27	35	45	55	75	no breakdown and no flashover
Partial Discharge		4.5	7.5	10.9	15	22.5	≤ 3 pC
		7.2	12	17.5	24	36	≤ 20 pC
Impulse Voltage Withstand	10 positive and 10 negative, 1.2/50 μs, between each conductor and the grounded screen	indoor:					no breakdown and no flashover
		60	75	95	125	170	
		outdoor:					
		70	95	110	150	200	
Load Cycling	63 cycles 5h heating, 3h cooling Conductor temperature: PE, PVC cables: 75°C XPE cables: 95°C	9	15	22	30	45	no breakdown and no flashover
Partial Discharge		4.5	7.5	10.9	15	22.5	≤ 3 pC
		7.2	12	17.5	24	36	≤ 20 pC
Thermal Short Circuit	1 s symmetrical fault with conductor temperature as for cable specification 1 s earth fault with screen or armour temperature as for cable specification						no visible signs of damage
Load Cycling	repeat	9	15	22	30	45	no breakdown and no flashover
Partial Discharge		4.5	7.5	10.9	15	22.5	≤ 3 pC
		7.2	12	17.5	24	36	≤ 20 pC
A.C. Voltage Withstand	4h	14	24	36	48	72	no breakdown and no flashover
Impulse Voltage Withstand	repeat	indoor:					
		60	75	95	125	170	no breakdown and no flashover
		outdoor:					
		70	95	110	150	200	
D.C. Voltage Withstand	30 min	28	48	72	96	144	no breakdown and no flashover
Humidity indoor terminations	conductivity 800 μS/cm, 100 h spray rate: 0.4 l/m³/h	4.5	7.5	10.9	15	22.5	no breakdown, no flashover, no visible tracking and no erosion
Salt-fog outdoor terminations	224 kg/m³	4.5	7.5	10.9	15	22.5	no flashover

Notes:

1. U_m is the highest phase to phase voltage. All other voltages are stated as phase to ground values.
2. Further details are given in Raychem specification PPS 3013.

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