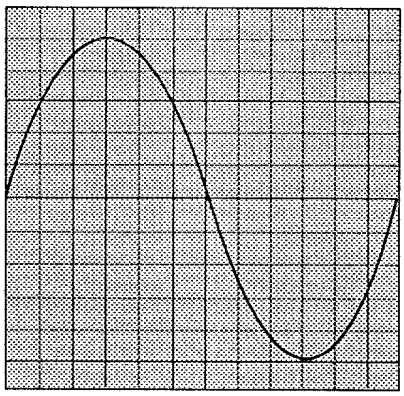

PPR 1085

Extended design tests to IEEE 48 - 1990 on 52 kV indoor and outdoor terminations for single core cable with extruded dielectric.

Pages:	6
Appendices:	5
Date:	March 1994

Tested by: M. Spiss	Signature:	Date: 11. 3. 1994
Prepared by: M. Wilck	Signature:	Date: 11. 3. 1994
Released by: J. Reed	Signature:	Date: 11. 3. 1994

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I. OBJECTIVE

The objective of this test was to evaluate the performance of heat shrinkable terminations IHVT / OHVT 5200 series, by testing to the applicable requirements of IEEE-48-1990.

II. SUMMARY

Two indoor terminations type IHVT 5211 and two outdoor terminations type OHVT 5211 were assembled on cables of 5 m length.

The two loops were tested to the applicable requirements of IEEE-48-1990. Section 7.4 "Design Tests".

The Cyclic Aging Test was extended to a total number of 120 cycles.

III. CONCLUSION

The indoor terminations IHVT 5211 and the outdoor terminations OHVT 5211 exceed the requirements of IEEE-48-1990 as outlined in this report.

IV. TEST SPECIMEN

Cable Data:

Manufacturer	:	NKF
Class	:	52 kV
Conductor	:	400 mm² Al solid round
Insulation	:	XLPE 12 mm
Insulation screen	:	extruded (bonded)
Ground shield	:	Cu-wires x-section ~ 95 mm²
Jacket	:	PE (overall diameter ~ 62 mm)

Termination Kit Data:

A. Indoor

Type	:	IHVT 5211
Total length (lug/support clamp)	:	~ 800 mm
Shed diameter	:	~ 175 mm
No. of sheds	:	2
Creepage length	:	> 980 mm
Basic construction	:	see Appendix 2 (ESD 1357 8/93)

B. Outdoor

Type	:	OHVT 5211
Total length (lug/support clamp)	:	~ 950 mm
Shed diameter	:	~ 205 mm
No. of sheds	:	4
Creepage length	:	> 1380 mm
Basic construction	:	see Appendix 2 (ESD 1357 8/93)

V. INSTALLATION

The terminations were installed in accordance with instruction ESD 1357, 8/93 "Terminations for Polymeric insulated cables 52 kV".
Each loop had at least three meters of cable between the termination.

VI. Testing

The terminations were tested to IEEE Std 48-1990 and the results are summarized below. The terminations were tested to the 46 kV voltage levels specified per Table 2 of IEEE Std 48-1990. All voltages were applied to the cable's conductor with the shield grounded.

1. Section 7.4.1.5,
"Partial Discharge (Corona) Extinction Voltage Test".

   Requirement - Each loop's discharge should be 3 pC or less when energized to 52 kV or, if the partial discharge level exceeds 3 pC at this level, the voltage may be reduced to
   40 kV. No discharges greater than 3 pC should be noted during a time interval of 3 seconds to 60 seconds.

   Results - Both loops were tested for discharge inception voltage (DIV) and discharge extinction voltage (DEV). All samples passed, the partial discharge was < 3 pC at 52 kV.

2. Section 7.4.1.1,
"Power Frequency Voltage 1 min Dry Withstand Test".

   Requirement - Each termination should withstand 120 kV for 1 minute with no dielectric breakdown or flashovers. If a flashover occurs the test is repeated. The sample fails if a second flashover or dielectric breakdown occurs.

   Results - All terminations passed.

3. Section 7.4.1.2,
"Power Frequency Voltage 10 sec Wet Withstand Test".

Requirement - To be tested in accordance with IEEE std 4-1978. Same pass/fail criteria as 7.4.1.1 except the voltage level to be100 kV.

Results - All indoor and outdoor terminations passed.

4. Section 7.4.1.3,
"Power Frequency Voltage 6 h Dry Withstand Test".

Requirement - Each termination should withstand 100 kV for 6 hours with no dielectric breakdown or flashovers. The total test duration is increased by twice the duration of any voltage interruption.

Results - All terminations passed.

5. Section 7.4.1.4,
"RIV (Radio Influence Voltage) Test".

Requirement - The radio influence voltage should not exceed 300 µV measured at 1 MHZ when maximum design line to ground voltage (29.5 kV) is applied.

Results - The RIV requirements were verified by the partial discharge testing performed. The partial discharge test is more sensitive than the RIV test allowing the conclusion that the RIV requirements are met by this design.

6. Section 7.4.1.6,
"Lightning Impulse Voltage Withstand".

Requirement - Each indoor and outdoor termination should withstand 10 positive and 10 negative consecutive impulses of 250 kV. The wave should be 1.2 x 50 µs and conform to the requirements in IEEE Std 4-1978. The virtual front time should not exceed 5 µs in cases where test piece capacitance prevents attainment of the requirement. Conditioning impulses may be used as outlined in IEEE Std 4-1978 and IEEE Std 82. If one flashover occurs, 10 additional impulses shall be applied. The samples are considered to fail if two impulses cause flashover.

Results - All terminations passed 250 kV.
Wave form see Appendix 4.1 and 4.2 and photo Appendix 5.

7. Section 7.4.1.7,
"Switching Impulse Voltage Wet Withstand Test."

Applicable to 345 kV and above (Terminations only)

Requirement - Each termination should withstand 10 positive and 10 negative consecutive impulses of the specified voltage magnitude. The wave should be 250 x 2500 µs and conform to the requirements in IEEE Std 4-1978. The wet test conditions shall conform to IEEE Std 4-1978. Conditioning impulse may be used as outlined in IEEE Std 4-1978 and IEEE Std 82.

Not applicable for 52 kV terminations.

8. Section 7.4.1.8,
"Direct Voltage 15 min Dry Withstand Test".

Requirement - Each termination shall be tested using negative direct voltage of 170 kV. Ripple should be less than 3 % at the specified level. The specified level of direct voltage must be applied at least 15 min. If a flashover occurs the test is repeated. The sample fails if a second flashover or dielectric breakdown occurs.

Results - All terminations passed.

9. Section 7.4.2.2,
Cyclic Aging Test."

A. Current Cycling with applied voltage

Requirement - Two terminations of each type must pass 30 days of current cycling at the cables emergency rating temperature. 53 kV shall be applied continuously to the samples for the entire 30 days. Each cycle is 24 hours long.
A 12 hours on / 12 hours off cycle should be used. The conductor temperature of 130°C ± 5 °C should be maintained for a minimum of 6 hours. The ground shield should be grounded on one side only during current cycling.

Results - All samples passed.
The cycling current of 1065 A was determined by monitoring the conductor and jacket temperature on an 1.5 m long cable sample. See Appendix 3 „Temperature Profile".

B. Post Current Cycling Electrical Testing

Requirement - "Partial Discharge (Corona) Extinction Voltage Test" per part 1 above and Lightning Impulse Voltage per part 6 above.

Results - All terminations passed.
Wave form see Appendix 4.3 and 4.4.

10. Section 7.4.3,
"Pressure Leak Tests".

Not applicable for „dry type" terminations.

11. Current cycling as per 9., 120 cycles.

Results - All samples passed post current cycling testing:
Partial discharge < 3 pC at 52 kV.

APPENDIX 1

SUMMARY OF TEST RESULTS

ON INDOOR AND OUTDOOR TERMINATIONS

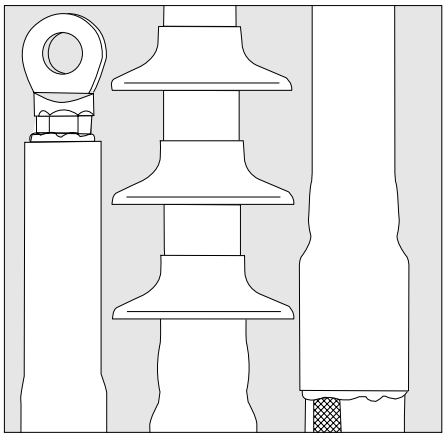
Test	Requirement	Results
Partial Discharge Test	< 3pC @ 46 kV (52 kV)	All samples passed
1 min AC withstand	1 min @ 120 kV	All samples passed
10 s Wet Withstand *	10 s @ 100 kV	All samples passed
6 h AC Withstand	6 h @ 100 kV	All samples passed
Radio Influence Test	< 300 µV @ 44 kV	Not applicable
Partial Discharge Test	< 3pC @ 46 kV (52 kv)	All samples passed
Impulse (BIL) Test	10 -ve/+ve, 250 kV 1.2 x 50 µs impulse	All samples passed
15 Minute DC Test	15 min @ -170 kV DC	All samples passed
Cyclic Aging Test - Initial DEV Test	< 3 pC @ 46 kV (52 kV)	All samples passed
- Load Cycles	30 cycles >6 h heating to 130°C cond temp each 24 h 53 kV AC	All samples passed
- DEV after 30 Cycles	< 3 pC @ 46 kV (52 kV)	All samples passed
- Impulse (BIL) Test	10 -ve/+ve, 250 kV 1.2 x 50 µs impulse	All samples passed
Pressure Leak Test		not applicable

Load Cycling DEV	90 cycles < 3 pC at 52 kV	All samples passed

* Indoor terminations type IHVT 5211 are not subjected to the wet test.

APPENDIX 2

E L E C T R I C A L
P R O D U C T S · D I V I S I O N



Installation Instruction ESD 1357 8/93

Terminations for Polymeric Insulated Cables 52 kV

Raychem

Before Starting

Check to ensure that the kit you are going to use fits the cable.

Refer to the kit label and the title of the installation instruction.

Components or work steps may have been improved since you last installed this product.

Carefully read and follow the steps in the installation instruction.

General Instructions

Use a propane (preferred) or butane gas torch.

Adjust the torch to obtain a soft blue flame with a yellow tip.

Pencil-like blue flames should be avoided.

Keep the torch aimed in the shrink direction to preheat the material.

Keep the flame moving continuously to avoid scorching the material.

Clean and degrease all parts that will come into contact with adhesive.

If a solvent is used follow the manufacturer's handling instructions.

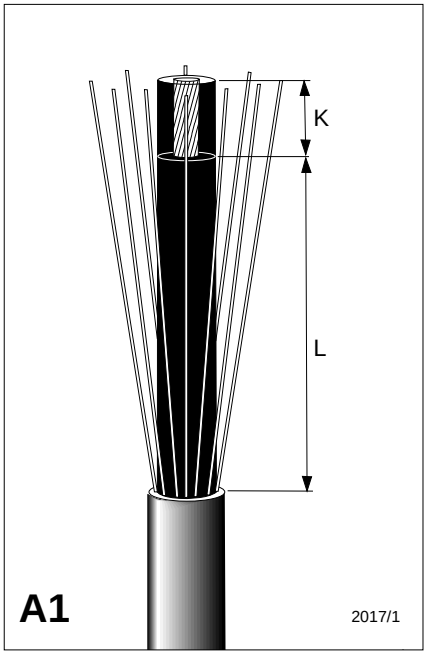
Tubing should be cut smoothly with a sharp knife leaving no jagged edges.

Start shrinking the tubing at the position recommended in the instruction.

Ensure that the tubing is shrunk smoothly all round before continuing along the cable.

Tubing should be smooth and wrinkle free with inner components clearly defined.

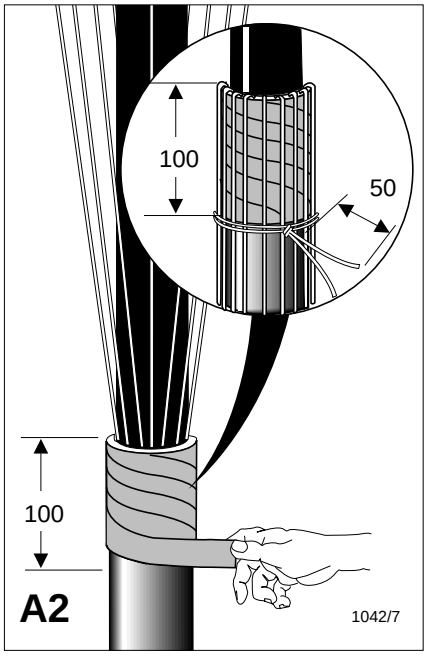
Cable Preparation



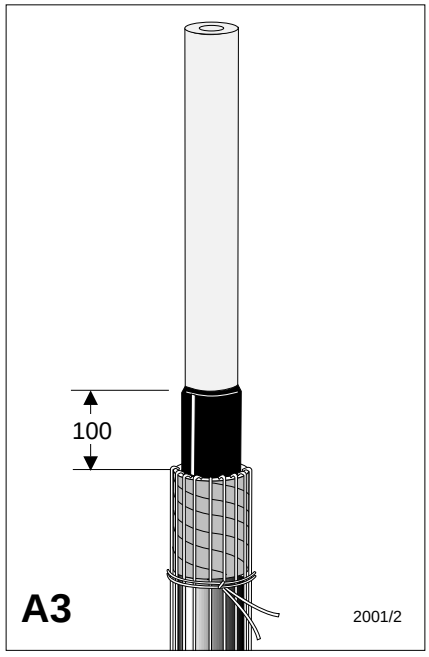
A. Cable with wire shield
Remove the oversheath to dimension L + K given in table 1.
Clean the end of the oversheath for up to 200 mm.

Table 1

L Indoor mm	L Outdoor mm	K
600	750	according to cable lug barrel hole + 5 mm



Apply sealant tape (red) with slight tension over 100 mm of the oversheath.
Bend back the shield wires. Tie the wires with a wire binder to the oversheath just below the sealant tape.
Leave wire ends 50 mm long.

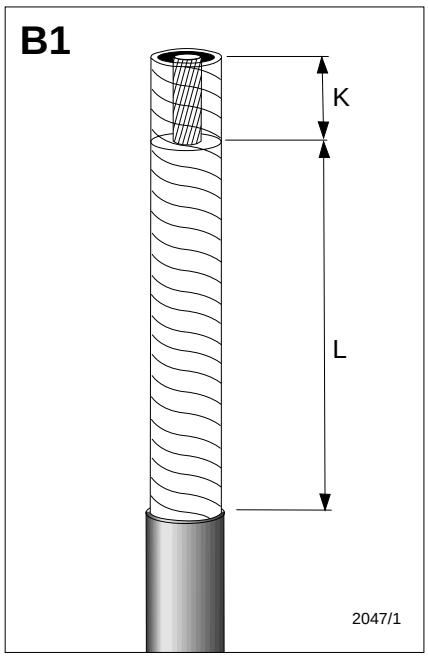


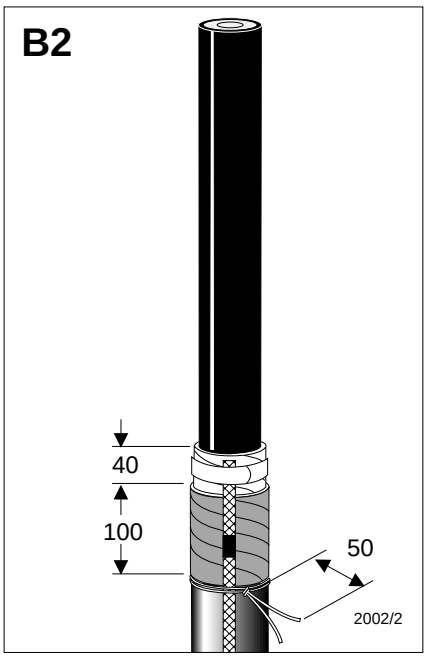
Thoroughly remove the core screen to within 100 mm of the oversheath cut.
The surface of the insulation should be free from all traces of conductive material. Chamfer the core screen.
Smooth out any irregularities.
Note: Do not nick the insulation.
Protect the mastic tape below from contamination.

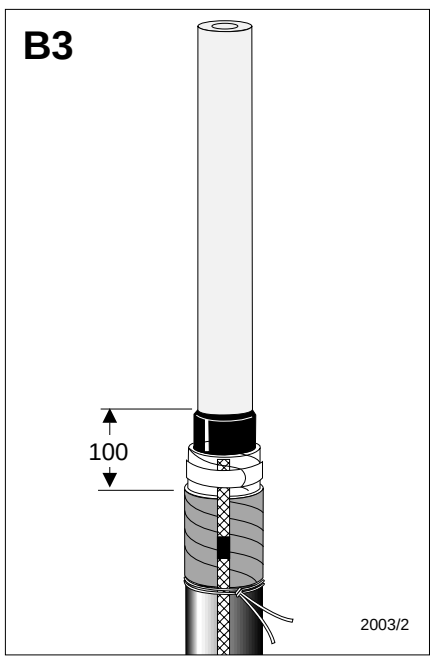
B. Cable with tape shield
Remove the oversheath to dimension L + K given in table 1.
Clean the end of the oversheath for up to 200 mm.

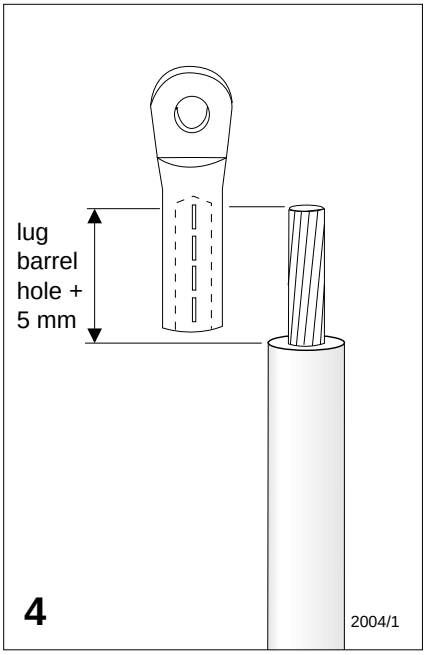
Remove the tape shield to within 40 mm of the oversheath cut. Apply red tape with slight tension over 100 mm of the oversheath.
Fix the earth lead to the tape shield with the roll spring (or any other equivalent method).
Fix the earth lead to the oversheath with a wire binder.Leave wire ends 50 mm long.

Thoroughly remove the core screen to within 100 mm of the oversheath cut.
The surface of the insulation should be free from all traces of conductive material.
Smooth out any irregularities.
Note: Do not nick the insulation.
Protect the mastic tape below from contamination.

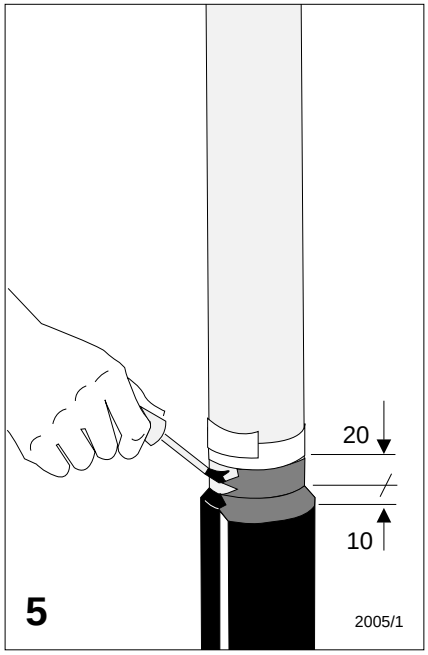




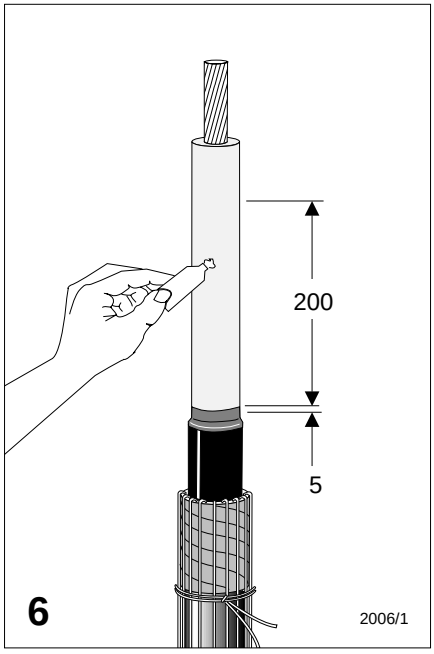




Cut back the insulation according to cable lug barrel hole + 5 mm.



Apply a PVC tape (adhesive side up) on the core insulation to leave a distance of approx. 20 mm (0.8") between the tape and core screen. Shake the bottle of conductive paint throughly. Apply the conductive paint onto the 20 mm screen for approximately 10 mm. When dry remove the PVC tape.

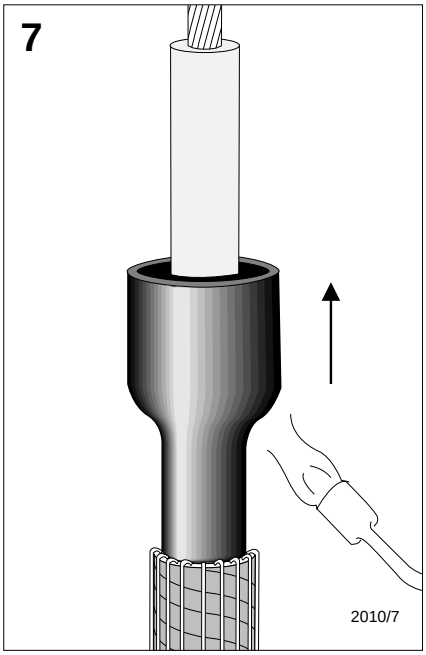


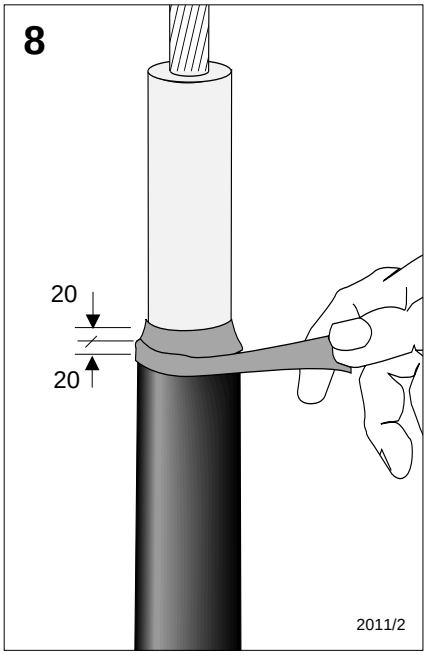
Apply a thin film of silicone grease. Cover 5 mm of the conductive paint and 200 mm of the insulation.

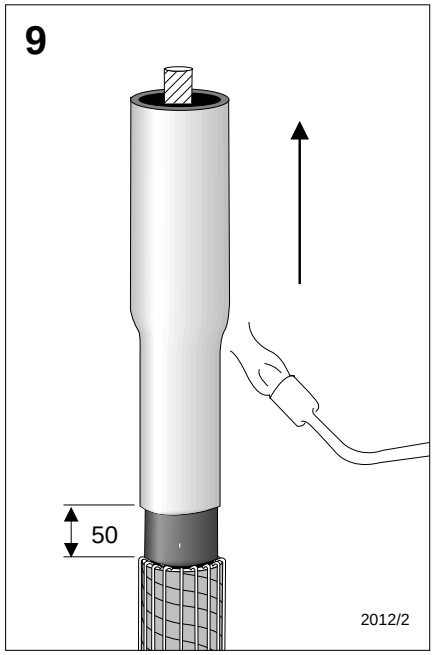
Place the long stress control tubing (black) over the core against the oversheath cut. Shrink down starting at the bottom and working upwards.

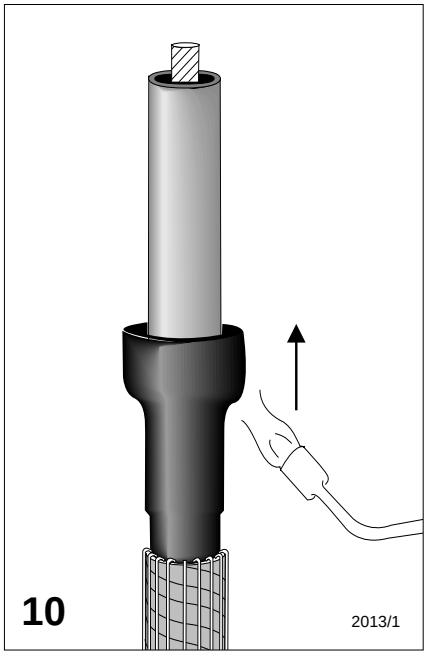
Apply red mastic using only slight tension and a small overlap. Cover 20 mm of the stress control tubing and 20 mm of the insulation.

Place the short tubing (red) over the core 50 mm above the oversheath cut. Shrink down starting at the bottom and working upwards.

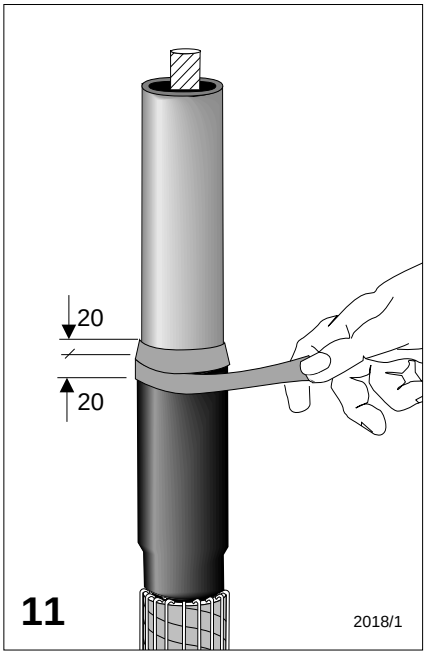




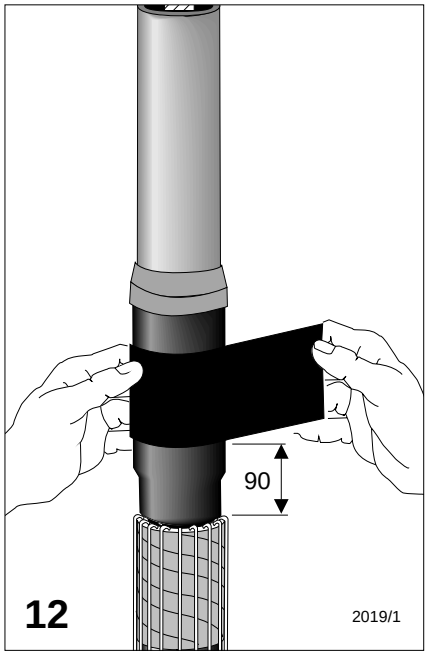




Place the short stress control tubing over the core against the oversheath cut. Shrink down starting at the bottom and working upwards.



Apply red mastic using only slight tension and a small overlap.
Cover 20 mm of the stress control tubing and 20 mm of the red tubing.

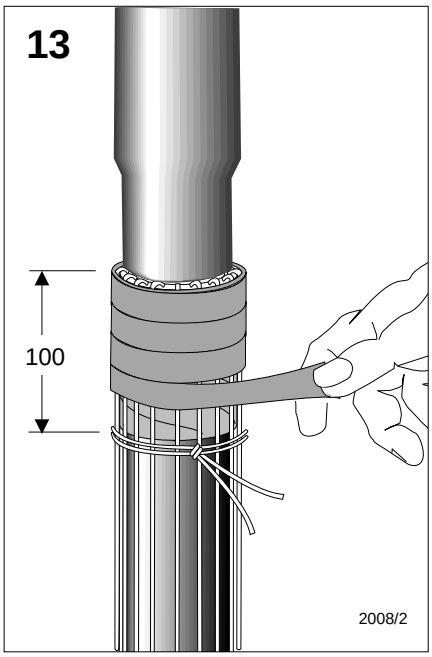


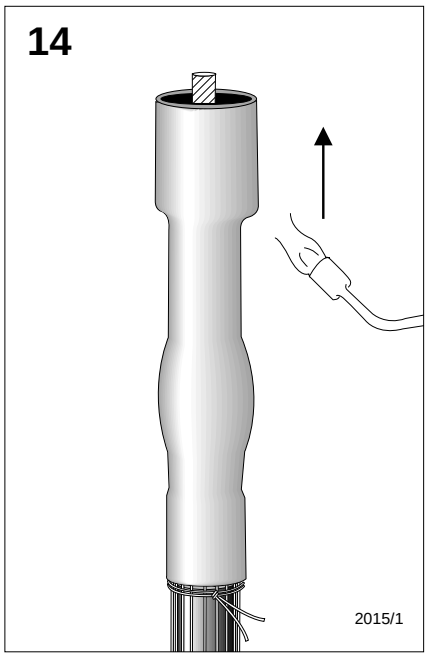
Wrap two layers of insulating profile over the stress control tubing starting 90 mm above the oversheath cut.

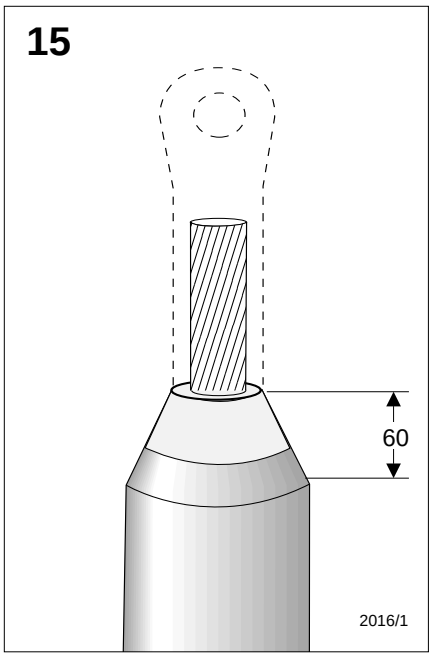
Wrap a layer of red mastic using only slight tension over the earth lead or shield wires.
Cover 100 mm of the oversheath end.

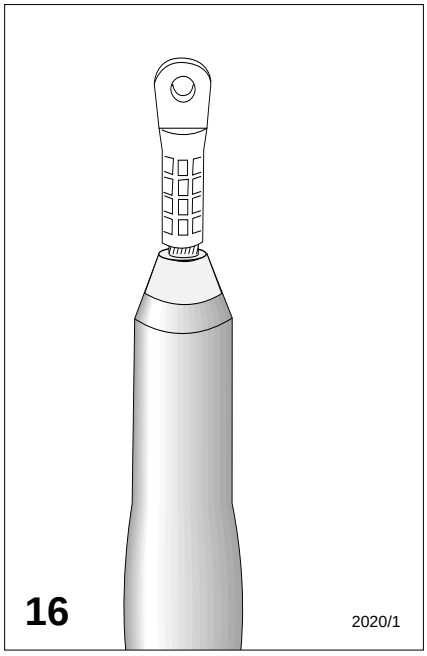
Place the long red tubing over the cable, completely covering the mastic. Shrink down starting at the bottom and working upwards.

Cut back the tubing to the insulation. Chamfer the insulation to the diameter of the cable lug to achieve a smooth transition.

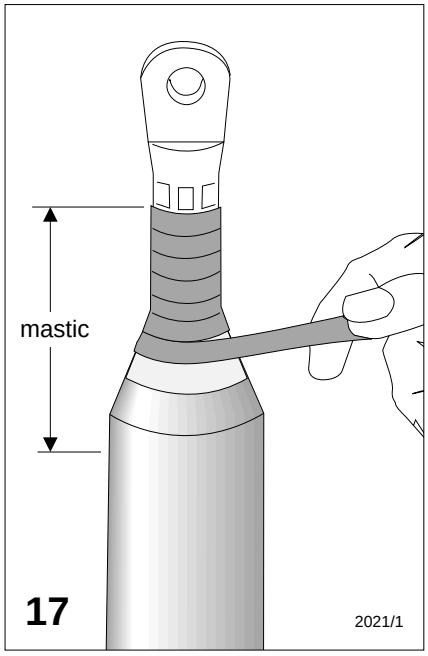




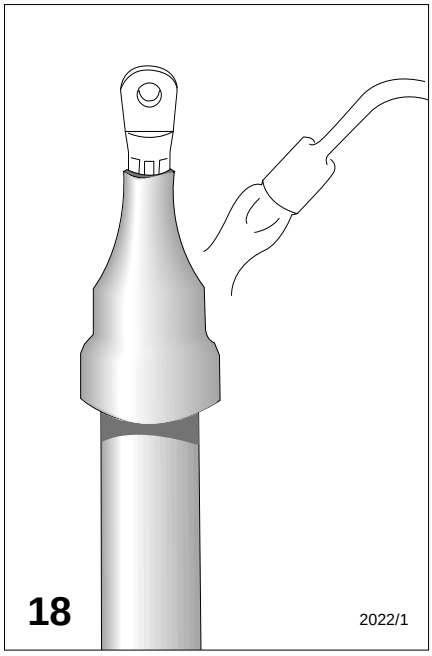




Install, clean and degrease the cable lug.



Wrap red mastic with slight tension around the insulation and connector. Fill up any gaps between insulation and cable lug.

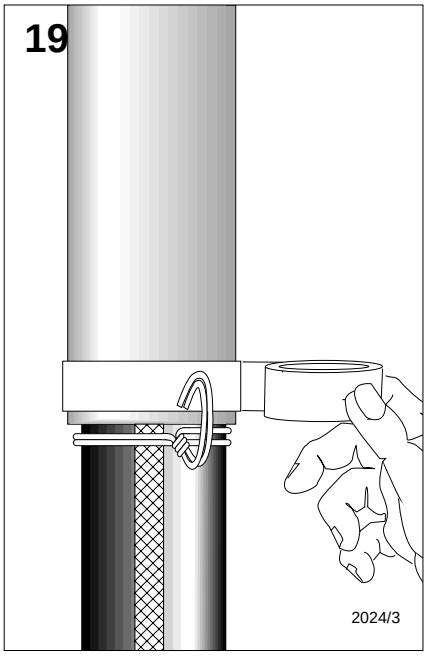


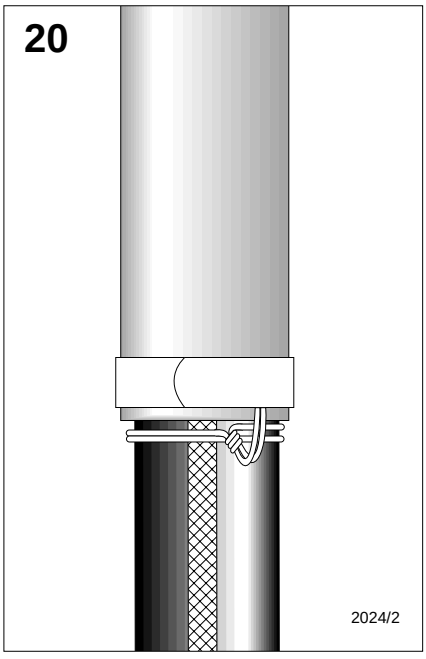
Position the sealing boot so that it covers the core and connector equally and shrink it into place, starting at the top.

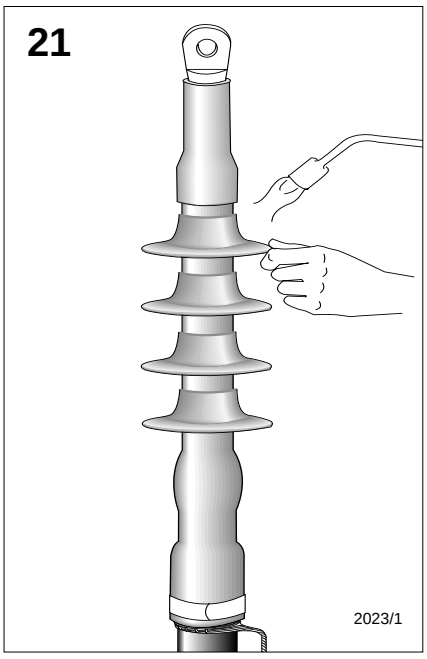
Wrap the roll spring twice over the tubing (red).
Position two ends of the wire binder onto the roll spring. Wire ends should not overlap the roll spring

Fold the wires back and wrap the rest of the roll spring over the wire binder. Tighten the roll spring with a twisting action.

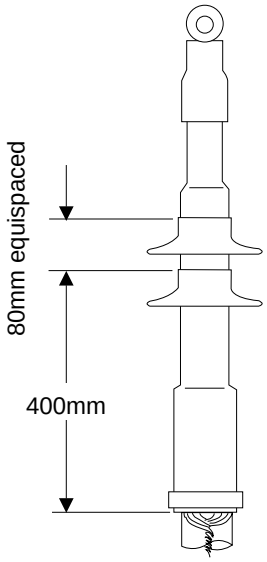
Shrink the skirts into place according to dimension in following drawing.





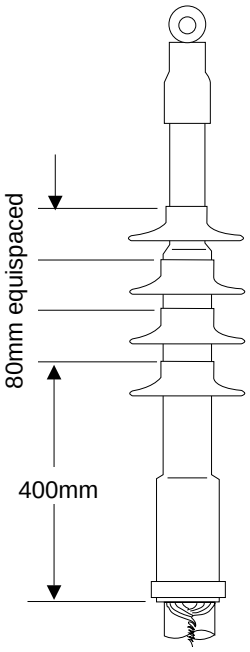


indoor



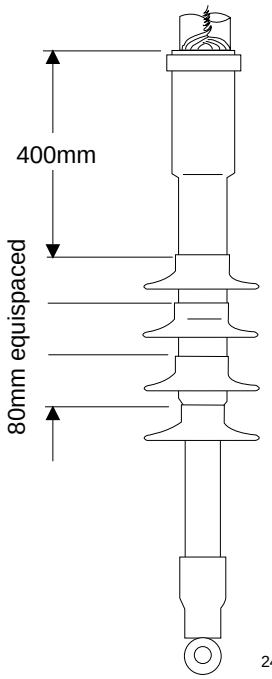
2470/11

outdoor

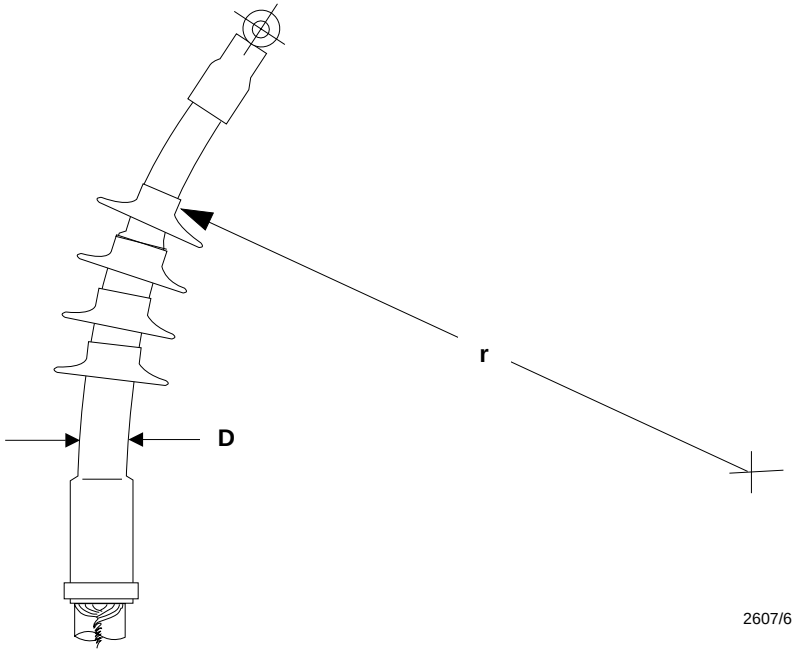


2470/13

reversed installation

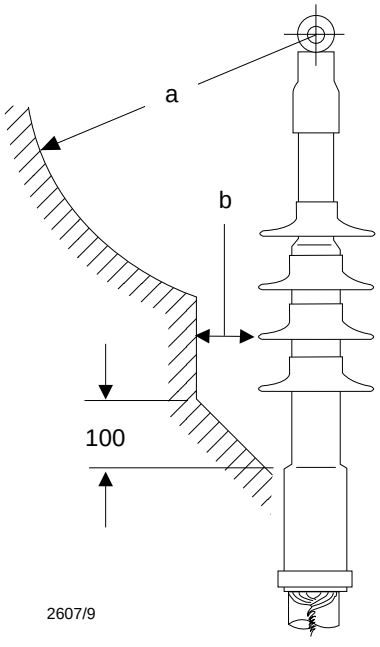


2470/12



2607/6

Min. clearance



2607/9

Max. system voltage (kV)	52
a air clearance	as for local specifications
b ph/ground (mm)	100
r min. bending radius 10 x **D**	before bending heat cable up to 70°C

Please dispose of all waste according to environmental regulations.

At Raychem we are committed to continuous quality improvement in every aspect of our business.
If you have comments on the installation instruction please contact your local Raychem office.

Raychem

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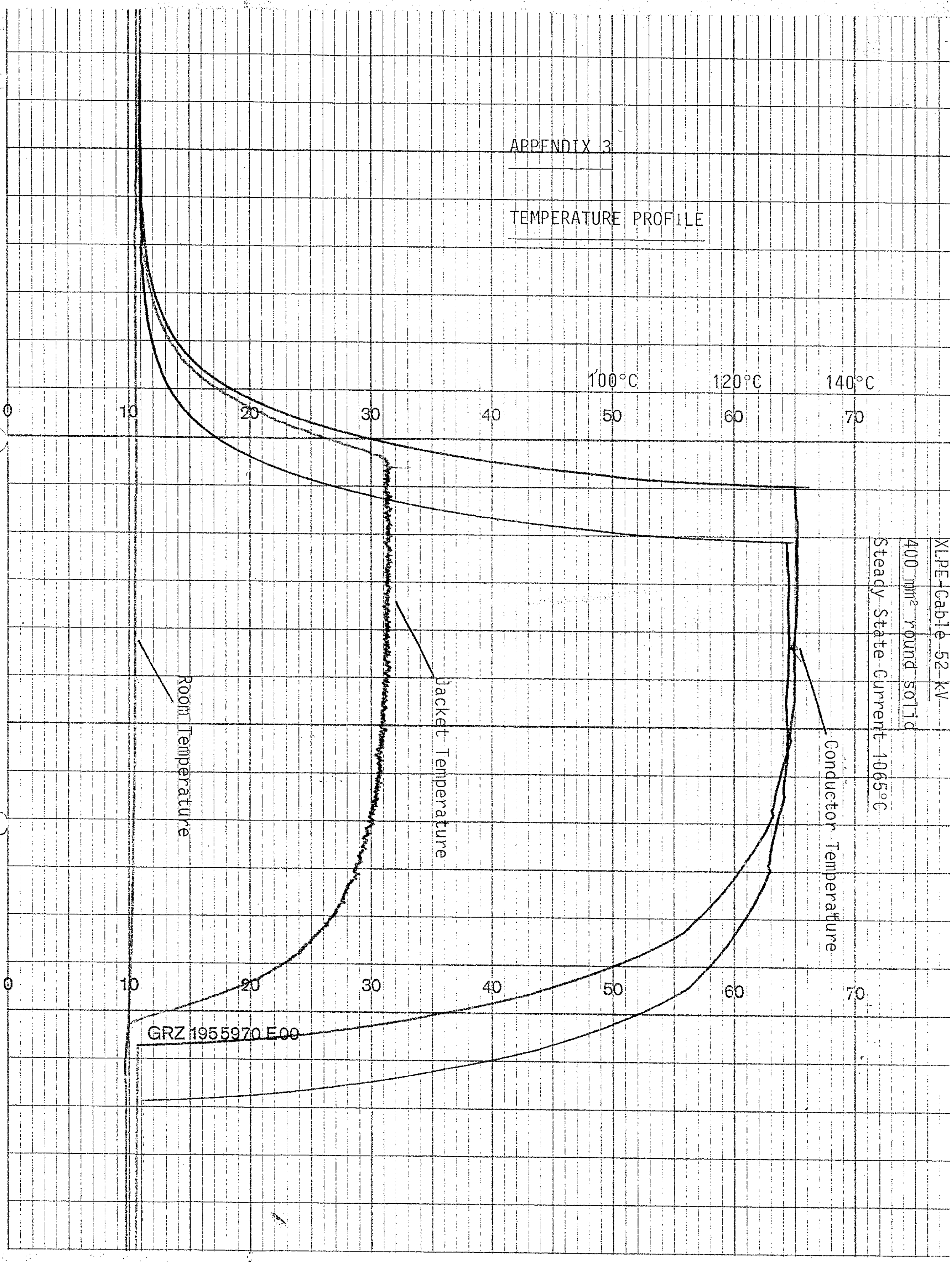
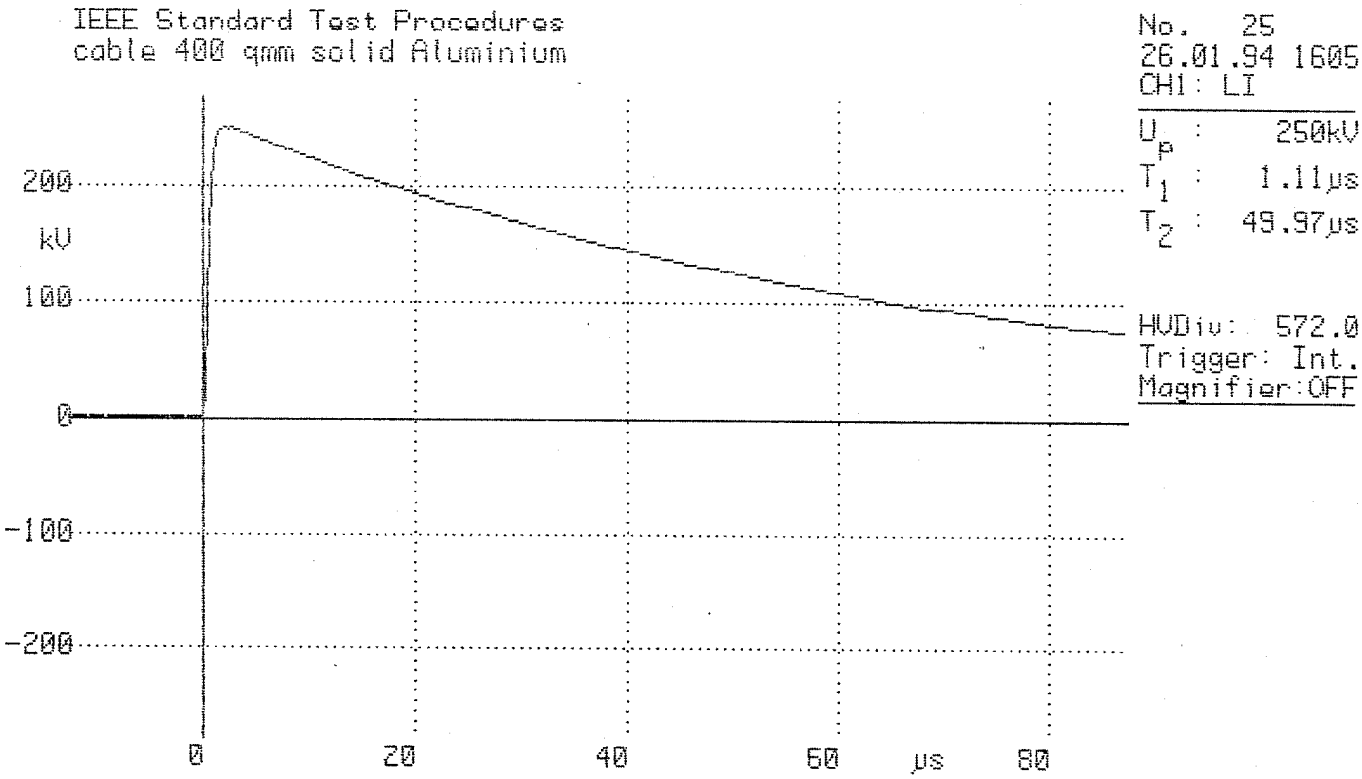
APPENDIX 3

TEMPERATURE PROFILE

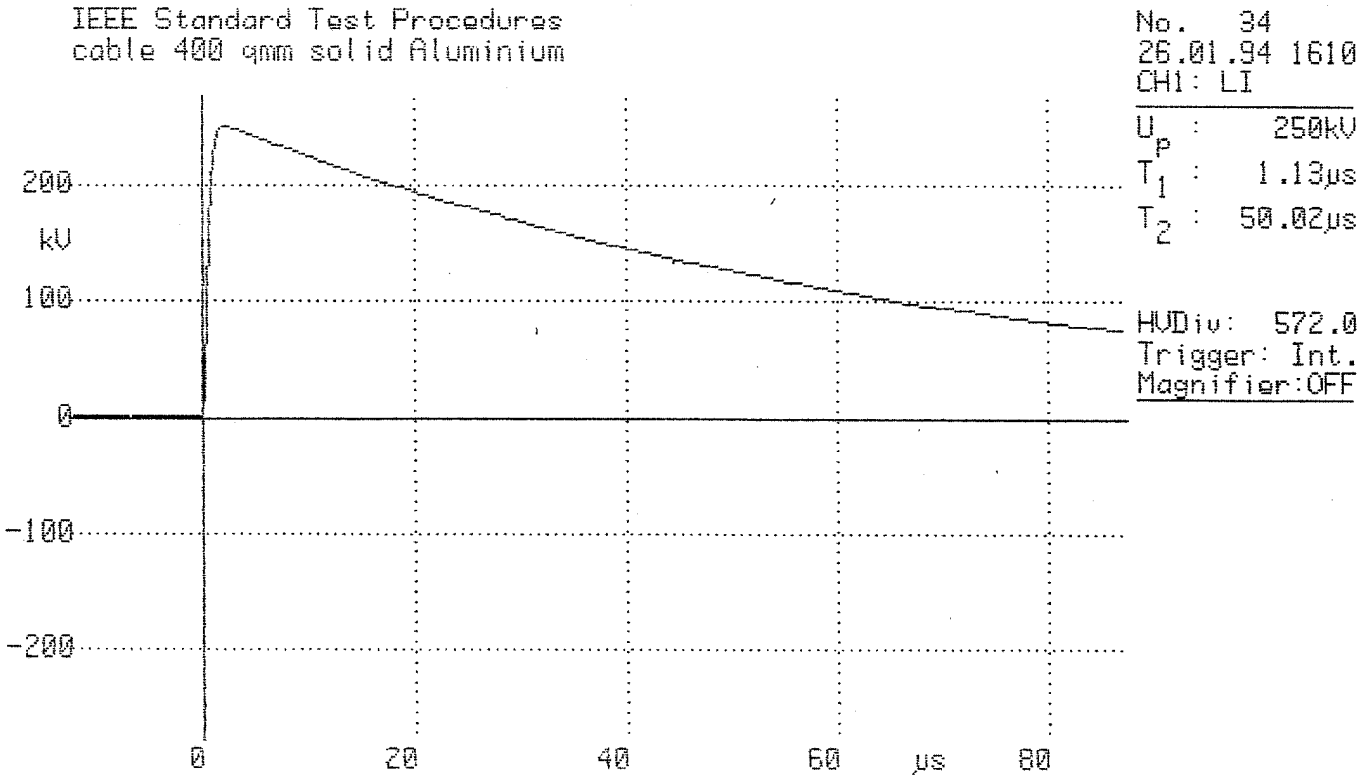


Lightning Impulse

First impulse negative
IHVT 5211

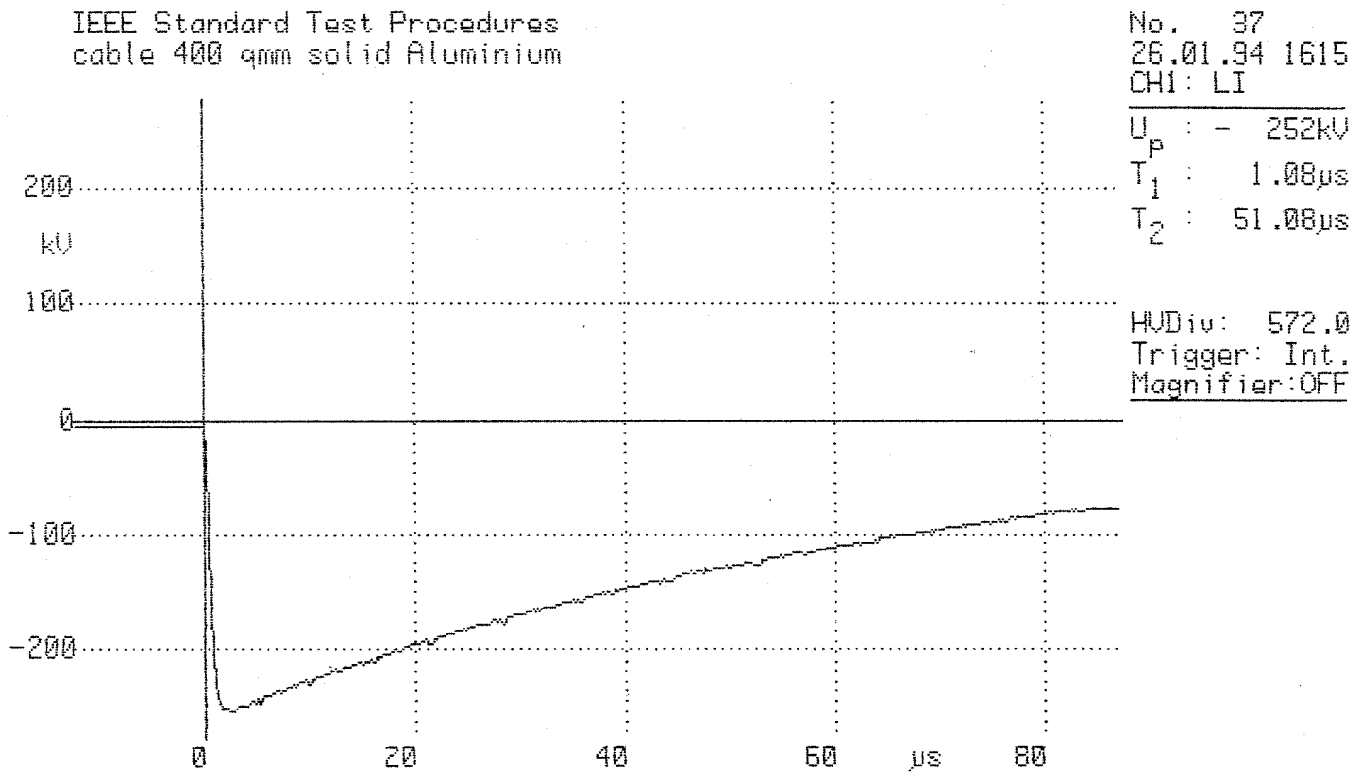


Tenth impulse positive
IHVT 5211

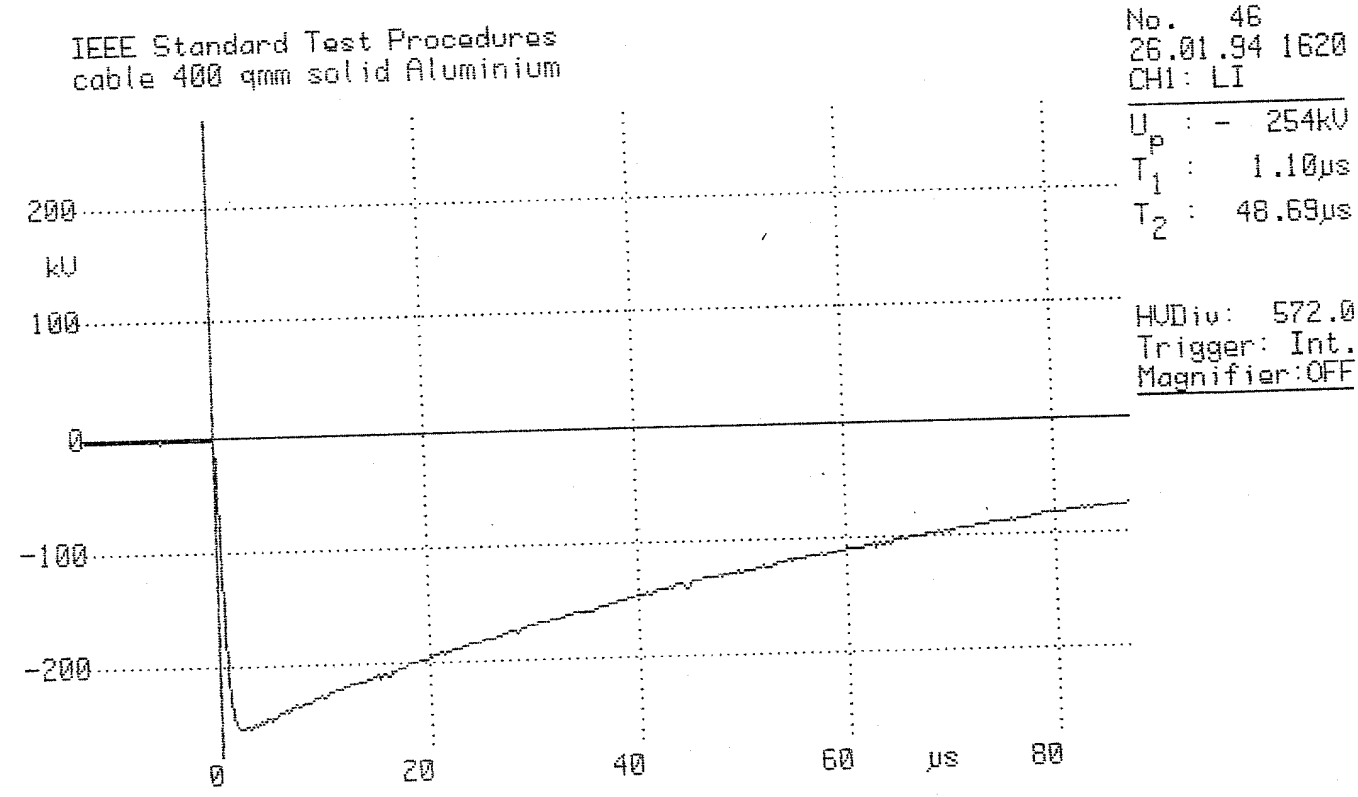


Lightning Impulse

First impulse negative
IHVT 5211

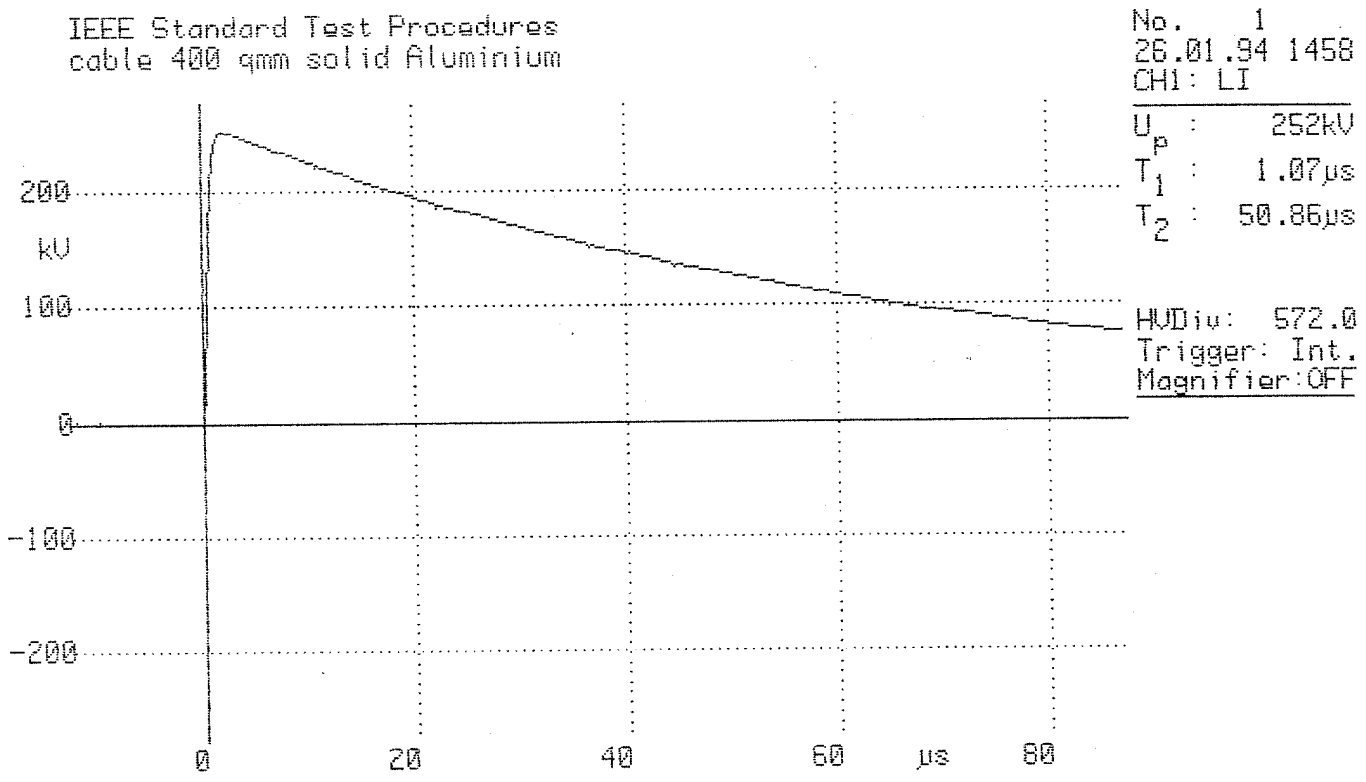


Tenth impulse negative
IHVT 5211

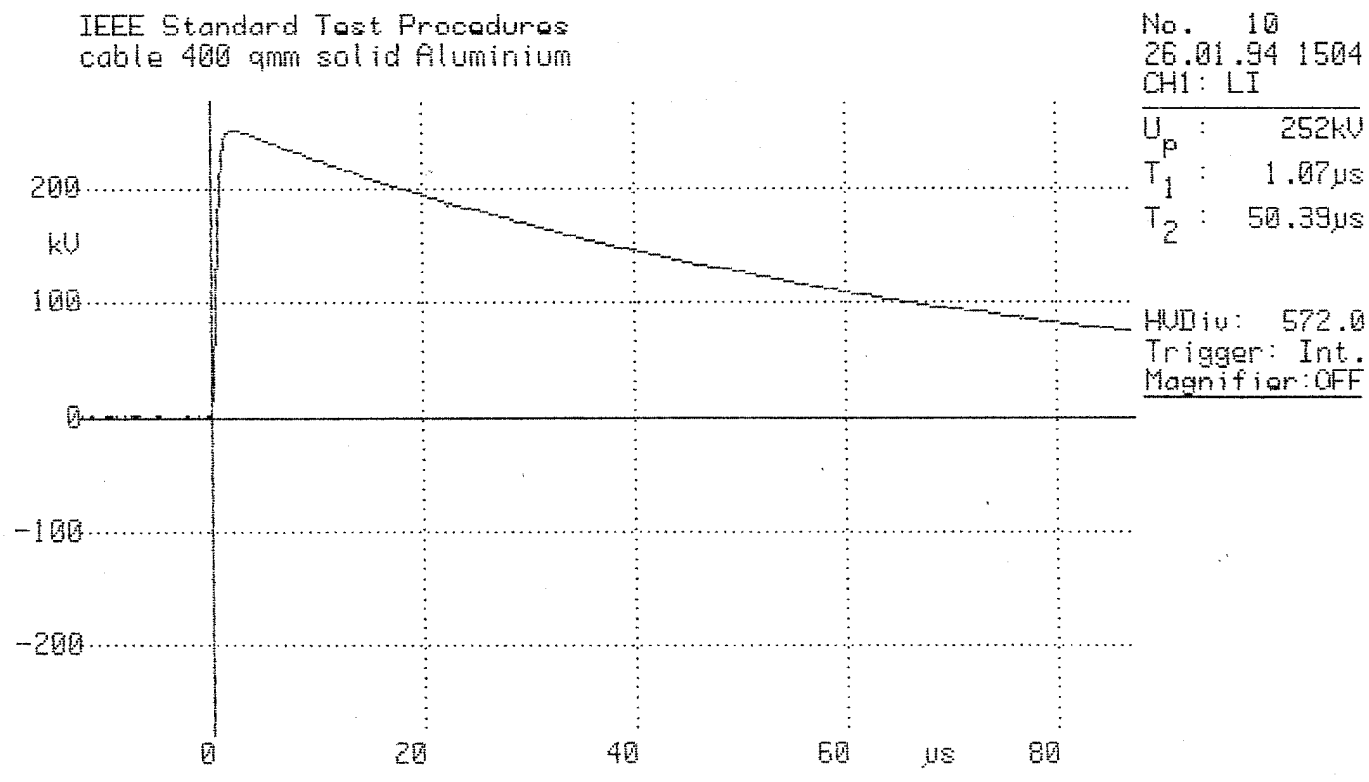


Lightning Impulse

First impulse positive
OHVT 5211

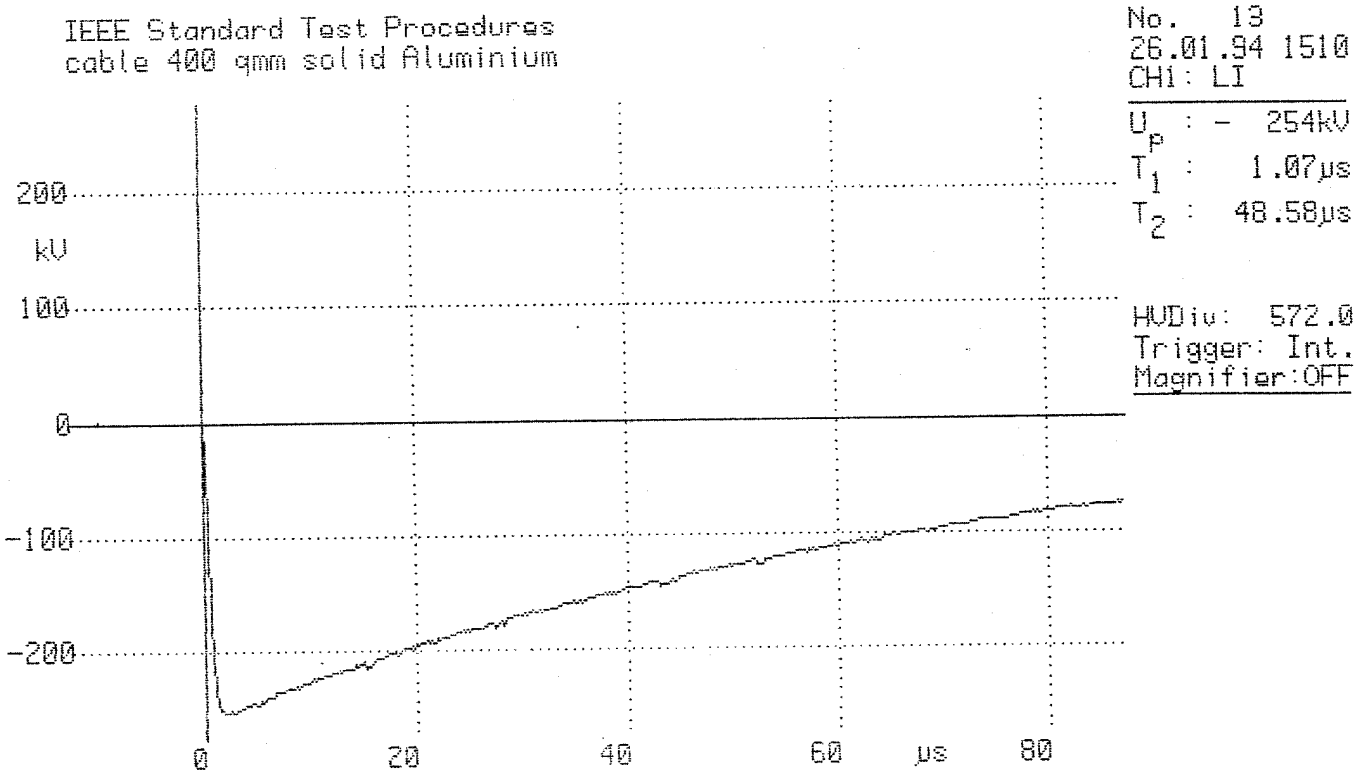


Tenth impulse positive
OHVT 5211

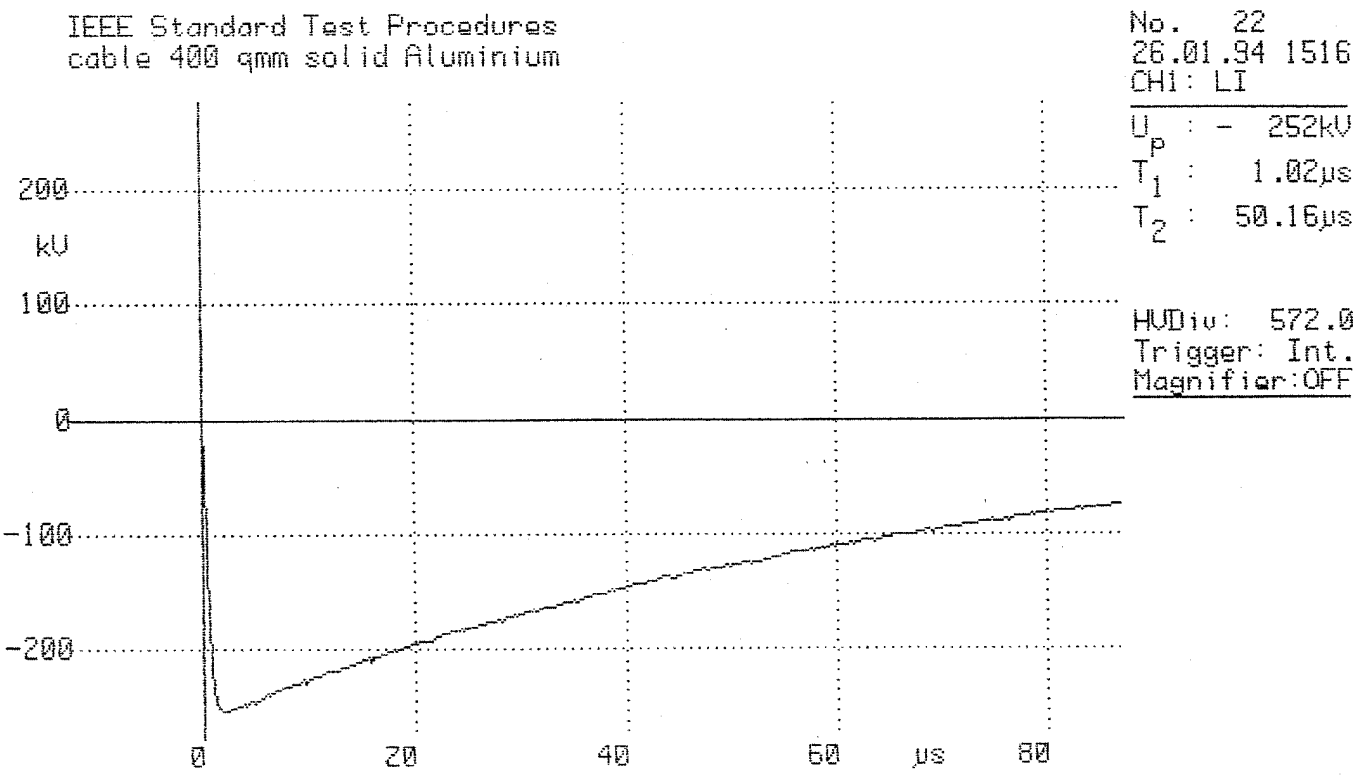


Lightning Impulse

First impulse negative
OHVT 5211

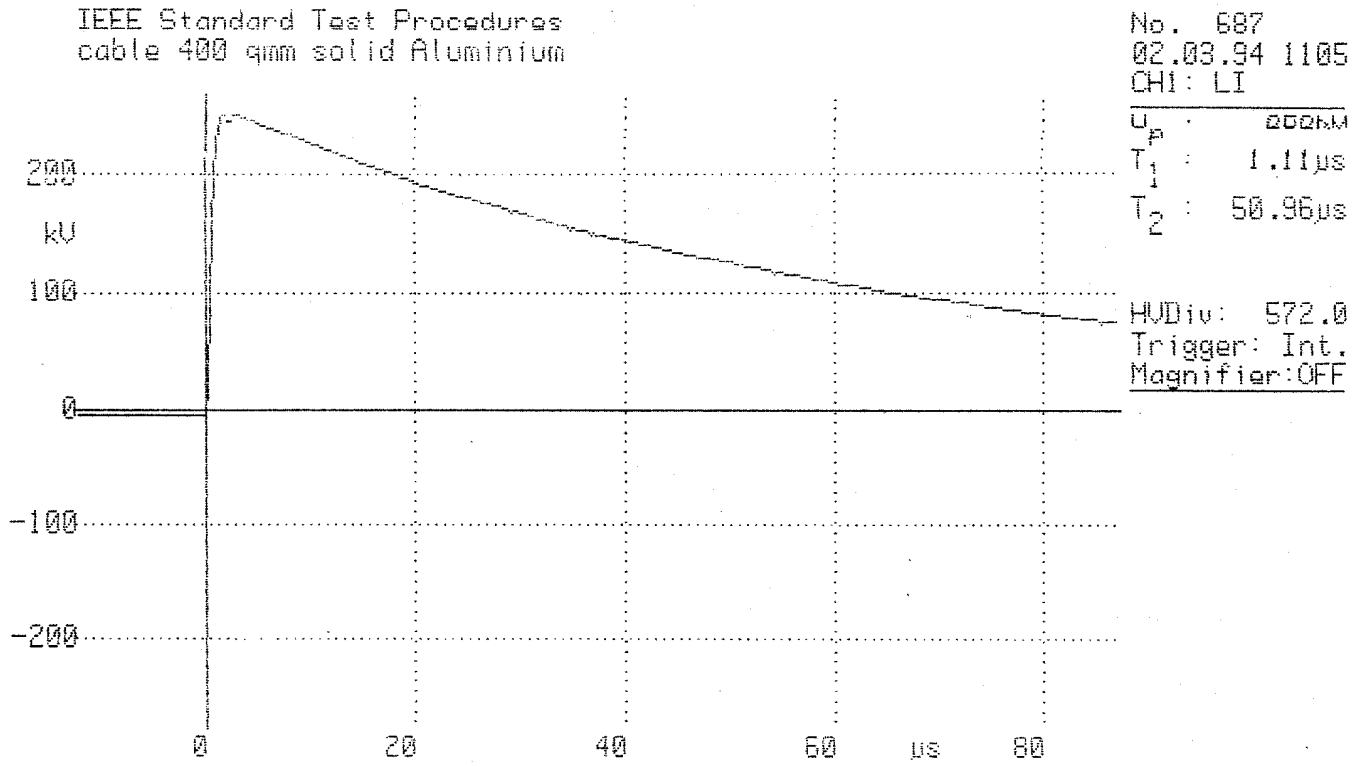


Tenth impulse negative
OHVT 5211

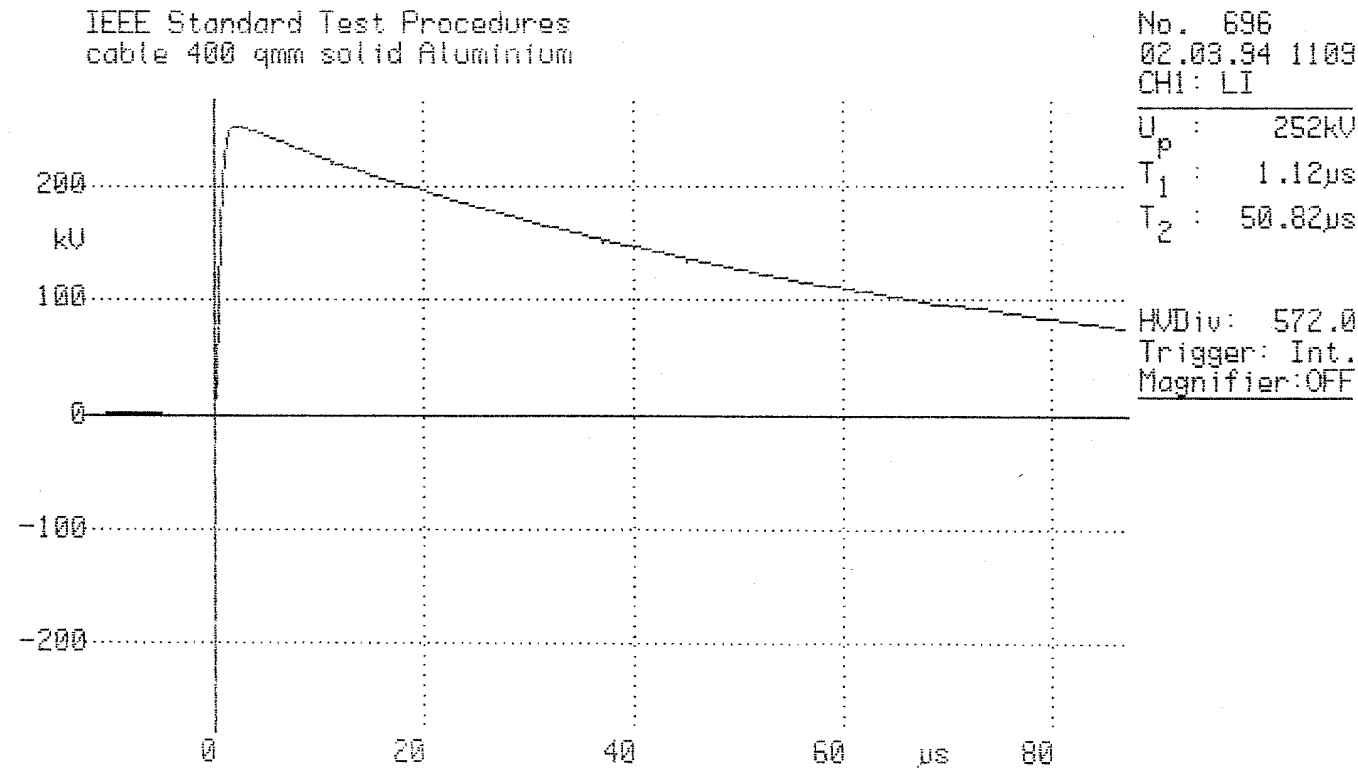


Lightning Impulse
Post Load Cycling

First impulse positive
IHVT 5211

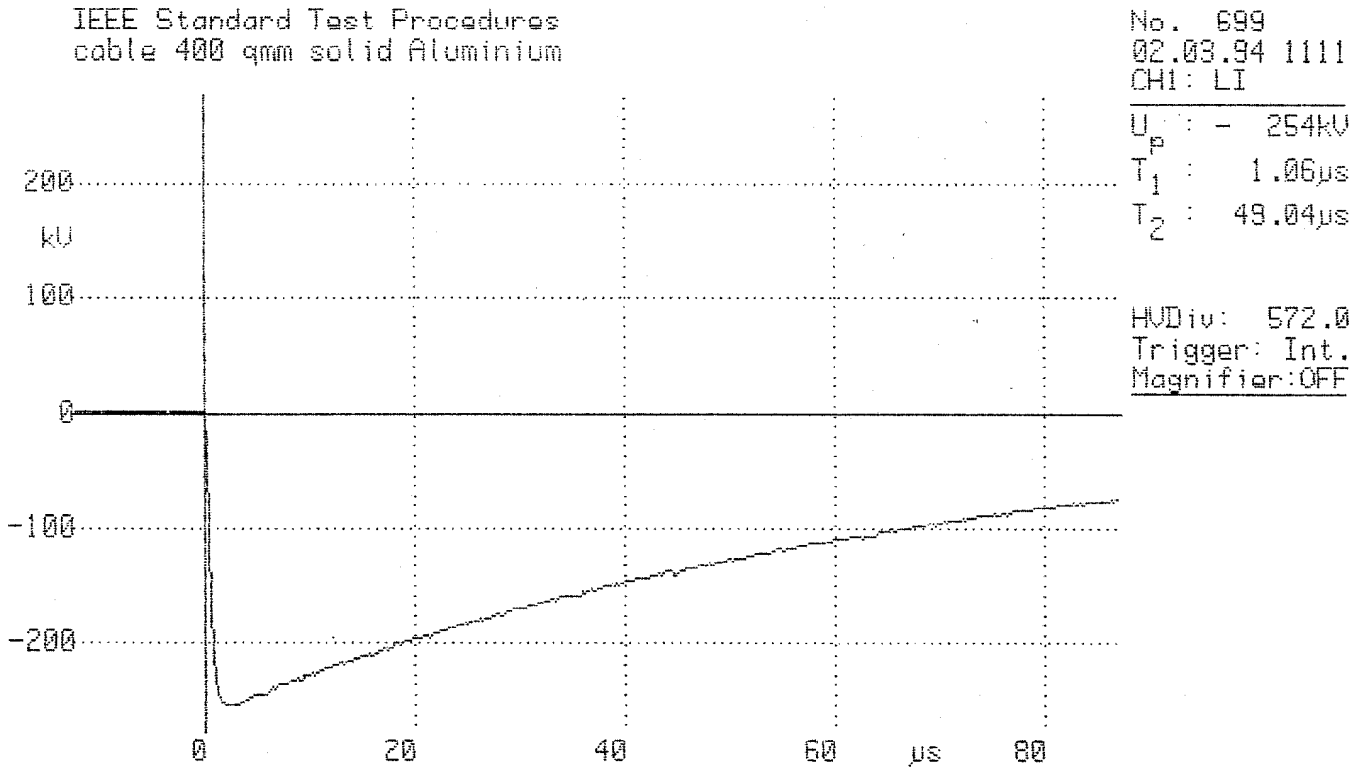


Tenth impulse positive
IHVT 5211

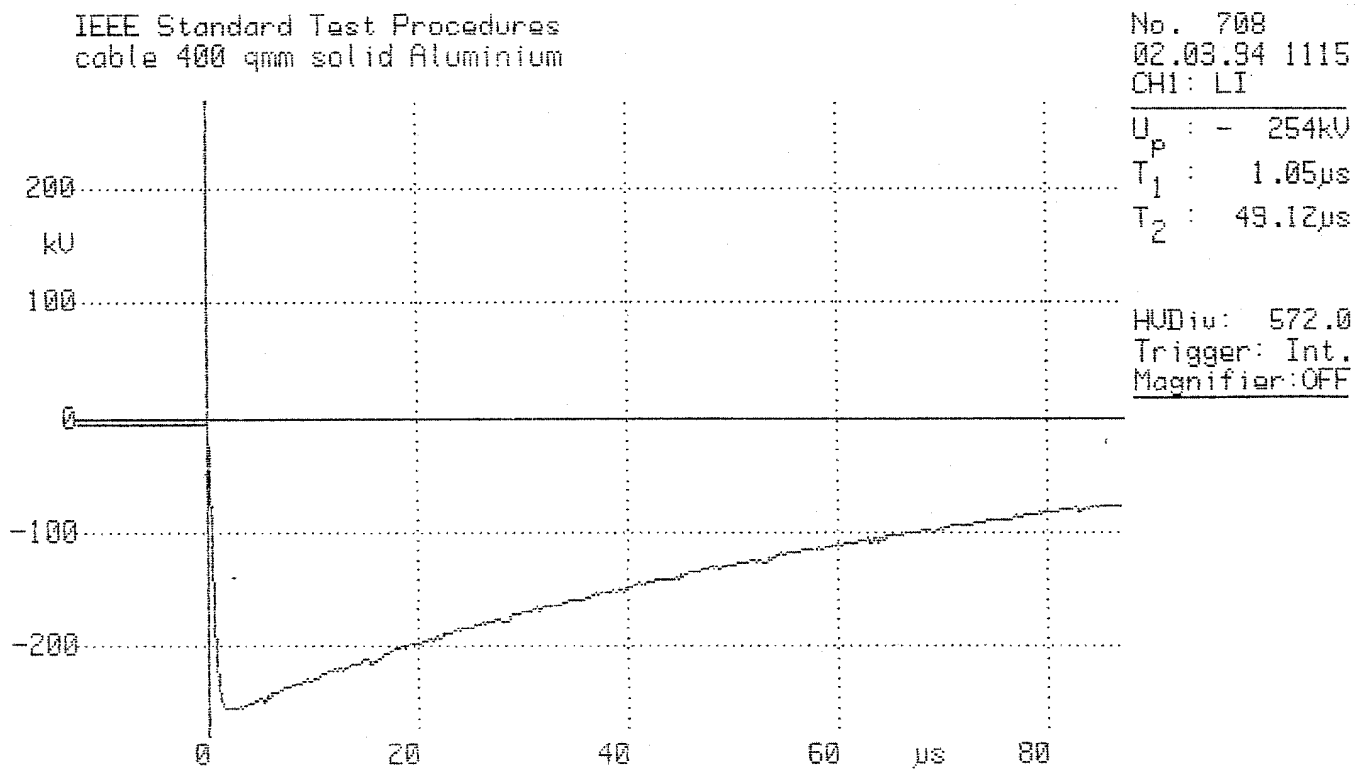


Lightning Impulse
Post Load Cycling

First impulse negative
IHVT 5211

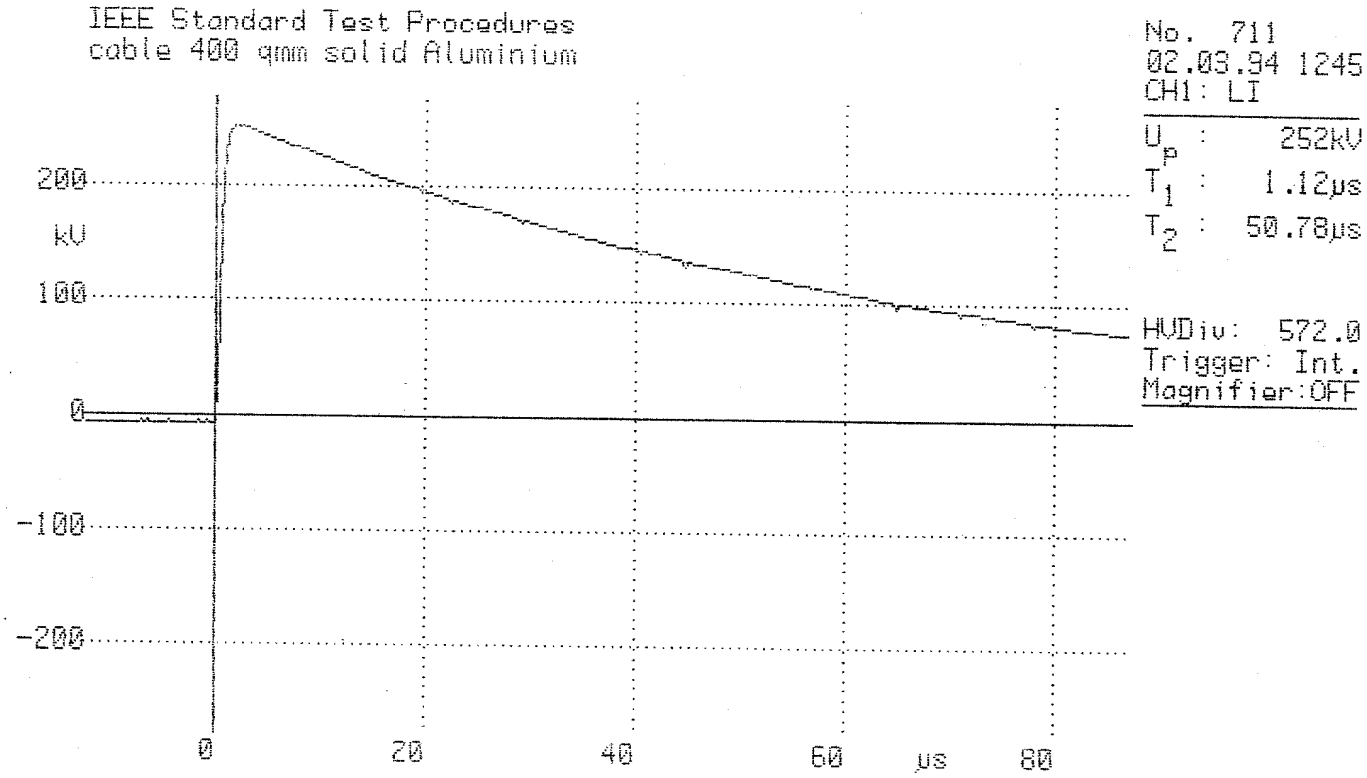


Tenth impulse negative
IHVT 5211

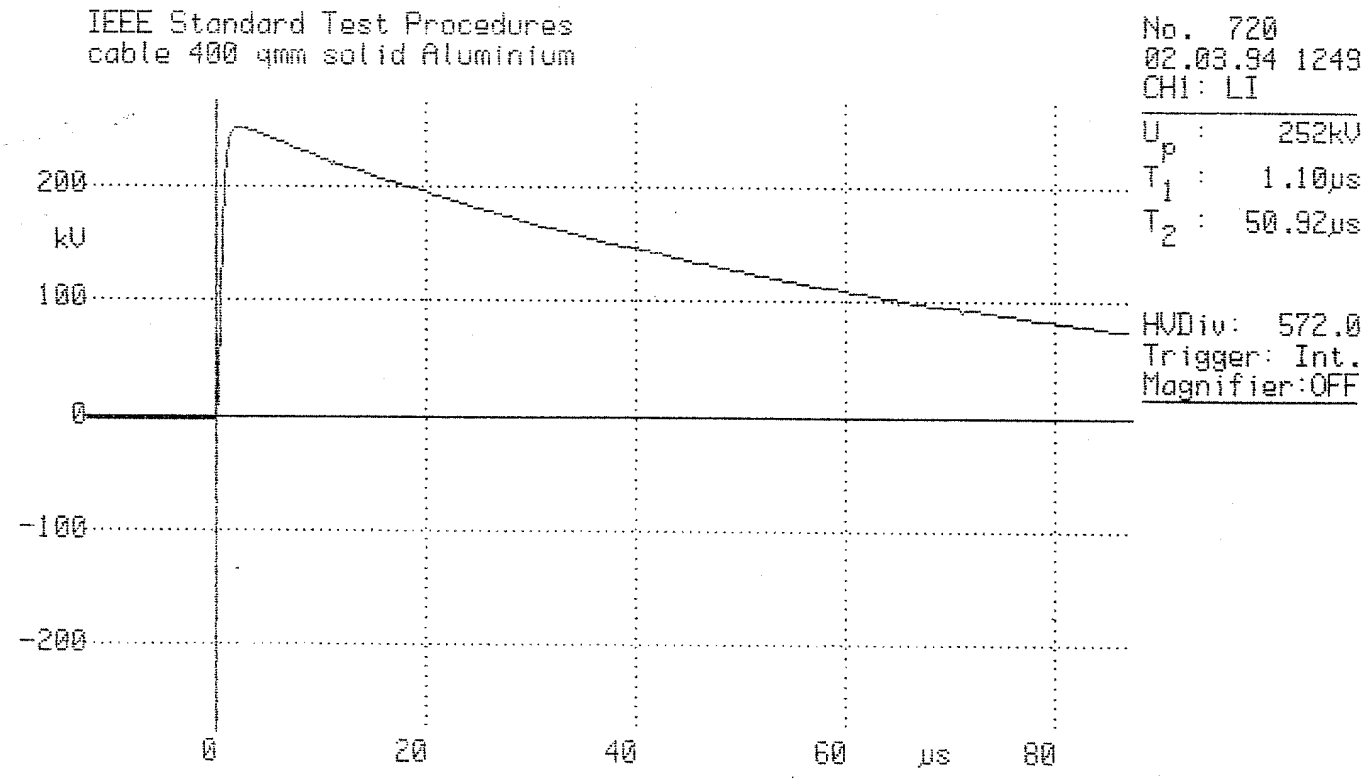


Lightning Impulse
Post Load Cycling

First impulse positive
OHVT 5211

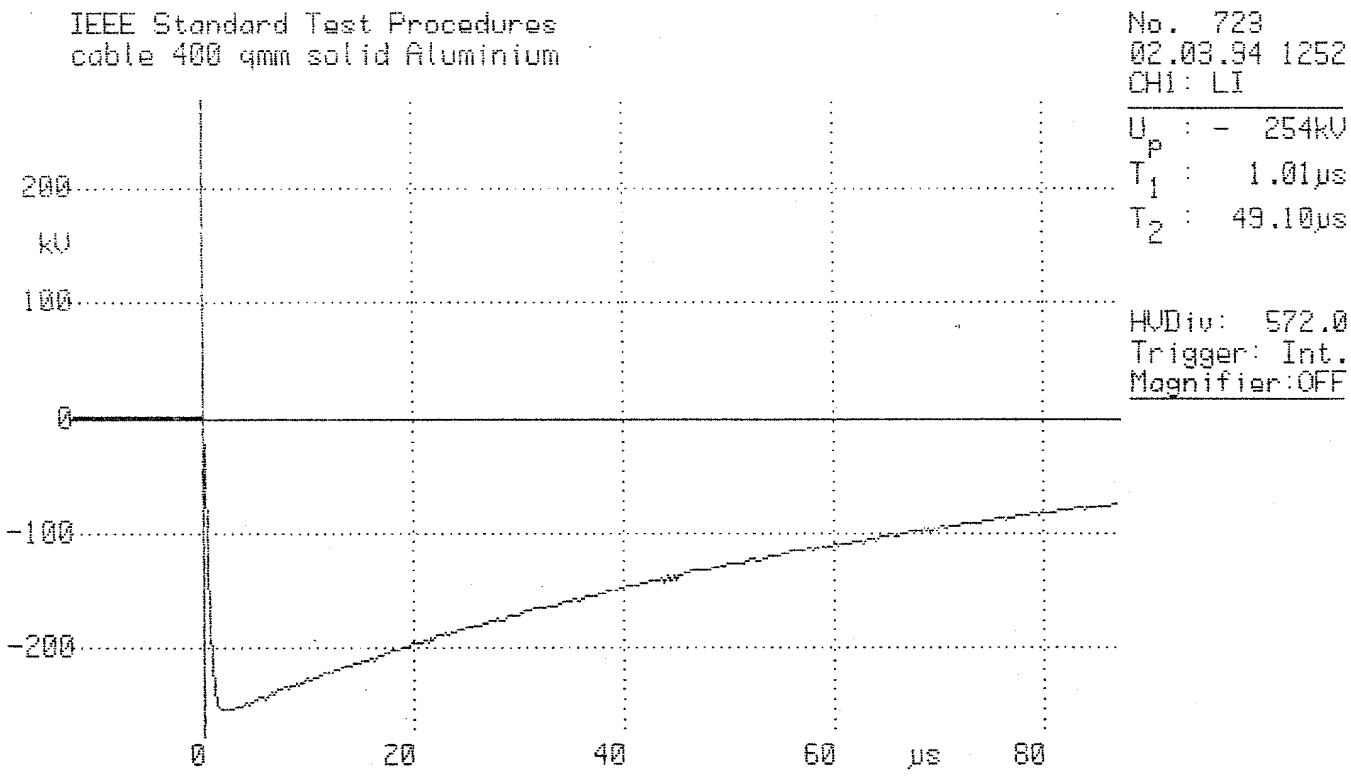


Tenth impulse positive
OHVT 5211

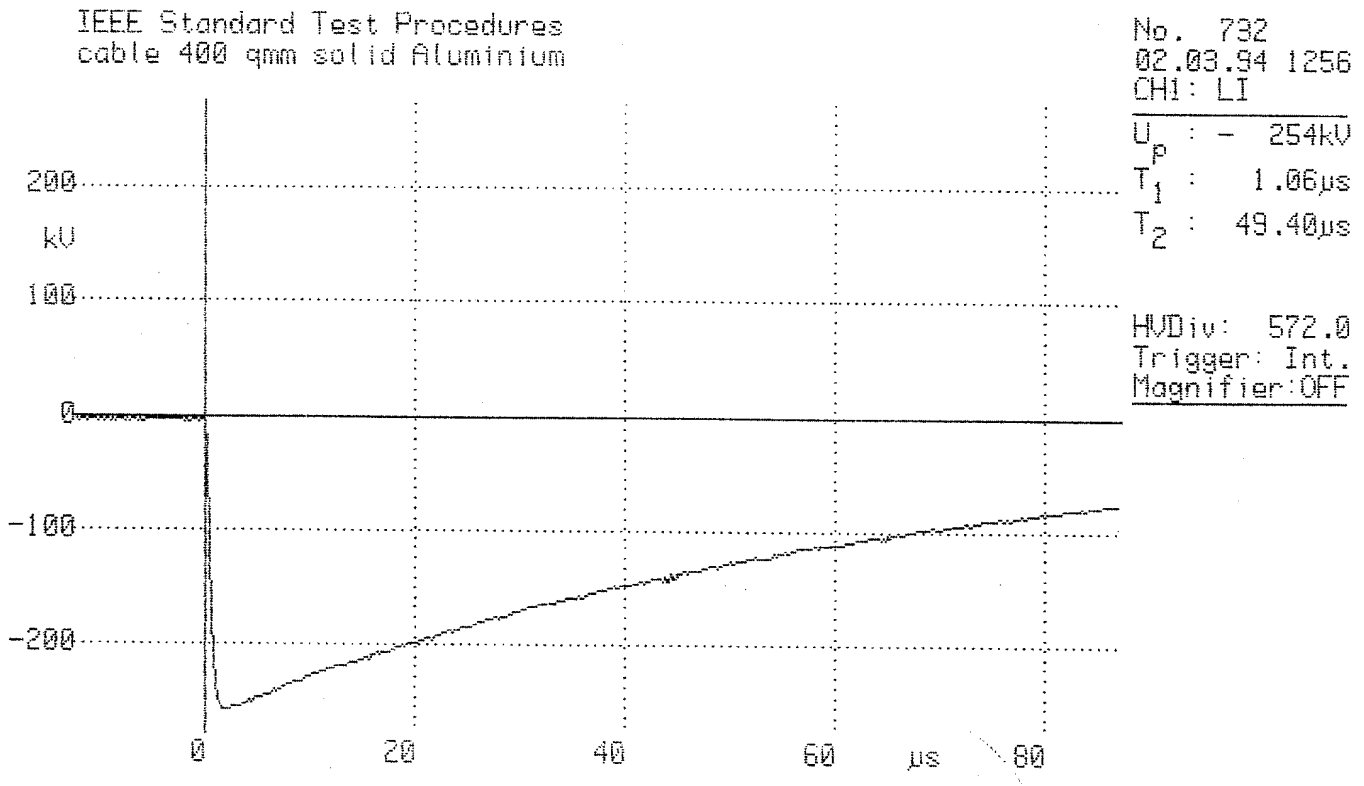


Lightning Impulse
Post Load Cycling

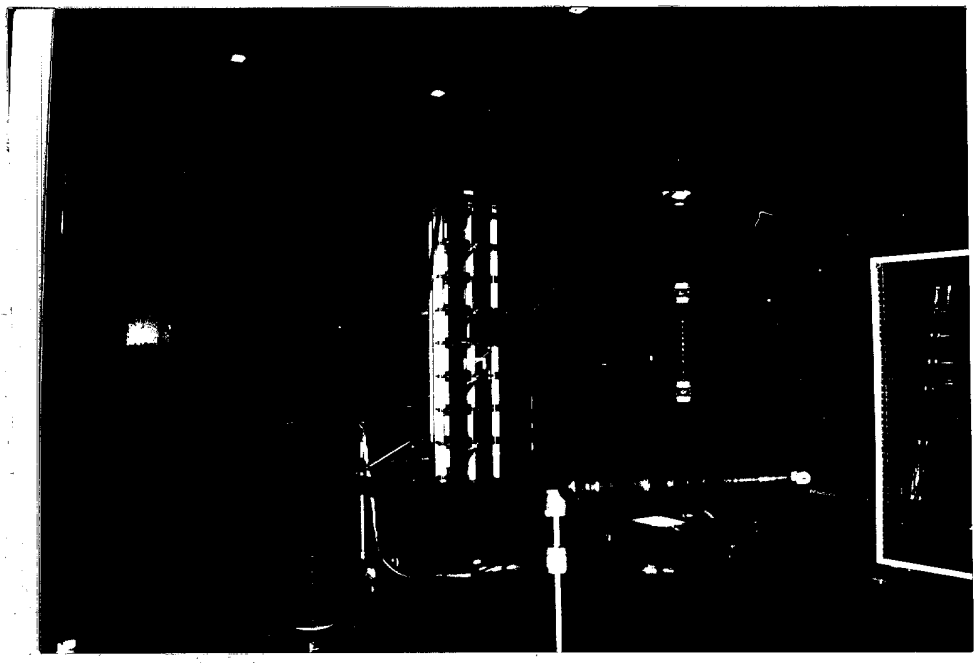
First impulse negative
OHVT 5211



Tenth impulse negative
OHVT 5211



Load Cycling Test



Impulse Testing