Heat-shrinkable termination systems for 3-core plastic and rubber insulated cables up to 36 kV

Raychem

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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.

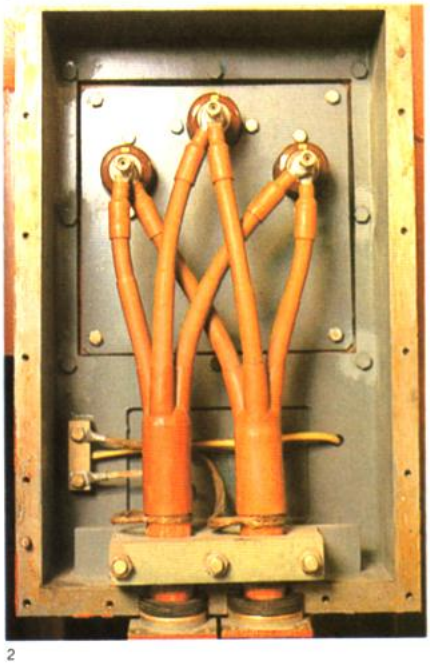
This technology is the basis of the Raychem termination system; a versatile and dependable link in the world's electricity networks proven in over ten years' extensive service in the field.

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.

1

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. Each termination kit can be used in the same way on cables with round or sector-shaped cores and various types of screen. Reversed installation is achieved simply by turning round the heat-shrinkable sheds used to extend the creepage path. The slim design and flexible materials make for easy handling and fitting into confined spaces.



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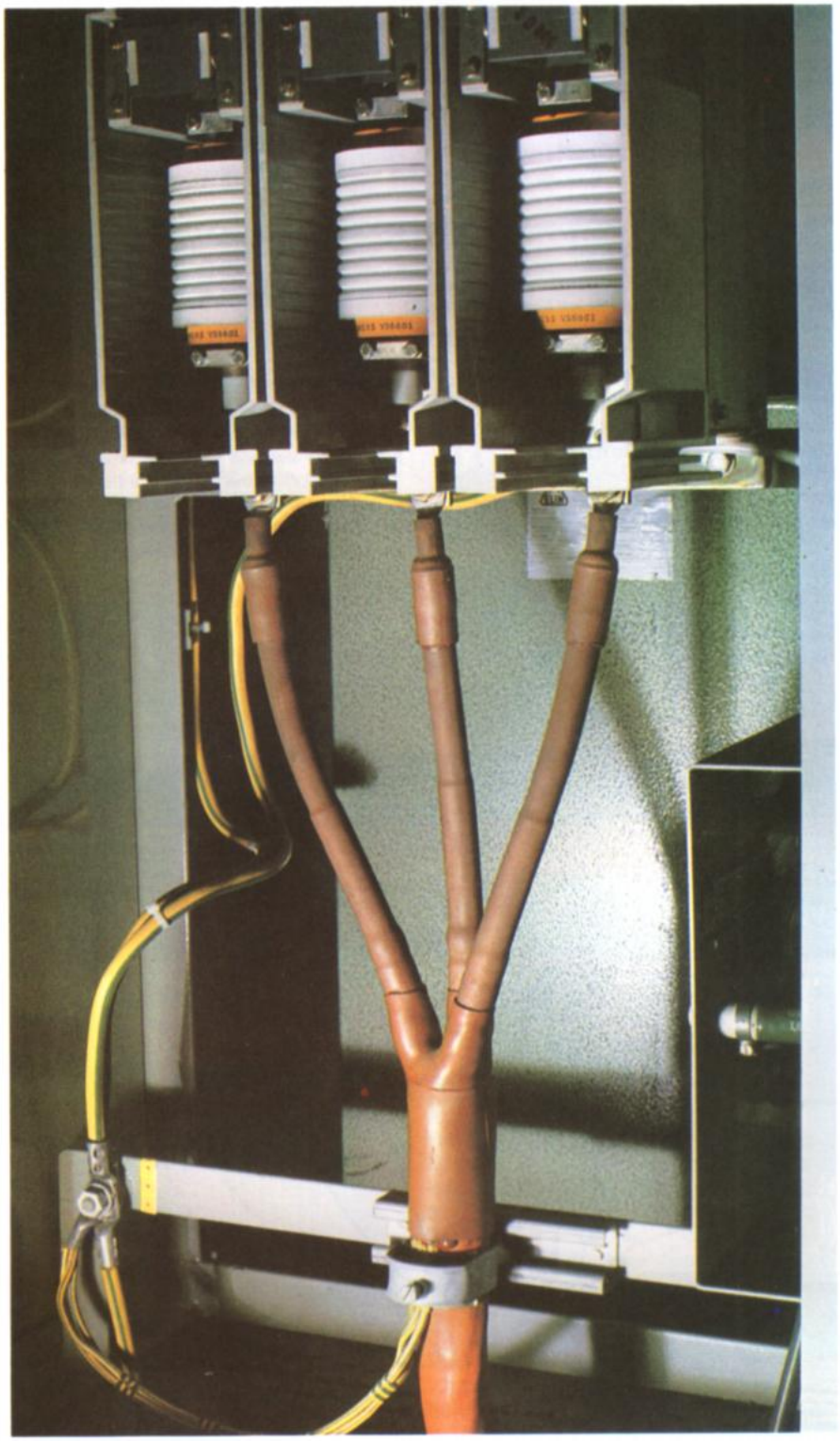
Moisture sealing

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. The cable is further protected from the harmful effects of water, dust and atmospheric pollution by a sealant-lined heat-shrinkable breakout installed over the cores and cable crutch to provide a sealed, non-tracking and weather-resistant surface from the connecting lugs to the oversheath.



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Cover photo: Raychem terminations, such as this 12 kV installation, are widely used in Scandinavia.

1, 4 Fitters at a Dutch shipyard installing Raychem terminations on 7.2 kV sector-shaped cables on a new car ferry.

2 Raychem 12 kV terminations were selected to meet requirements of high reliability, compactness and flexibility for ventilation equipment connections in a major Alpine road tunnel project.

3 This 12 kV installation in Austria shows the heat-shrinkable connector boots and breakout at the cable crutch that provide a non-tracking, rugged seal against humidity and ozone over the whole cable end.

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.

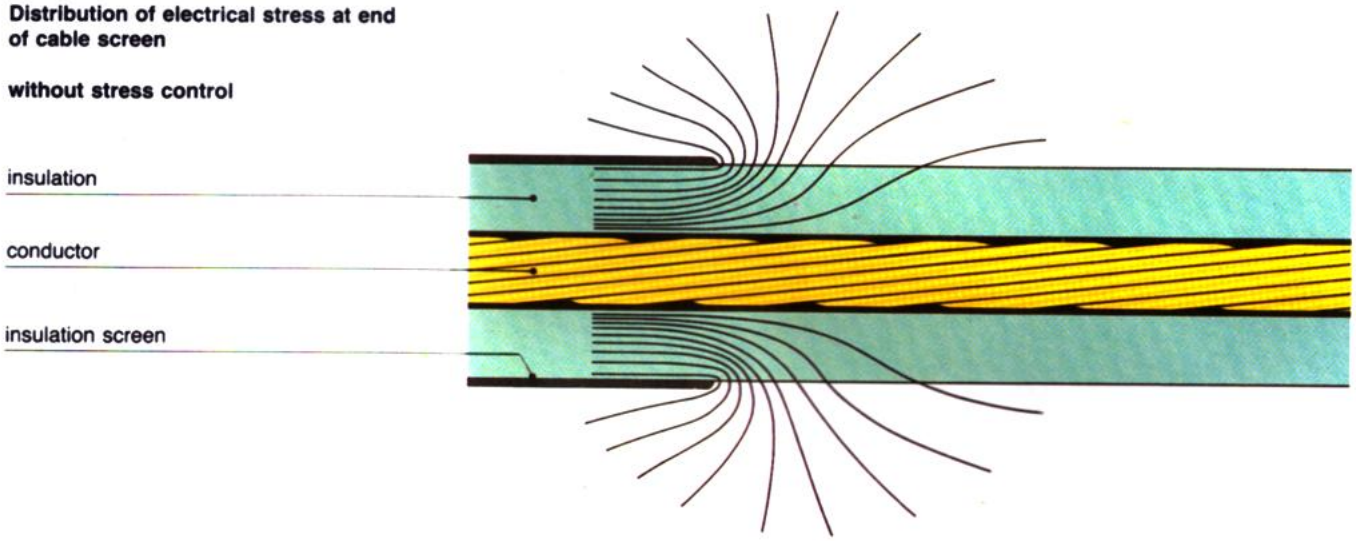
Compact and versatile stress control

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.

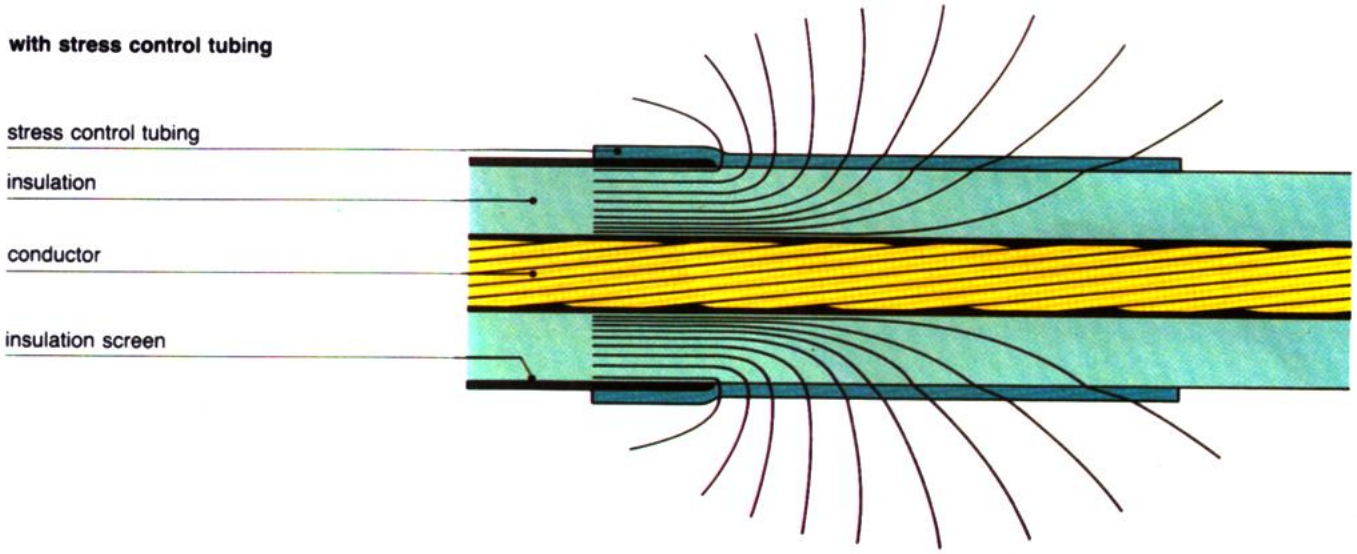
Stress at the end of the insulation screen is controlled by the tubing's defined impedance characteristic, suppressing discharges and preventing damage to the cable in service. The heat-shrinkable feature simplifies installation and allows the system to be used on different cable constructions, easily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

Distribution of electrical stress at end of cable screen

without stress control



with stress control tubing



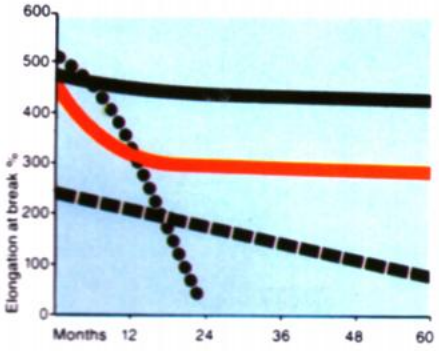
Long-term weather-resistance

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.

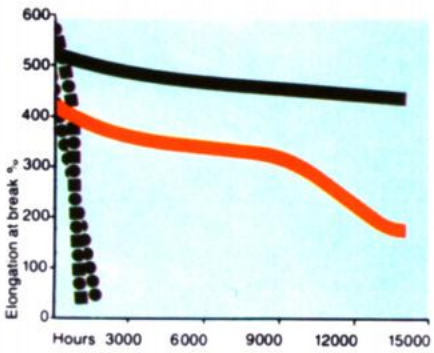
Retention of elongation is a measure of resistance to cracking by ultra-violet light.

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

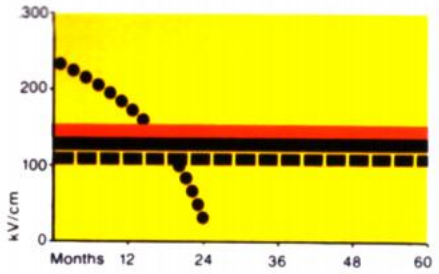
Elongation after natural weathering



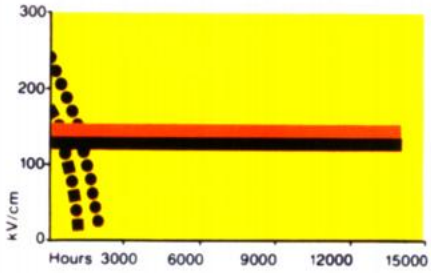
Elongation after accelerated weathering



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.

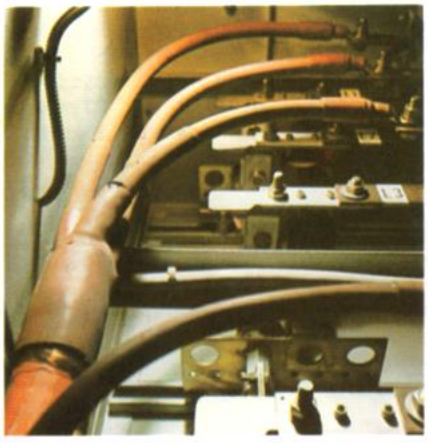
Indoor and outdoor application

Electrical utilities and contractors specify the Raychem system for its proven field performance in many different applications. The terminations here and countless others have shown Raychem terminations' suitability for a wide range of cable designs, equipment configurations and environmental conditions.

1 Reliability in conditions of intense ultra-violet light and high humidity, combined with easy, rapid installation, have led to many installations of Raychem terminations in the Middle East, such as this transformer connection of a 3-core plastic cable for up to 12 kV.

2, 3 Switchgear connections for 12 kV in Tirol.

1



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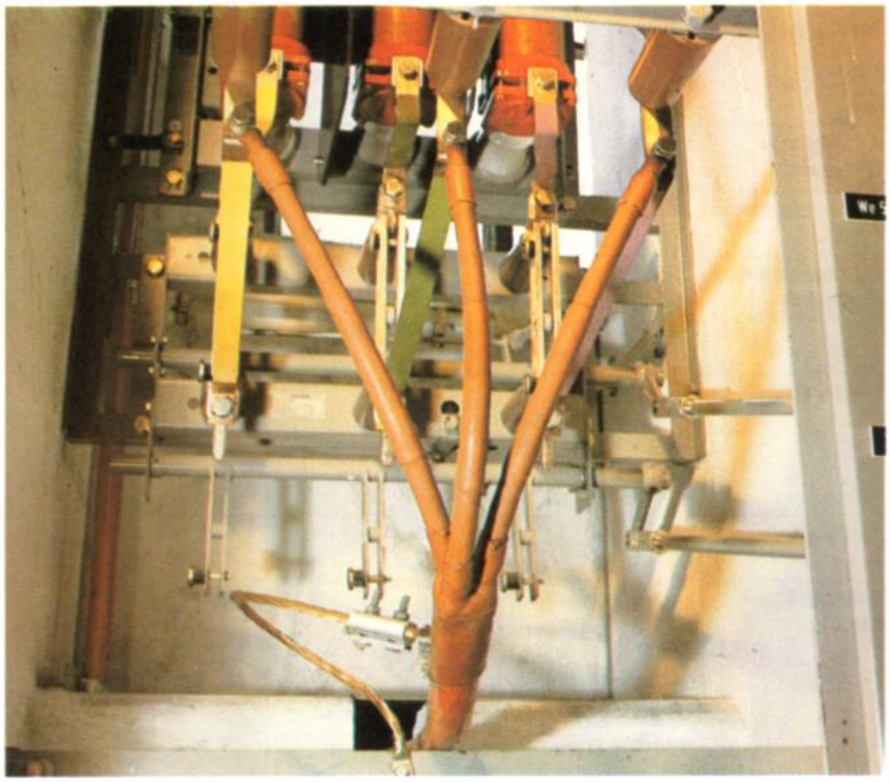

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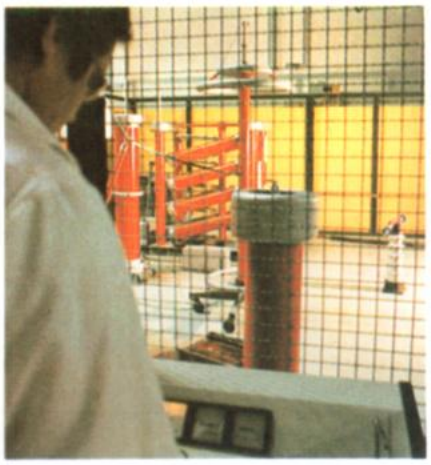
Technical service

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.



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4 High voltage testing is carried out at Raychem Energy Division laboratories in Munich and San Francisco.

5

5 A Raychem engineer instructing cable fitters in the preparation of a 12 kV plastic cable prior to installation in a cable box, originally designed for compound-filling, using a Raychem termination.

Ordering Information

Raychem terminations are available for 3-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.

Minimum performance for Raychem terminations for 3-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:					no breakdown and no flashover
		60	75	95	125	170	
		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
Dynamic Short Circuit	63 kA						no visible signs of damage
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.

(2)

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