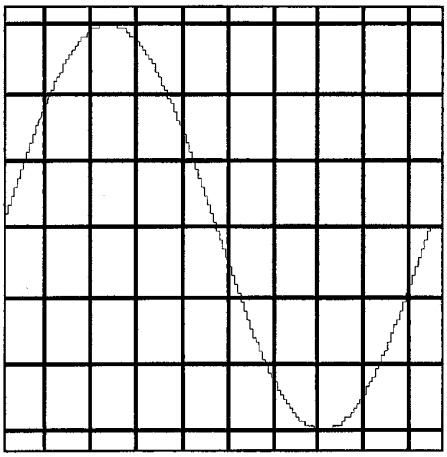

Test Report

PPR 1362-CEE

12.7/22 (24)kV
POLT-24x/1XI (IXSU-F51xx)
Indoor Termination
tested in accordance with
CENELEC HD 629.1 S1: 1996
Specification

Pages: 41

Tested by: **M. Becker** (Application Engineer, Energy Products)	Signature:		Date: 16.11.99
Prepared by: **M. Becker** (Application Engineer, Energy Products)	Signature:		Date: 16.11.99
Released by: **W. Haverkamp** (Technical Manager, Energy Products)	Signature: i.V.		Date: 16.11.99

TYCO ELECTRONICS Raychem GmbH
Energy Division
Haidgraben 6
D-85521 Ottobrunn
Munich, Germany
Tel. +49 89 6089-380
Fax +49 89 6089-654

Test Report PPR 1362-CEE:

Subject of Test:	Indoor Termination POLT-24x/1XI (internal name IXSU-F51xx) for 24 kV single core polymeric unarmoured cables
Date of Tests:	January 1999 – September 1999
Requirements:	CENELEC HD 629.1 S1: 1996
Manufacturer:	Raychem GmbH Ottobrunn
Location of Tests:	Raychem EPD Laboratories, Ottobrunn - Germany Elektrisches Prüfamt Stadtwerke München
Test Purpose:	Qualification Testing to meet CENELEC requirements
Reference:	Laboratory Book 4230, page 14,15,16,20,22
Test Results:	***The POLT-24D/1XI (IXSU-F5131) 24 kV indoor termination was tested in accordance with CENELEC HD 629.1 S1:1996. The tests were carried out on single core XLPE Aluminium cables with conductor cross sections of 95 mm^2 and 240 mm^2.*** ***All samples passed the test requirements in accordance with the CENELEC HD 629.1 S1:1996 12,7/22 (24) kV specification. The POLT-24D/1XI (IXSU-F5131) is qualified for cross sections from 70mm^2 to 240mm^2.*** ***Additional tests qualified the remaining kits to cover the cross sections: POLT-24C/1XI (IXSU-F5121) for 25-70 mm^2, POLT-24E/1XI (IXSU-F 5141 for 185-400 mm^2, POLT-24F/1XI (IXSU-F5151) for 400-800mm^2.***

Content:

1. CENELEC Test for POLT-24D/1XI (IXSU-F5131) for Cross Section 70-240 mm^2

1.1. Test Sequence

The test sequen ce of the POLT-24D/1XI (IXSU-F5131) In door Termin ation for 12,7/22 (24) kV was done in accordance with HD 629.1 S1:1996 table 3 on page 12.

Table 1: Indoor terminations for extruded insulation cables

	Test	Test clause of HD 628	A1	A2	A3	Test requirements
1	DC voltage dry withstand	5	X	X		15 min @ 6 U_0 = 76 kV
2	AC voltage dry withstand	4	X	X		5 min @ 4.5 U_0 = 57 kV
3	Partial discharge at ambient temperature	7	X			XLPE: max 10 pC @ 1.73U_0=22kV
4	Impulse voltage at elevated temperature	6	X			10 impulses of each polarity U=125kV 1.2/50µs
5	Electrical heat cycling in air	9	X			3 cycles 5/3h @ 32 kV conductor temperature 95-100°C
6	Partial discharge at ambient temperature at elevated temperature	7	 X X			 max. 10 pC @ 22 kV max. 10 pC @ 22 kV
7	Electrical heat cycling in air	9	X			123 cycles 5/3 @ 32 kV conductor temperature 95-100°C
8	Partial discharge at ambient temperature at elevated temperature	7	 X X			 max. 10 pC @ 22 kV max. 10 pC @ 22 kV
9	Thermal short circuit (conductor)	11		X		2 short circuit for 1s
10	Impulse voltage at ambient temperature	6	X	X		10 impulses of each polarity U=125kV 1.2/50µs
11	AC voltage dry withstand	4	X	X		15 min @ 2.5 U_0 = 32 KV
12	Humidity	13			X	300 h duration at 16kV / 70mS/m
13	Examination	-	X	X	X	For information only

1.2. Test Samples

Cable:

Manufacturer:	Kabelmetal
Type:	NA2XS2Y 12/20 kV
Design:	XLPE, extruded screen
Conductor:	stranded Aluminium
Cross section conductor:	95 mm^2 and 240 mm^2
Shielding wires	Copper wires
Cross section shielding	16 mm^2 and 25 mm^2
Voltage rating:	12/20 kV
Length of test loop:	approx. 2,50 m

Product:

Kit description		POLT-24D/1XI (IXSU-F5131)
Insulating tubing:	3	HVOT-50/16-340/242 Batch EA13882
Screen cut filler:	3	S1189-1-100
Sealant:	3	S1085-3-200
Installation instruction:	1	EPP 0778 3/99

1.3. Test Sequence A1

1.3.1. D.C. Voltage Test according to Section 5 of HD 628

Requirement: D.C. Voltage Withstand 15 min @ 76 kV

Result: No breakdown occurred on the 4 test loops

relative humidity of air	*atmospheric pressure*	*temperature*
32 %	962 hPa	22° C

1.3.2. A.C. Voltage Test according to Section 4 HD 628

Requirement: A.C. voltage of U_{rms}= 57 kV, 50 Hz was applied between the conductor and the grounded screen for 5 minutes. The voltage was continuously increased within 10 seconds to the specified value and then held constant during the required test period.

Result: No breakdown occurred on the 4 test loops

1.3.3. Partial Discharge Test at ambient temperature acc. Sec. 7 HD 628

Requirement: Maximum PD level @ 22kV ≤ 10pC

The lugs were made corona free by using ring electrodes and an A.C test voltage of 1.25*U = 30kV was applied for 1 min. Then the voltage was decreased to the A.C. test voltage of U_{PD} = 22 kV and within 1 minute the maximum value of the partial discharge magnitude was measured.

Result: Measured PD level is below the limit of 10 pC

	Loop 1 95 mm²	*Loop 2 95 mm²*	*Loop 1 240 mm²*	*Loop 2 240 mm²*
PD value [pC] @ 22kV	bnl	bnl	bnl	bnl

bnl....basic noise level $q_n \leq 1$pC

1.3.4. Impulse Voltage at Elevated Temperature

Requirement: An impulse voltage with rise time of approx. 1.2 µs and half-value decay time with approx. 50 µs was applied. The test loops were exposed to 10 impulses each of an impulse voltage of 125 kV of positive and negative polarity between the conductor and the grounded screen. The test loops were heated up to a temperature of 95-100°C.

Result: No breakdown occurred on the 4 test loops. The impulse diagrams below show no discrepancies from the calibration oscillogram.

relative humidity of air	*atmospheric pressure*	*temperature*
32 %	962 hPa	22° C

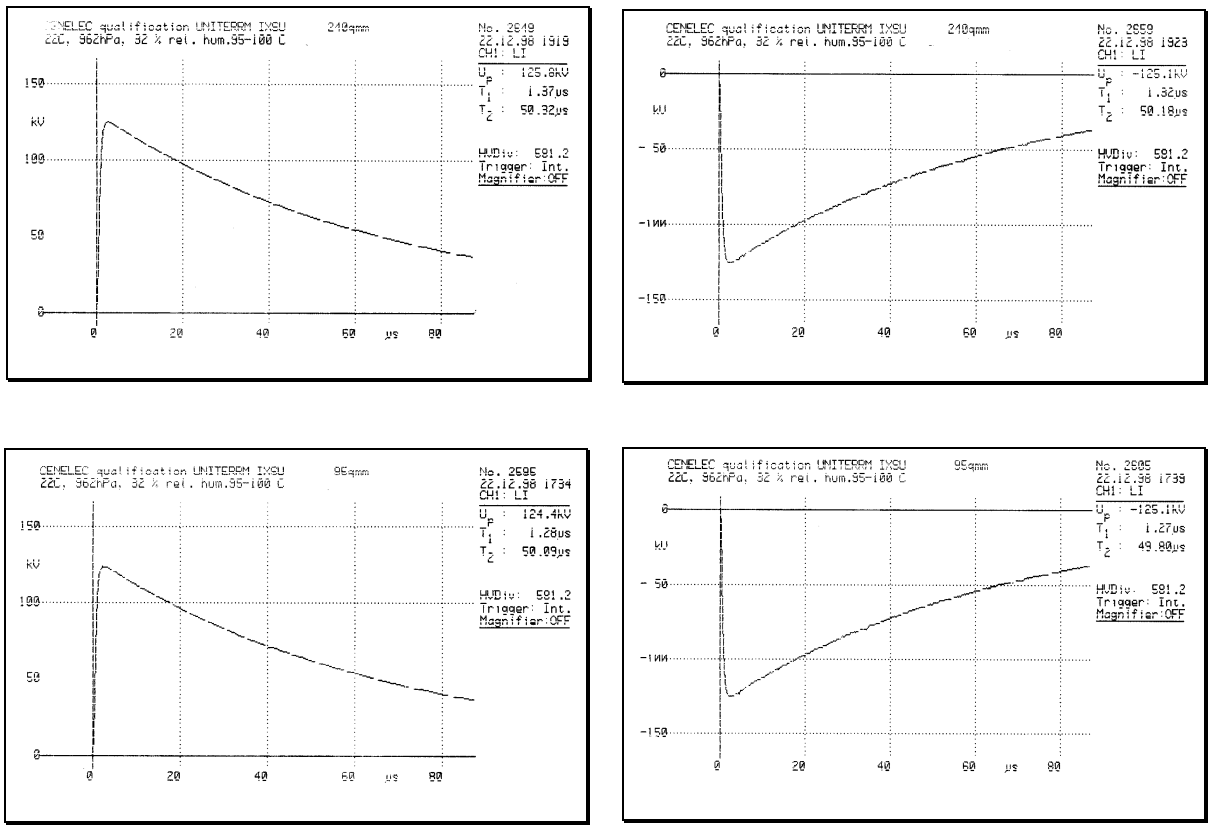

Fig. 1: Impulse oscillograms for 95mm^2 and 240mm^2 XLPE cables

Fig. 2: Photo shows the 240 mm^2 samples during the impulse voltage test

1.3.5. Electrical Heat Cycling in Air acc. to Section 9 HD 628

Requirement: The test loops, suspended free in air, were subjected to 3 load cycles with a continuously applied AC test voltage of 32 kV. Each load cycle consists of a 5 hours heating period and a 3 hours cooling period. The test loops were heated up to a temperature of 95-100°C.

Result: No breakdown occurred on the 4 test loops.

relative humidity of air	*atmospheric pressure*	*temperature*
33 %	937 hPa	20° C

1.3.6. PD at Elevated and Ambient Temperature acc. to Sec 7 of HD 628

a) Partial Discharge at Ambient Temperature after 3rd Load Cycle

Requirement: Maximum PD level @ 22kV ≤ 10pC
Identical test as in 1.3.3

Result: Measured PD level was below the limit of 10 pC

	Loop 1 95 mm²	*Loop 2 95 mm²*	*Loop 1 240 mm²*	*Loop 2 240 mm²*
PD value [pC] @ 22kV	bnl	bnl	bnl	bnl

bnl....basic noise level $q_n \leq 1pC$

b) Partial Discharge at Elevated Temperature after 3rd Load Cycle

Requirement: Maximum PD level @ 22kV ≤ 10pC

The conductors were heated up to a temperature of 95-100°C. Then identical test as in 1.3.3.

Result: Measured PD level was below the limit of 10 pC

	Loop 1 95 mm²	*Loop 2 95 mm²*	*Loop 1 240 mm²*	*Loop 2 240 mm²*
PD value [pC] @ 22kV	bnl	bnl	bnl	bnl

bnl.....basic noise level $q_n \leq 1pC$

1.3.7. Electrical Heat Cycling in Air acc. to Section 9 HD 628

Requirement: Test equivalent to 1.3.5, but 123 cycles

Result: No breakdown occurred on the 4 test loops.

*relative humidity of air**	*atmospheric pressure**	*Temperature**
35 %	948 hPa	24° C

*) Recorded at start of load cycling

1.3.8. PD at Elevated and Ambient Temperature acc. to Sec 7 of HD 628

a) Partial Discharge at Ambient Temperature after 123rd Load Cycle

Requirement: Maximum PD level @ 22kV ≤ 10pC
Identical test as in 1.3.3

Result: Measured PD level was below the limit of 10 pC

	Loop 1 95 mm²	*Loop 2 95 mm²*	*Loop 1 240 mm²*	*Loop 2 240 mm²*
PD value [pC] @ 22kV	bnl	bnl	bnl	bnl

bnl.....basic noise level $q_n \leq 1pC$

b) Partial Discharge at Elevated Temperature after 123th Load Cycles

Requirement: Maximum PD level @ 22kV ≤ 10pC

The conductors were heated up to a temperature of 95-100°C. Then identical test like in 1.3.3.

Result: Measured PD level was below the limit of 10 pC

	Loop 1 95 mm²	*Loop 2 95 mm²*	*Loop 1 240 mm²*	*Loop 2 240 mm²*
PD value [pC] @ 22kV	bnl	bnl	bnl	bnl

bnl....basic noise level $q_n \leq 1pC$

1.3.9. Impulse Voltage at Ambient Temperature

Requirement: An impulse voltage with rise time of approx. 1.2 µs and half-value decay time with approx. 50 µs was applied. The test loops were exposed to 10 impulses each of an impulse voltage of 125 kV of positive and negative polarity between the conductor and the grounded screen.

Result: No breakdown occurred on the 4 test loops. The impulse diagrams below show no discrepancies from the calibration oscillogram.

relative humidity of air	*atmospheric pressure*	*temperature*
36 %	966 hPa	21° C

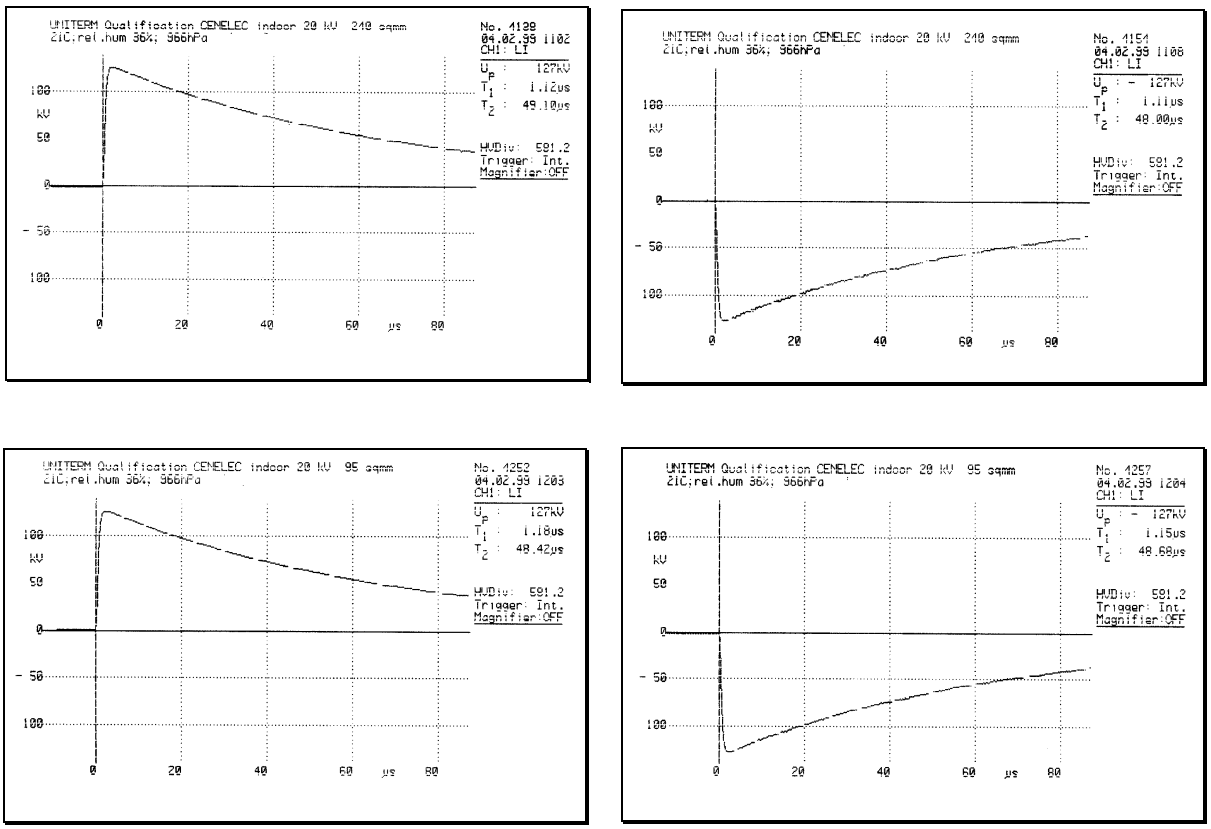

Fig. 3: Impulse oscillograms for 95mm^2 and 240mm^2 XLPE cables after 126 cycles heat cycling

1.3.10. A.C. Voltage Dry Withstand

Requirement: A.C. voltage of U_{rms} = 32 kV, 50 Hz was applied between the conductor and the grounded screen for 15 minutes. The voltage was continuously increased within 10 seconds to the specified value and then held constant during the required test period.

Result: No breakdown occurred on the 4 test loops

1.3.11. Examination

All tested samples looked optically good. After cutting open no signs of destruction could be seen.

1.4. Test Sequence A2

1.4.1. D.C. Voltage Test according to Section 5 of HD 628

Requirement: D.C. Voltage Withstand 15 min @ 76 kV

Result: No breakdown occurred on the 4 test loops

relative humidity of air	*Atmospheric pressure*	*temperature*
42 %	951 hPa	20° C

1.4.2. A.C. Voltage Test according to Section 4 HD 628

Requirement: A.C. voltage of U_{rms}= 57 kV, 50 Hz was applied between the conductor and the grounded screen for 5 minutes. The voltage was continuously increased within 10 seconds to the specified value and then held constant during the required test period.

Result: No breakdown occurred on the 4 test loops

1.4.3. Thermal Short Circuit Test according to Section 11 HD 628

Requirement:
The thermal equivalent short circuit current during 1 second duration was calculated based on CENELEC HD 628 S1:1996. This short circuit load application was repeated once, each time after the conductor had cooled down to ambient temperature. (Ambient temperature 21°C)

	cross section [mm²]	*Conductor*	*Short circuit current [kA]*
Loop 1	95	Aluminium	11,4
Loop 2	240	Aluminium	28,8

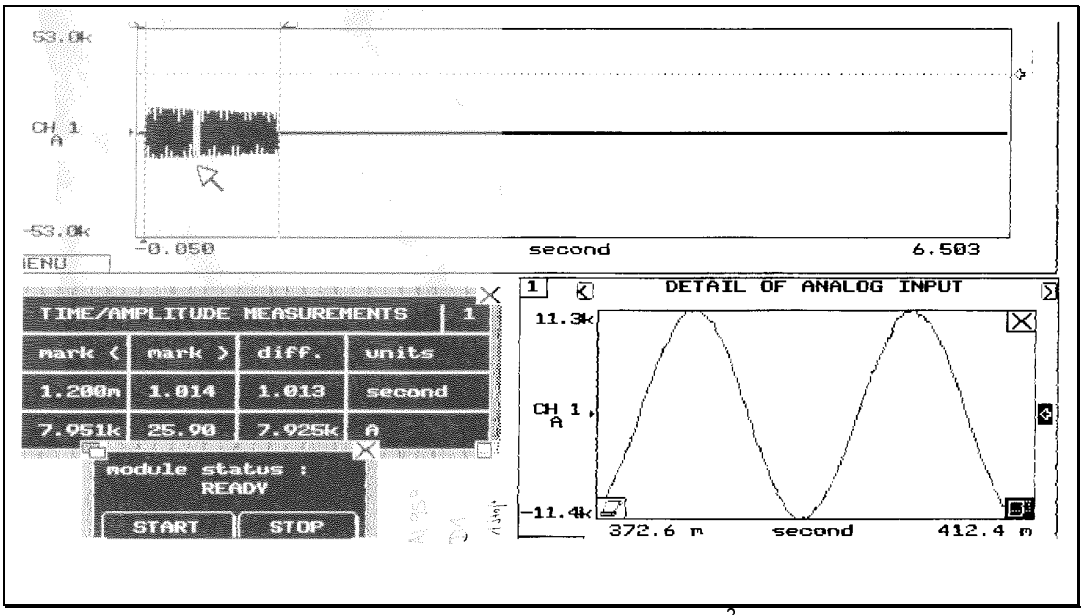

Fig 5: Thermal short circuit oscillogram for 95 mm^2 XLPE AL cables
Carried out in "Elektrisches Prüfamt München"

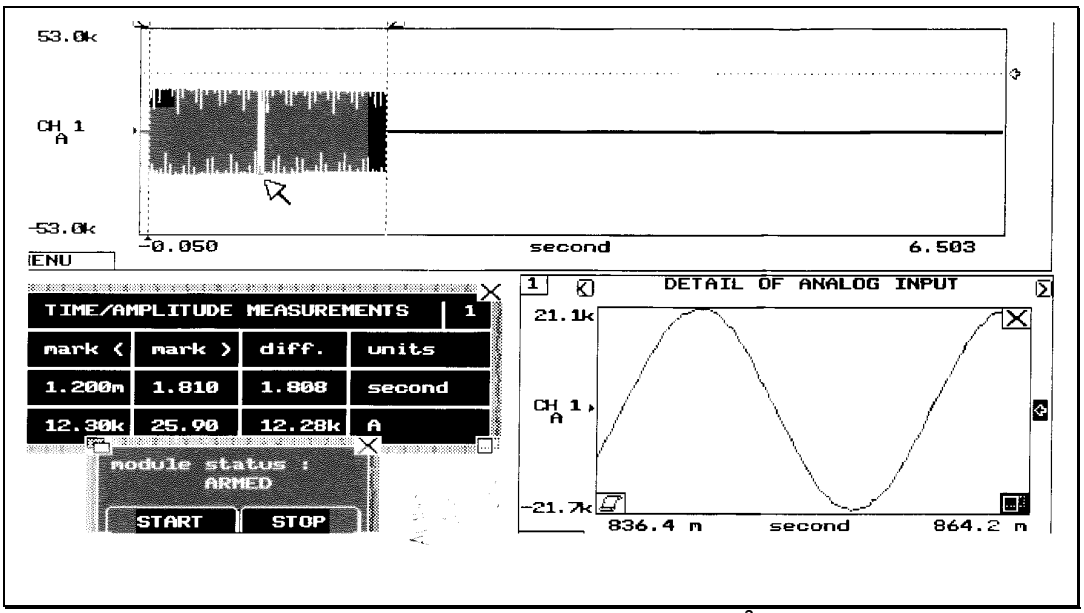

Fig 5: Thermal short circuit oscillogram for 240 mm^2 XLPE AL cables
Carried out in "Elektrisches Prüfamt München"

Result: No breakdown occurred on the 4 test loops

The thermal short circuit oscillograms in figures 4 and 5 do not show any discrepancies from the calibration oscillogram. A visual check did not show any damage on the test loops.

1.4.4. Impulse Voltage at Ambient Temperature

Requirement: An impulse voltage with rise time of approx. 1.2 µs and half-value decay time with approx. 50 µs was applied. The test loops were exposed to 10 impulses each of an impulse voltage of 125 kV of positive and negative polarity between the conductor and the grounded screen.

Result: No breakdown occurred on the 4 test loops. The impulse diagrams below show no discrepancies from the calibration oscillogram.

relative humidity of air	*atmospheric pressure*	*temperature*
45 %	963 hPa	23° C

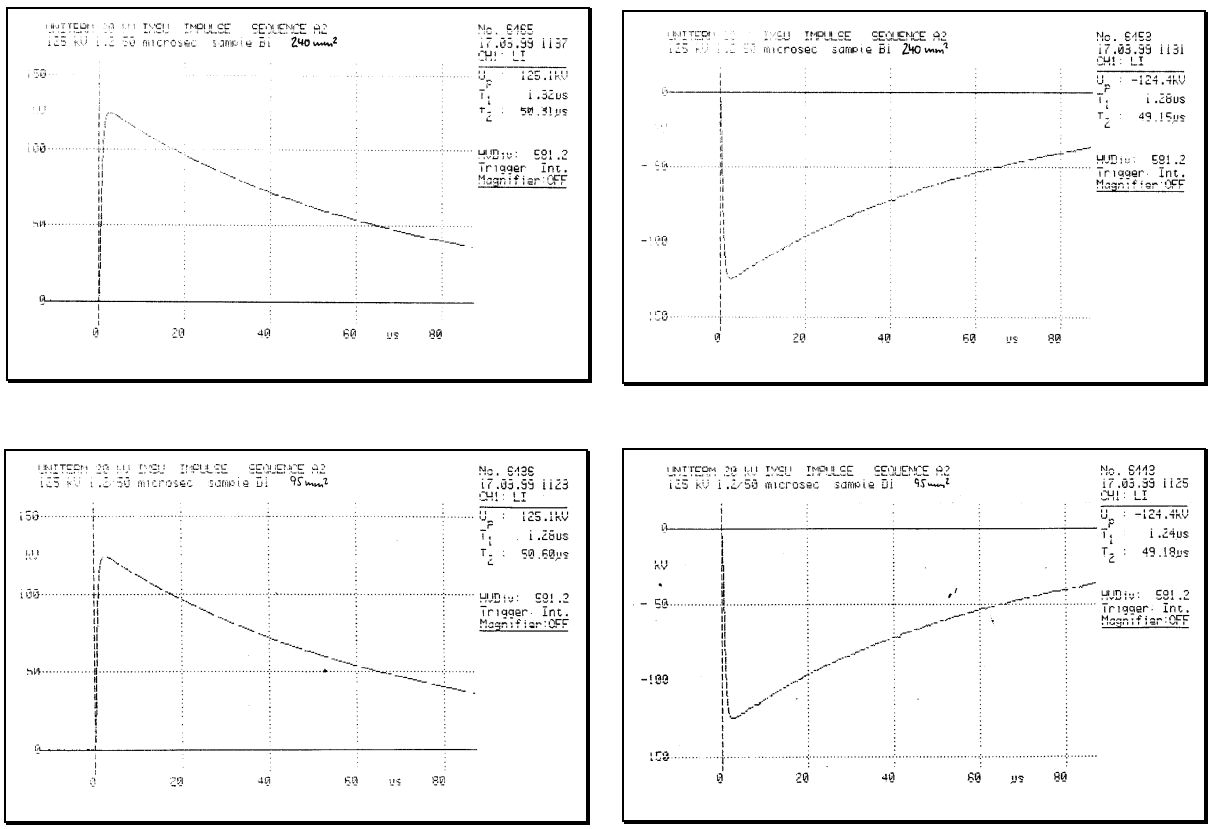

Fig. 6: Impulse oscillograms for 95mm² and 240mm² XLPE cables after thermal short circuit

1.4.5. A.C. Voltage Test according to Section 4 HD 628

Requirement: A.C. voltage of U_{rms} = 32 kV, 50 Hz was applied between the conductor and the grounded screen for 15 minutes. The voltage was continuously increased within 10 seconds to the specified value and then held constant during the required test period.

Result: No breakdown occurred on the 4 test loops

1.4.6. Examination

All tested samples looked optically good. After cutting open no signs of destruction could be seen.

1.5. Test Sequence A3

The 300 h humitidy test was done in accordance with section 13 HD 628.

A.C. voltage of U_{rms} = 16 kV, 50 Hz was applied between the conductor and the grounded screen for 300 h. The voltage was continuously increased within 10 seconds to the specified value and was then held constant during the required test. The water with a conductivity of 70 ± 10 mS/m was sprayed continuously at rate of 0.4 ± 0.1 l/(h*m³) into the test chamber.

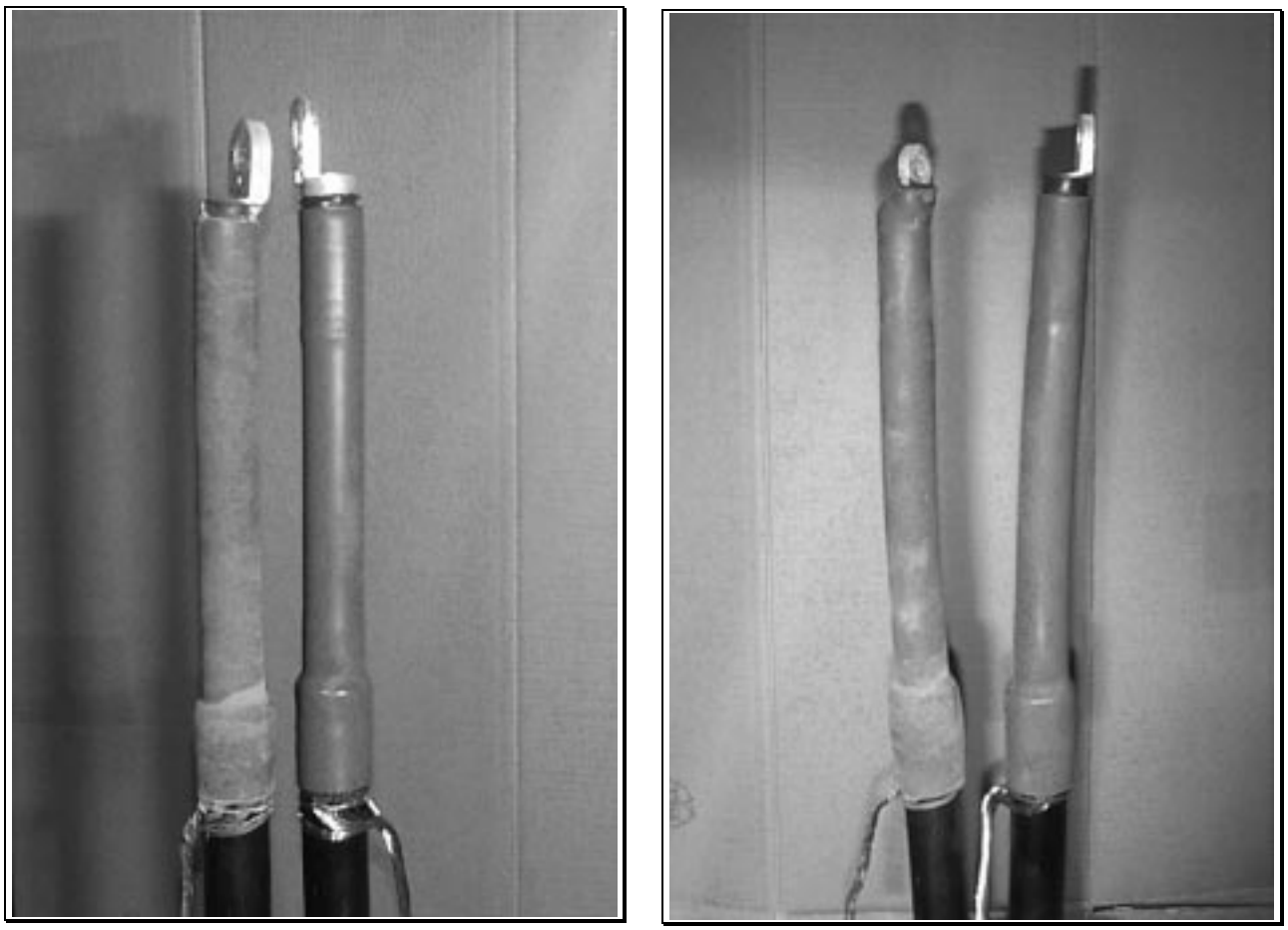

Fig 6: Photos show terminations after/before humity testing, left 240mm^2, right 95mm^2

Result: No fuse trip occurred during the test

1.6. Summary Test Results

The POLT-24D/1XI (IXSU-F5131) 24kV indoor termination was tested in accordance with the CENELEC HD 629.1 S1:1996. The tests were carried out on 24 kV XLPE cables with cross sections of 95 mm^2 and 240 mm^2. For all cross sections two loops were used.

All samples passed the test requirements in accordance with the CENELEC HD 629.1 S1: 1996 12,7/22 (24) kV specification.

2. Additional CENELEC Test for POLT-24E/1XI (IXSU-F5141) (185-400 mm2)

2.1. Test Programme

Additional tests for other cross sections of the POLT-24x/1XI (IXSU-F) Indoor Termination product familiy for 12.7/22 (24kV) was done in accordance with the test sequence in HD 629.1 S1:1996 table 10, page 20.

Table 2: Test sequence according to CENELEC

	Test	Test clause of HD 628	Test sequence	Test requirements
1	DC voltage dry withstand	5	X	15 min @ 6 U_0 = 76 kV
2	AC voltage dry withstand	4	X	5 min @ 4.5 U_0 = 57 kV
3	Partial discharge at ambient temperature	7	X	XLPE: max 10 pC @ 1.73U_0=22kV
4	Impulse voltage at ambient temperature	6	X	10 impulses of each polarity U=125kV 1.2/50µs
5	Electrical heat cycling in air	9	X	10 cycles 5/3h @ 32 kV conductor temperature 95-100°C
6	Partial discharge at ambient temperature at elevated temperature	7	 X X	 max. 10 pC @ 22 kV max. 10 pC @ 22 kV
7	AC voltage dry withstand	4	X	15 min @ 2.5 U_0 = 32 KV
8	Examination	-	X	For information only

2.2. Test samples

Cable:

Manufacturer:	Kabelmetal
Type:	NA2XS2Y 12/20 kV
Design:	XLPE, extruded screen
Conductor:	stranded Aluminium
Cross section conductor:	240 mm^2 and 300 mm^2
Shielding wires	Copper wires
Cross section shielding	25 mm^2
Voltage rating:	12/20 kV
Length of test loop:	approx. 2,50 m
Quantity of loops:	2 for 240 mm^2 2 for 300 mm^2

Product:

Kit description		POLT-24E/1XI (IXSU-F5141)
Insulating tubing:	3	HVOT-62/21-340/242 Batch EB10821
Screen cut filler:	3	S1189-1-150
Sealant:	3	S1085-3-200
Installation instruction:	1	EPP 0778 3/99

2.3. Test Sequence

2.3.1. D.C. Voltage Test according to Section 5 of HD 628

Requirement: D.C. Voltage Withstand 15 min @ 6 U_0 = 76 kV

Result: No breakdown occurred on the 4 test loops

relative humidity of air	*atmospheric pressure*	*temperature*
50 %	960 hPa	22° C

2.3.2. A.C. Voltage Test according to Section 4 HD 628

Requirement: A.C. voltage of U_{rms}= 57 kV, 50 Hz was applied between the conductor and the grounded screen for 5 minutes. The voltage was continuously increased within 10 seconds to the specified value and then held constant during the required test period.

Result: No breakdown occurred on the 4 test loops

2.3.3. Partial Discharge Test at Ambient Temp. acc. to Sec. 7 HD 628

Requirement: Maximum PD level @ 22kV ≤ 10 pC

The lugs were made corona free by using ring electrodes and an A.C test voltage of 1.25*U = 30 kV was applied for 1 min. Then the voltage was decreased to the A.C. test voltage of U_{PD} = 22 kV and within 1 minute the maximum value of the partial discharge magnitude was measured.

Result: Measured PD level is below the limit of 10 pC

	Loop 1 240 mm²	Loop 2 240 mm²	Loop 1 300 mm²	Loop 2 300 mm²
PD value [pC] @ 22kV	bnl	bnl	bnl	bnl

bnl....basic noise level $q_n \leq 1$pC

2.3.4. Impulse Voltage at Ambient Temperature

Requirement: An impulse voltage with rise time of approx. 1.2 µs and half-value decay time with approx. 50 µs was applied. The test loops were exposed to 10 impulses each of an impulse voltage of 125 kV of positive and negative polarity between the conductor and the grounded screen.

Result: No breakdown occurred on the 4 test loops. The impulse diagrams below show no discrepancies from the calibration oscillogram.

relative humidity of air	*atmospheric pressure*	*temperature*
50 %	960 hPa	22° C

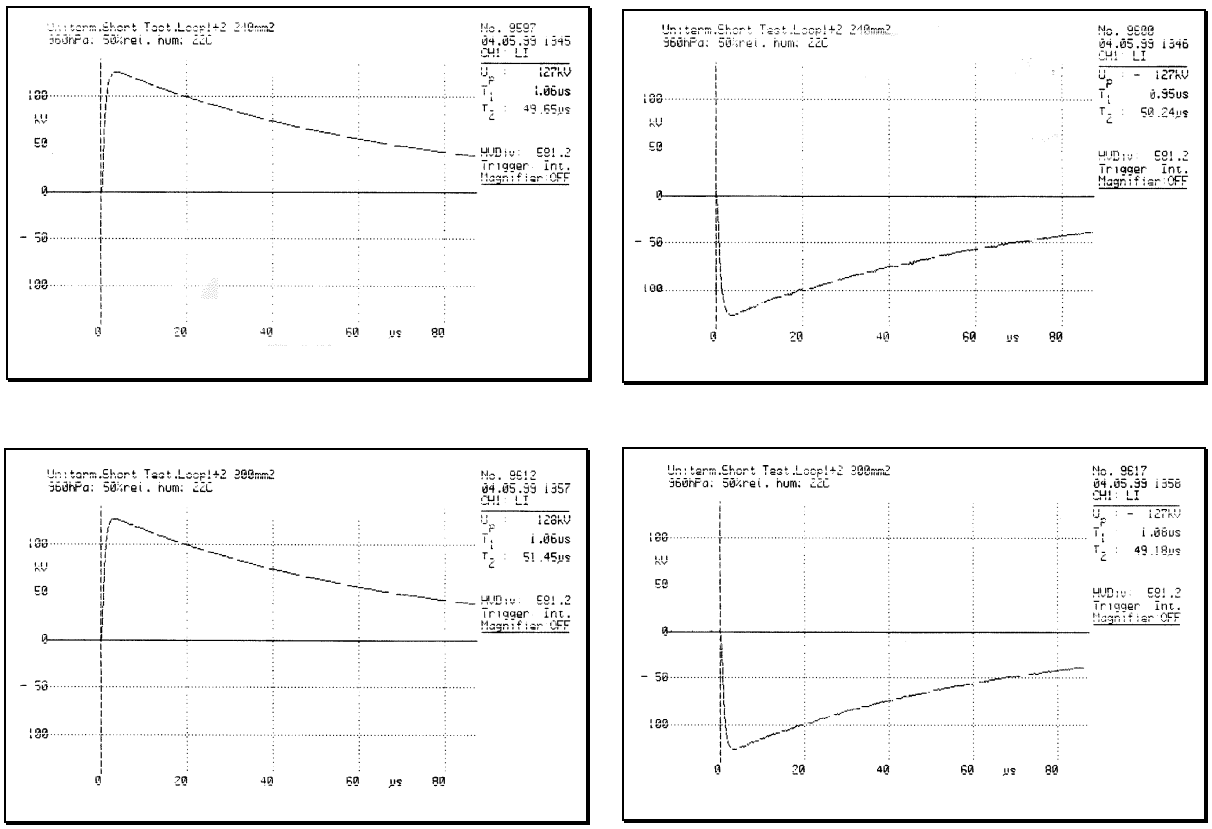

Fig. 7: Impulse oscillograms for 240mm^2 and 300mm^2 XLPE cables

2.3.5. Electrical Heat Cycling in Air acc. to Section 9 HD 628

Requirement: The test loops, suspended free in air, were subjected to 10 load cycles with a continuously applied AC test voltage of 32 kV. Each load cycle consists of a 5 hours heating period and a 3 hours cooling period. The test loops were heated up to a temperature of 95-100°C.

Result: No breakdown occurred on the 4 test loops.

*relative humidity of air**	*atmospheric pressure**	*temperature**
45 %	937 hPa	20° C

*) at begin of load cycling

2.3.6. PD at Elevated and Ambient Temperature acc. to Sec 7 of HD 628

a) Partial Discharge at Ambient Temperature after 10th Load Cycle

Requirement: Maximum PD level @ 22kV ≤ 10pC
Identical test acc. to 1.3.3

Result: Measured PD level was below the limit of 10 pC

	Loop 1 240 mm²	*Loop 2 240 mm²*	*Loop 1 300 mm²*	*Loop 2 300 mm²*
PD value [pC] @ 22kV	bnl	bnl	bnl	bnl

bnl...basic noise level $q_n \leq 1pC$

b) Partial Discharge at Elevated Temperature after 10th Load Cycle

Requirement: Maximum PD level @ 22kV ≤ 10pC

The conductors were heated up to a temperature of 95-100°C. Then identical test as in 1.3.3.

Result: Measured PD level was below the limit of 10 pC

	Loop 1 240 mm²	*Loop 2 240 mm²*	*Loop 1 300 mm²*	*Loop 2 300 mm²*
PD value [pC] @ 22kV	bnl	bnl	bnl	bnl

bnl....basic noise level $q_n \leq 1pC$

2.3.7. A.C. Voltage Dry Withstand

Requirement: A.C. voltage of U_{rms} = 32 kV, 50 Hz was applied between the conductor and the grounded screen for 15 minutes. The voltage was continuously increased within 10 seconds to the specified value and then held constant during the required test period.

Result: No breakdown occurred on the 4 test loops

2.3.8. Examination

All tested samples looked optically good. After cutting open no signs of destruction could be seen.

3. Additional CENELEC Test for POLT-24C/1XI (IXSU-F5121) (25-70 mm^2)

3.1. Test Programme

Additional tests for other cross sections of the POLT-24x/1XI (IXSU-F) Indoor Termination product familiy for 12.7/22 (24kV) were done in accordance with the test sequence in HD 629.1 S1:1996 table 10, page 20.

Table 3: Test sequence according to CENELEC

	Test	Test clause of HD 628	Test sequence	Test requirements
1	DC voltage dry withstand	5	X	15 min @ 6 U_0 = 76 kV
2	AC voltage dry withstand	4	X	5 min @ 4.5 U_0 = 57 kV
3	Partial discharge at ambient temperature	7	X	XLPE: max 10 pC @ 1.73U_0=22kV
4	Impulse voltage at elevated temperature	6	X	10 impulses of each polarity U=125kV 1.2/50µs
5	Electrical heat cycling in air	9	X	10 cycles 5/3h @ 32 kV conductor temperature 95-100°C
6	Partial discharge at ambient temperature at elevated temperature	7	 X X	 max. 10 pC @ 22 kV max. 10 pC @ 22 kV
7	AC voltage dry withstand	4	X	15 min @ 2.5 U_0 = 32 KV
8	Examination	-	X	For information only

3.2. Test samples

Cable:

Manufacturer:	Kabelmetal
Type:	NA2XS2Y 50 mm^2 // N2XSY 35mm^2
Design:	XLPE, extruded screen
Conductor:	stranded Aluminium respectively Copper
Cross section conductor:	50 mm^2 and 35 mm^2
Shielding wires	Copper wires
Cross section shielding	16 mm^2
Voltage rating:	12/20 kV
Length of test loop:	approx. 2,50 m
Quantity of loops:	2 for 35 mm^2 2 for 50 mm^2

Product:

Kit description		POLT-24C/1XI (IXSU-F5121)
Insulating tubing:	3	HVOT-38/12-340/242 Batch EB10831
Screen cut filler:	3	S1189-1-100
Sealant:	3	S1085-3-150
Installation instruction:	1	EPP 0778 3/99

3.3. Test Sequence

3.3.1. D.C. Voltage Test according to Section 5 of HD 628

Requirement: D.C. Voltage Withstand 15 min @ 6 U_0 = 76 kV

Result: No breakdown occurred on the 4 test loops

relative humidity of air	*atmospheric pressure*	*temperature*
53 %	958 hPa	28° C

3.3.2. A.C. Voltage Test according to Section 4 HD 628

Requirement: A.C. voltage of U_{rms}= 57 kV, 50 Hz was applied between the conductor and the grounded screen for 5 minutes. The voltage was continuously increased within 10 seconds to the specified value and then held constant during the required test period.

Result: No breakdown occurred on the 4 test loops

3.3.3. Partial Discharge Test at Ambient Temp. acc. to Sec. 7 HD 628

Requirement: Maximum PD level @ 22kV ≤ 10 pC

The lugs were made corona free by using ring electrodes and an A.C test voltage of 1.25*U = 30 kV was applied for 1 min. Then the voltage was decreased to the A.C. test voltage of U_{PD} = 22 kV and within 1 minute the maximum value of the partial discharge magnitude was measured.

Result: Measured PD level is below the limit of 10 pC

	Loop 1 35 mm²	Loop 2 35 mm²	Loop 1 50 mm²	Loop 2 50 mm²
PD value [pC] @ 22kV	bnl	bnl	bnl	bnl

bnl....basic noise level $q_n \leq 1$pC

3.3.4. Impulse Voltage at Elevated Temperature

Requirement: An impulse voltage with rise time of approx. 1.2 µs and half-value decay time with approx. 50 µs was applied. The test loops were exposed to 10 impulses each of an impulse voltage of 125 kV of positive and negative polarity between the conductor and the grounded screen. The test loops were heated up to a temperature of 95-100°C.

Result: No breakdown occurred on the 4 test loops. The impulse diagrams below show no discrepancies from the calibration oscillogram.

relative humidity of air	atmospheric pressure	temperature
53 %	958 hPa	28° C

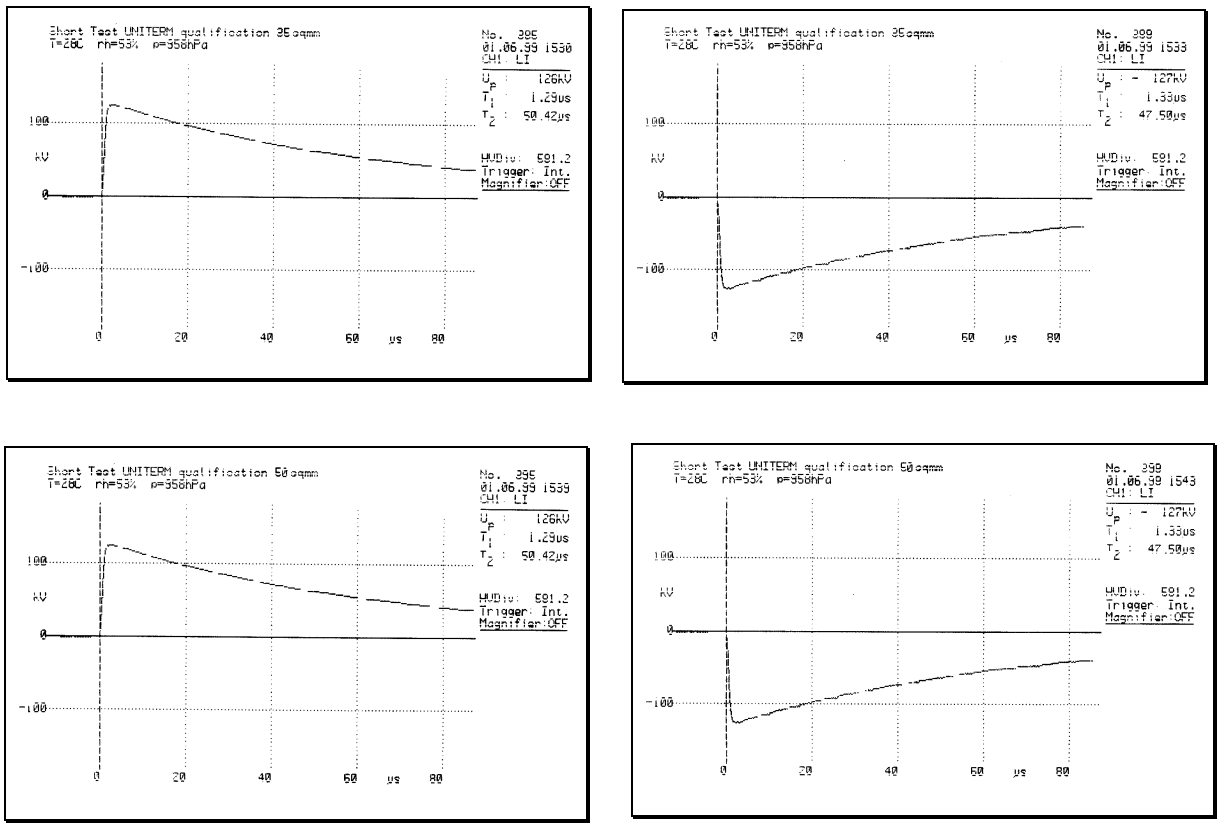

Fig. 8: Impulse oscillograms for 35mm^2 and 50 mm^2 XLPE cables

3.3.5. Electrical Heat Cycling in Air acc. to Section 9 HD 628

Requirement: The test loops, suspended free in air, were subjected to 10 load cycles with a continuously applied AC test voltage of 32 kV. Each load cycle consists of a 5 hours heating period and a 3 hours cooling period. The test loops were heated up to a temperature of 95-100°C.

Result: No breakdown occurred on the 4 test loops.

*Relative humidity of air**	*atmospheric pressure**	*temperature**
45 %	937 hPa	20° C

*) at begin of load cycling

3.3.6. PD at Elevated and Ambient Temperature acc. to Sec 7 of HD 628

a) Partial Discharge at Ambient Temperature after 10th Load Cycle

Requirement: Maximum PD level @ 22kV ≤ 10pC
Identical test acc. to 1.3.3

Result: Measured PD level was below the limit of 10 pC

relative humidity of air	*atmospheric pressure*	*temperature*
35 %	948 hPa	24° C

	Loop 1 35 mm²	*Loop 2 35 mm²*	*Loop 1 50 mm²*	*Loop 2 50 mm²*
PD value [pC] @ 22kV	bnl	bnl	bnl	bnl

bnl...basic noise level $q_n \leq 1pC$

b) Partial Discharge at Elevated Temperature after 10th Load Cycle

Requirement: Maximum PD level @ 22kV ≤ 10pC

The conductors were heated up to a temperature of 95-100°C. Then identical test as in 1.3.3.

Result: Measured PD level was below the limit of 10 pC

	Loop 1 35 mm²	*Loop 2 35 mm²*	*Loop 1 50 mm²*	*Loop 2 50 mm²*
PD value [pC] @ 22kV	bnl	bnl	bnl	bnl

bnl...basic noise level $q_n \leq 1pC$

3.3.7. A.C. Voltage Dry Withstand

Requirement: A.C. voltage of U_{rms} = 32 kV, 50 Hz was applied between the conductor and the grounded screen for 15 minutes. The voltage was continuously increased within 10 seconds to the specified value and then held constant during the required test period.

Result: No breakdown occurred on the 4 test loops

3.3.8. Examination

All tested samples looked optically good. After cutting open no signs of destruction could be seen.

4. Additional CENELEC Test for POLT-24F/1XI (IXSU-F5151) (400-800 mm^2)

4.1. Test Programme

Additional tests for other cross sections of the POLT-24x/1XI (IXSU-F) Indoor Termination product familiy for 12.7/22 (24kV) were done in accordance with the test sequence in HD 629.1 S1:1996 table 10, page 20.

Table 4: Test sequence according to CENELEC

	Test	Test clause of HD 628	Test sequence	Test requirements
1	DC voltage dry withstand	5	X	15 min @ 6 U_0 = 76 kV
2	AC voltage dry withstand	4	X	5 min @ 4.5 U_0 = 57 kV
3	Partial discharge at ambient temperature	7	X	XLPE: max 10 pC @ 1.73U_0=22kV
4	Impulse voltage at elevated temperature	6	X	10 impulses of each polarity U=125kV 1.2/50µs
5	Electrical heat cycling in air	9	X	10 cycles 5/3h @ 32 kV conductor temperature 95-100°C
6	Partial discharge at ambient temperature at elevated temperature	7	 X X	 max. 10 pC @ 22 kV max. 10 pC @ 22 kV
7	AC voltage dry withstand	4	X	15 min @ 2.5 U_0 = 32 KV
8	Examination	-	X	For information only

4.2. Test samples

Cable:

Manufacturer:	Kabelmetal
Type:	NA2XS2Y 12/20 kV
Design:	XLPE, extruded screen
Conductor:	stranded Aluminium
Cross section conductor:	400 mm^2
Shielding wires	Copper wires
Cross section shielding	35 mm^2
Voltage rating:	12/20 kV
Length of test loop:	approx. 2,50 m
Quantity of loops:	2 for 400 mm^2

Product:

Kit description		POLT-24F/1XI (IXSU-F5151)
Insulating tubing:	3	HVOT-82/29-340/242 Batch EA12212
Screen cut filler:	3	S1189-1-200
Sealant:	3	S1085-3-300
Installation instruction:	1	EPP 0778 3/99

4.3. Test Sequence

4.3.1. D.C. Voltage Test according to Section 5 of HD 628

Requirement: D.C. Voltage Withstand 15 min @ 6 U_0 = 76 kV

Result: No breakdown occurred on the 2 test loops

relative humidity of air	*atmospheric pressure*	*temperature*
52 %	956 hPa	26° C

4.3.2. A.C. Voltage Test according to Section 4 HD 628

Requirement: A.C. voltage of U_{rms}= 57 kV, 50 Hz was applied between the conductor and the grounded screen for 5 minutes. The voltage was continuously increased within 10 seconds to the specified value and then held constant during the required test period.

Result: No breakdown occurred on the 2 test loops

4.3.3. Partial Discharge Test at Ambient Temp. acc. to Sec. 7 HD 628

Requirement: Maximum PD level @ 22kV $\leq$ 10 pC

The lugs were made corona free by using ring electrodes and an A.C test voltage of 1.25*U = 30 kV was applied for 1 min. Then the voltage was decreased to the A.C. test voltage of U_{PD} = 22 kV and within 1 minute the maximum value of the partial discharge magnitude was measured.

Result: Measured PD level is below the limit of 10 pC

	Loop 1 400 mm²	*Loop 2 400 mm²*
PD value [pC] @ 22kV	bnl	bnl

bnl...basic noise level $q_n \leq 1$pC

4.3.4. Impulse Voltage at Elevated Temperature

Requirement: An impulse voltage with rise time of approx. 1.2 µs and half-value decay time with approx. 50 µs was applied. The test loops were exposed to 10 impulses each of an impulse voltage of 125 kV of positive and negative polarity between the conductor and the grounded screen. The test loops were heated up to a temperature of 95-100°C.

Result: No breakdown occurred on the 2 test loops. The impulse diagrams below show no discrepancies from the calibration oscillogram.

relative humidity of air	*atmospheric pressure*	*temperature*
52 %	956 hPa	26° C

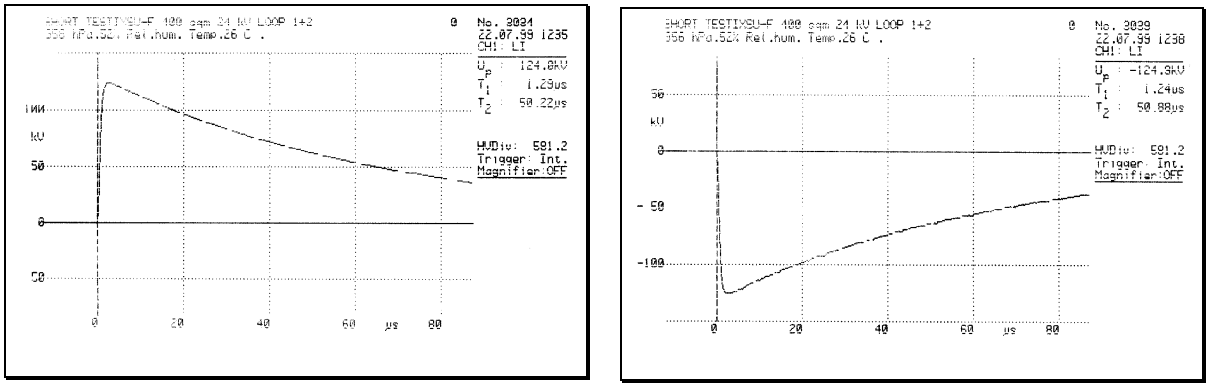

Fig. 9: Impulse oscillograms for 400 mm^2 XLPE cables

4.3.5. Electrical Heat Cycling in Air acc. to Section 9 HD 628

Requirement: The test loops, suspen ded free in air, were subjected to 10 load cycles with a continuously applied AC test voltage of 32 kV. Each load cycle consists of a 5 hours heating period and a 3 hours cooling period. The test loops were heated up to a temperature of 95-100°C.

Result: No breakdown occurred on the 2 test loops.

*Relative humidity of air**	*atmospheric pressure**	*temperature**
50 %	947 hPa	25° C

*) at begin of load cycling

4.3.6. PD at Elevated and Ambient Temperature acc. to Sec 7 of HD 628

a) Partial Discharge at Ambient Temperature after 10th Load Cycle

Requirement: Maximum PD level @ 22kV ≤ 10pC
Identical test acc. to 1.3.3

Result: Measured PD level was below the limit of 10 pC

	Loop 1 400 mm²	*Loop 2 400 mm²*
PD value [pC] @ 22kV	bnl	bnl

bnl....basic noise level $q_n \leq 1pC$

b) Partial Discharge at Elevated Temperature after 10th Load Cycle

Requirement: Maximum PD level @ 22kV ≤ 10pC

The conductors were heated up to a temperature of 95-100°C. Then identical test as in 1.3.3.

Result: Measured PD level was below the limit of 10 pC

	Loop 1 400 mm²	*Loop 2 400 mm²*
PD value [pC] @ 22kV	bnl	bnl

bnl....basic noise level $q_n \leq 1pC$

4.3.7. A.C. Voltage Dry Withstand

Requirement: A.C. voltage of U_{rms} = 32 kV, 50 Hz was applied between the conductor and the grounded screen for 15 minutes. The voltage was continuously increased within 10 seconds to the specified value and then held constant during the required test period.

Result: No breakdown occurred on the test loops

4.3.8. Examination

The tested sample looks optically good. After cutting open no signs of destruction could be seen.