Ex.2.

RESEARCH , DEVELOPMENT AND
TESTING NATIONAL INSTITUTE
FOR ELECTRICAL ENGINEERING

LIT

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INCERCARE
ROMANIA
RENAR
SR EN ISO/CEI 17025:2005
CERTIFICAT DE ACREDITARE
Nr. 450 - L

TEST REPORT
No. 41629 / 30.06.2008

1. **Product:Early Streamer Emission Active Lightning Conductor–ESELC type Petex - S**
2. **Test:** Evaluation of the initiation advance according to NFC 17 – 102 / 1995 norm.
3. **Test order:** CONTRACT No. 1295/18.06.2008
4. **Customer:** FOREND Elk. Malz. Dis Tic. A.S.
5. **Customer's address:** 19 Mayis Mah. Buyukdere Cd. Basman Han , No: 4 Kat:4 34360 Sisli Istanbul - TURKEY
6. **Test result:** There are presented the measurements results
7. **Test responsible:** Eng. D. Stanciu

Test Supervisor
Eng. A. Ungureanu

Q.A. Responsible:
Eng. Gh. Macovei

APPROVED
LABORATORY HEAD
Eng. Dorin Popa

ICMET
DIVIZIA DE ÎNALTĂ TENSIUNE
CRAIOVA

8. **The test report contains 12 pages.**
9. **The test report was edited in 4 ex.; 1 ex. to LIT and 3 ex. to customer.**

CAUTION:
a. The test result makes reference only to tested product .
b. Integral reproduction of the test report is forbidden.
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d. Reports without original signatures are not valid.
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1. Tested material

Early Streamer Emission Lightning Conductor (ESELC) type Petex - S
See photo on page 9 and drawing on page 10.
Lightning Conductor supplied by FOREND Elk. Malz. Dis Tic.A.S.

2. Type of tests

A switching impulse wave negative polarity and a DC voltage of negative polarity are applied on the upper metallic plane.

3. Specification

N F C 17 – 102 / 1995 Appendix C

4. Test equipment

Laboratory inner dimensions: 48 m x 32 m x 27 m (height)
Altitude: 100 m above see level
4200 kV High Voltage Impulse Generator type SPF 340; 340 kWs, TUR Dresden - Germany
1000 kV Rectifier cascade type GS 1000 / 30; 30 mA; TUR Dresden – Germany
1400 kV Damped capacitive divider, ICMET Craiova, Romania;
TR – AS transient – recorder, Dr.Strauss System Electronik, GmbH- Germany
Impulse calibrator type KAL – 1000, 0.84 / 60 μs and 20 / 3000 μs Dr.Strauss System Electronik, GmbH – Germany
Fluke calibrator type 5500 A.

5. Test circuit

See the test circuit diagram on page 11
The measuring system that consists of 1400 kV damped capacitive divider and TR – AS transient recorder was calibrated by Accredited Laboratory DKD – K – 18702, Romania with Calibration Certificate 0060 of 14th January 2004 and checked before beginning of measurement with the impulse calibrator KAL 1000, calibrated by PTB – Braunschweig – Germany, calibration certificate 260 PTB 06, and Fluke 5500 A calibrator calibrated by Metrology National Institute of Romania, order calibration certificate No. 000256 – DKD – K – 39701 / 05.06.

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Expanded uncertainty of measurements parameter inside of limits, prescribed by IEC 60060 – 2 / 1994 for SI Approved Measuring Systems (3 % for peak values and 10 % for time parameters).

6. Mounting arrangement

See the test set up on page 12
See photo on the pages 9

The lightning conductor tested is put on a 5 x 5 m grounded metallic plane and connected to ground.
A square metallic plane, dimensions: 4.5 m / 4.5 m / 0.2 m with the edges rounded, is suspended above the lightning conductor and connected the high voltage.

7. Test procedure

The DC polarization of the upper plane is adjusted on the square metallic plane.
The negative impulse wave is adjusted in order to obtain a flashover.
The height of the lightning conductor (h) and the distance between the ground and the square plane (H) are measured at the beginning of each test.
The atmospheric conditions taken before and after each test.
The peak value (Up) of the impulses and the triggering time (T_B) are recorded at each impulse.
One hundred significant impulses are applied on the lightning conductor.
The early streamer emission lightning conductor (ESELC) is to be compared with a simple rod lightning conductor (SRLC).
Tests are performed is the same conditions and configuration for each lightning conductor: ESELC and SRLC.
The test on SRLC (100 significant impulses) was performed in two series and circled by the test on the ESELC.

Height of lightning conductor (h) adjusted to:	1020 mm
Distance between ground / square plane (H) adjusted to:	2500 mm
h / H:	0.41
Polarization voltage:	62.5 kV
Peak time / Rise time of the full wave:	531 µs / 272 µs
Time interval between consecutive impulses:	> 1 min

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8. TEST ON **SRLC** BEFORE AND AFTER TEST OF **ESELC type Petex - S**

8.1. Reception date: 19.06.2008

8.2. Test date: 20.06.2008

8.3. Atmospheric conditions

	FIRST SERIES	SECOND SERIES
BEFORE TEST	Beginning of the test: 13h00 p = 1003 mb t = 22.4 °C hr = 62.1 %	Beginning of the test: 16h20 p = 1002 mb t = 22.8 °C hr = 60.8 %
AFTER TEST	End of the test: 14h00 p = 1002 mb t = 22.6 °C hr = 60.8 %	End of the test: 17h35 p= 1001 mb t = 22.9 °C hr = 59.9 %

8.4. Results

See tables on page 6

Number of significant impulses: 100

Average of significant T_B:

- calculated from the experimental wave T'_{PTS} = 317.8 µs Stdev: 18.14 %
- transferred on the reference waveform: T_{PTS} = 364.2 µs

See curves on page 8

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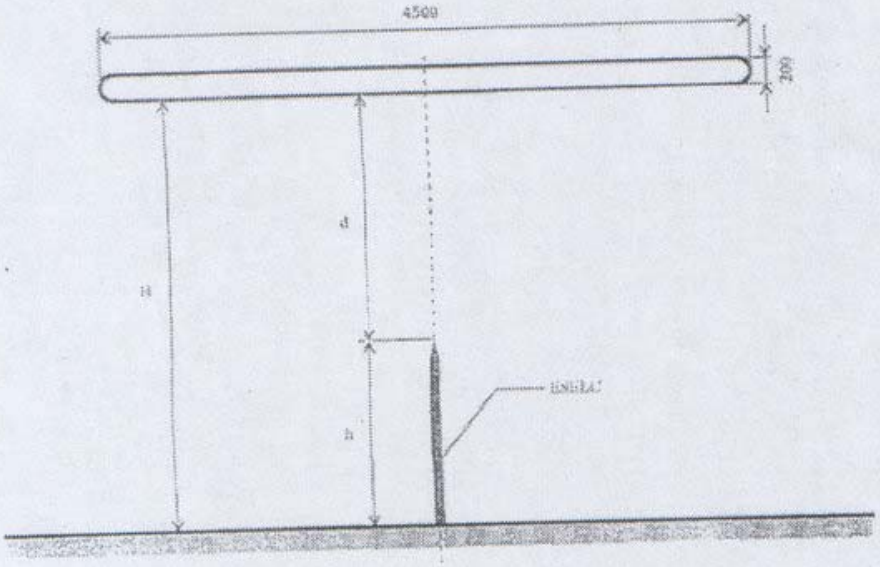
TEST SET UP ON EARLY STREAMER
EMISSION LIGHTNING CONDUCTOR
(ESELC)



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9. TEST ON **ESELC** TYPE **Petex - S**

9.1. Reception date: 19.06.2008

9.2. Test date: 20.06.2008

9.3. Atmospheric conditions

BEFORE TEST	Beginning of the test: 14h10 p = 1002 mb t = 22.6 °C hr = 61.5 %
AFTER TEST	End of the test: 16h00 p= 1006 mb t = 22.8 °C hr = 60.1 %

9.4. Results

See tables on page 7

Number of significant impulses: 100

Average of significant T_B:

- calculated from the experimental wave T'_{PDA}= 291.2 µs Stdev: 20.8 %
- transferred on the reference waveform: T_{PDA} = 333.7 µs

See curves on page 8

Measuring uncertainty for ΔT is 5.5 %.
The uncertainty stated is expanded uncertainty obtained by multiplying the standard uncertainty by the coverage factor k = 2. The value of measurand lies within the assigned range of values with probability of 95 %.

Triggering advance: $\Delta T = T_{PTS} - T_{PDA} = 364.2 - 333.7 = 30.5\ \mu s \pm 4.7\ \mu s$

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Test on SRLC before and after test on ESELC type Petex - S

Impulse no.	T_B µs	Impulse no.	T_B µs	Impulse no.	T_B µs
1	446	41	264	80	377
2	394	42	279	81	358
3	371	43	300	82	306
4	337	44	327	83	316
5	256	45	254	84	336
6	245	46	324	85	287
7	407	47	365	86	414
8	303	48	283	87	325
9	375	49	237	88	423
10	311	50	235	89	346
11	261	Second	series	90	300
12	266	51	331	91	305
13	294	52	287	92	277
14	343	53	337	93	292
15	317	54	269	94	362
16	247	55	312	95	280
17	430	56	247	96	276
18	458	57	293	97	321
19	358	58	281	98	265
20	468	59	246	99	284
21	281	60	333	100	311
22	285	61	295		
23	336	62	310		
24	308	63	281		
25	262	64	287		
26	334	65	289		
27	244	66	400		
28	312	67	282		
29	346	68	324		
30	292	69	308		
31	263	70	291		
32	263	71	501		
33	373	72	342		
34	358	73	454		
35	266	74	360		
36	271	75	439		
37	299	76	246		
38	292	77	297		
39	412	78	255		
40	288	79	268		

NS: No significant
T_B: Break-down time

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Test on ESELC type Petex - S

Impulse no.	T_B µs	Impulse no.	T_B µs	Impulse no.	T_B µs
1	329	44	353	87	255
2	257	45	400	88	340
3	253	46	244	89	202
4	279	47	404	90	242
5	250	48	312	91	315
6	276	49	303	92	263
7	224	50	318	93	390
8	263	51	334	94	392
9	225	52	269	95	313
10	237	53	322	96	388
11	274	54	322	97	293
12	277	55	247	98	287
13	284	56	283	99	315
14	247	57	300	100	388
15	190	58	249		
16	261	59	302		
17	246	60	502		
18	213	61	375		
19	202	62	342		
20	208	63	416		
21	232	64	266		
22	243	65	279		
23	283	66	281		
24	228	67	274		
25	194	68	261		
26	280	69	250		
27	228	70	335		
28	251	71	455		
29	281	72	305		
30	316	73	459		
31	244	74	336		
32	216	75	268		
33	286	76	258		
34	371	77	327		
35	260	78	201		
36	261	79	257		
37	261	80	336		
38	251	81	320		
39	345	82	260		
40	229	83	295		
41	250	84	275		
42	324	85	382		
43	314	86	318		

NS: No significant
T_B : Break-down time

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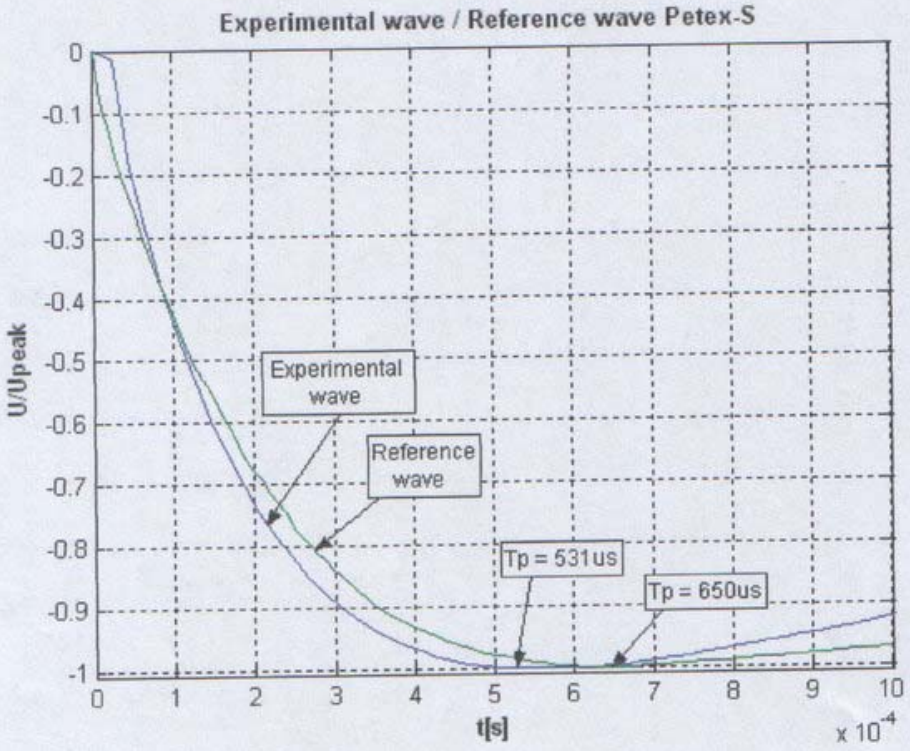

T'_{PTS} = 317.8 µs
T'_{PDA} = 291.2 µs
T_{PTS} = 364.2 µs
T_{PDA} = 333.7 µs
$\Delta T = T_{PTS} - T_{PDA}$ = 30.5 µs

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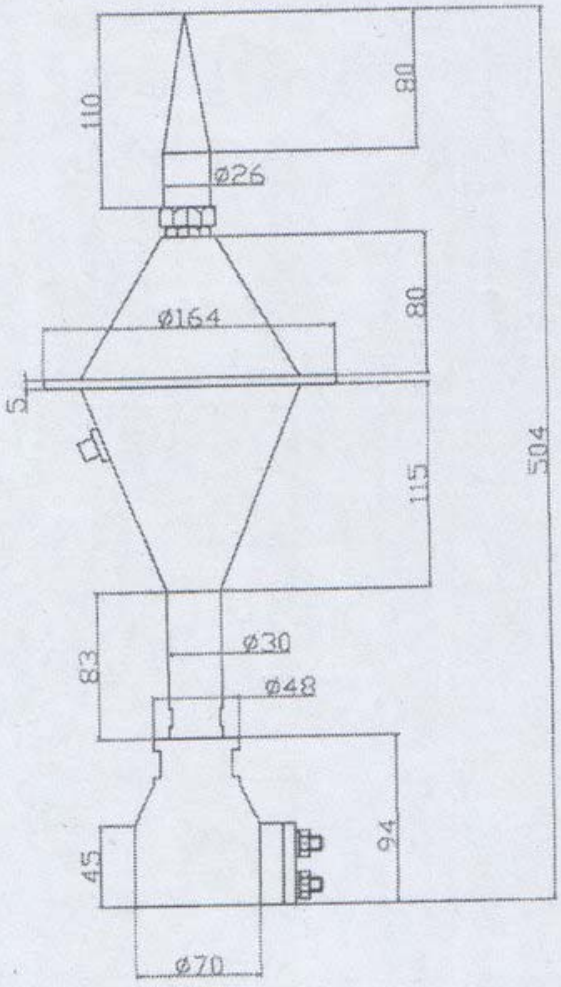

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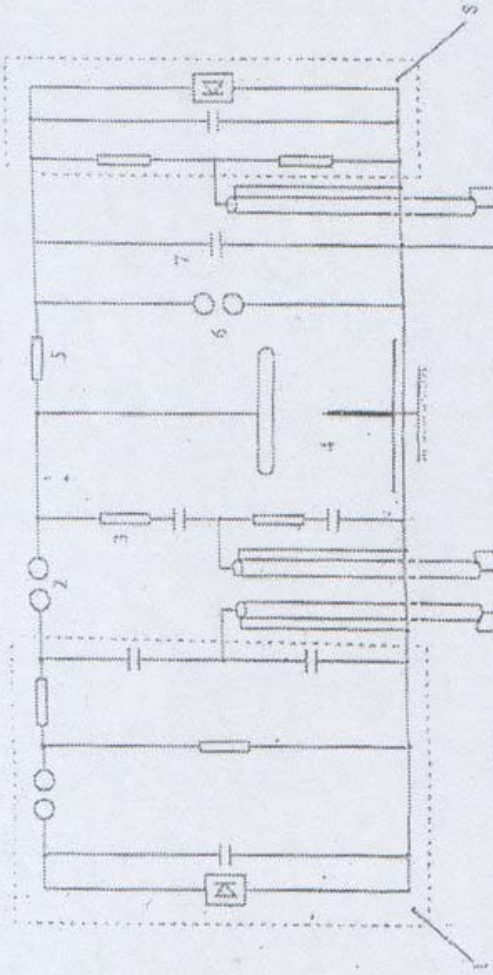
Test circuit diagram on lightning conductor



1 - HV Impulse Generator SPF 340/1200
2 - Serial protective gap, Φ = 250 mm
3 - Damped capacitive divider, 1500 kV
4 - Test configuration
5 - Resistance 2 MΩ
6 - Parallel protective gap, Φ = 500 mm
7 - Capacitor 4,5 nF
8 - Rectifier cascade OS 1000/30
9 - Transient recorder TR - AS 100 - 10
10 - Measurement voltmeter