Ex 2.14

RESEARCH-DEVELOPMENT AND TESTING NATIONAL
INSTITUTE FOR ELECTRICAL ENGINEERING

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acreditat pentru
ÎNCERCARE
RENAR
SR EN ISO/CEI 17025:2005
CERTIFICAT DE ACREDITARE
nr. LI 450/2009

TEST REPORT
No.42808 / 15.11.2010

1.CUSTOMER: Forend Elk.Malz. ve Dis Tic.A.S.
19 Mayis Mah. Buyukdere Cd. Basman Han
No:4 Kat:4 Sisli –Istanbul TURKEY

2.MANUFACTURER: Forend Elk.Malz. ve Dis Tic.A.S.
19 Mayis Mah. Buyukdere Cd. Basman Han
No:4 Kat:4 Sisli –Istanbul TURKEY

3. TESTED PRODUCT: Early Streamer Emission Lightning Conductor (ESELC) type
FOREND – EU
Prototype

4. REFERENCE STANDARD: NFC 17.102:1995 (Rectification January 2009) Appendix C
UNE 21186:1996 Anexo C

5. TEST PERFORMED: - Determination of the initiation advance

6. TEST DATE: 09.11.2010

7. TEST RESULTS: The product passed the test.

8. The report contains: 13 pages

9. The test report is edited in 4 copies, copy no.1 remain in laboratory and copies 2, 3 and 4 are sent to the customer.

HEAD OF HV DIVISION
Eng. PĂTRU Ion

ICMET
ÎNCERCĂRI DE ÎNALTĂ TENSIUNE
CRAIOVA

HEAD OF HV LABORATORY
Eng. BADEA Ion

a. The results refer only to test product mentioned on point 3.
b. Integral reproduction of the present report is forbidden.
c. Partial reproduction of the present report is allowed with the written approval of laboratory.
d. All signatures of the present report are original ones.

Code F-01.09.01(e)

Content **page**

HVD

TEST REPORT No. 42808

1. Identification of the test product:

Type: FOREND EU

Serial / year: prototype / 2010

Technical Specification / Drawing: - / -

Contract // Test order: 1676 / 28.10.2010 // 21496 / 02.11.2010

Product receiving date: 05.11.2010

Product condition at receiving: New

2. Test program: - Determination of the initiation advance

3. Responsible for tests: Eng. I. Badea

4. Opinions and interpretation (if necessary):

5. Present at the test: -

Code F-01.09.01(e)

1. Tested material

Early Streamer Emission Lightning Conductor (ESELC) type Forend – EU.
See photo on page 11 and drawing on page 13.
Lightning Conductor supplied by FOREND Elk. Malz. ve 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 (Rectification January 2009) Appendix C
UNE 21186:1996 Anexo 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.
Keithley, serial no. 1070037 – USA.

5. Test circuit

See the test circuit diagram on page 12
The measuring system that consists of 1400 kV damped capacitive divider and TR – AS transient recorder was calibrated by Accredited Laboratory DKD – K – 18701, Romania with Calibration Certificate 176' of 29th January 2009 and checked before beginning of measurement with the impulse calibrator KAL 1000, calibrated by PTB – Braunschweig – Germany, calibration certificate 4066 PTB 08, and Fluke 5500 A calibrator calibrated by Metrology National Institute of Romania, order calibration certificate No. 000457 – DKD – K – 39701 / 17.10.2008.

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 13
See photo on the pages 11

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:	1050 mm
Distance between ground / square plane (H) adjusted to:	2200 mm
h / H:	0.477
Polarization voltage:	53 kV
Peak time / Rise time of the full wave:	593 μs / 272 μs
Time interval between consecutive impulses:	> 1 min

8. TEST ON SRLC BEFORE AND AFTER TEST OF ESELC type *FOREND – EU*

8.1. Reception date: 05.11.2010

8.2. Test date: 09.11.2010

8.3. Atmospheric conditions

	FIRST SERIES	SECOND SERIES
BEFORE TEST	Beginning of the test: 16h15 p = 983 mb t = 14 ^{0}C hr = 63 %	Beginning of the test: 19h50 p = 985 mb t = 13.8 ^{0}C hr = 63.5 %
AFTER TEST	End of the test: 17h16 p = 983 mb t = 14 ^{0}C hr = 63 %	End of the test: 21h20 p= 985 mb t = 13.8 ^{0}C hr = 63.5 %

8.4. Results

See tables on page 8

Number of significant impulses: 100

Average of significant T_B:

- calculated from the experimental wave T'_{PTS} = 360.16 µs Stdev: 17.34 %
- transferred on the reference waveform: T_{PTS} = 439.91 µs

See curves on page 10

9. TEST ON ESELC type *FOREND – EU*

9.1. Reception date: 05.11.2010

9.2. Test date: 09.11.2010

9.3. Atmospheric conditions

BEFORE TEST	Beginning of the test: 17h30 p = 983 mb t = 14 ^{0}C hr = 63 %
AFTER TEST	End of the test: 19h40 p= 983 mb t = 14 ^{0}C hr = 63%

9.4. Results

See tables on page 9

Number of significant impulses: 100

Average of significant T_B:

- calculated from the experimental wave T'_{PDA}= 322.66 µs Stdev: 17.52 %
- transferred on the reference waveform: T_{PDA} = 376.21 µs

See curves on page 10

Measuring uncertainty for ΔT is 5.7 %.
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: $\Delta T = T_{PTS} - T_{PDA} = 439.91 - 376.21 = 63.70$ µs ± 3.6 µs

Test on SRLC before and after test on ESELC type *FOREND – EU*

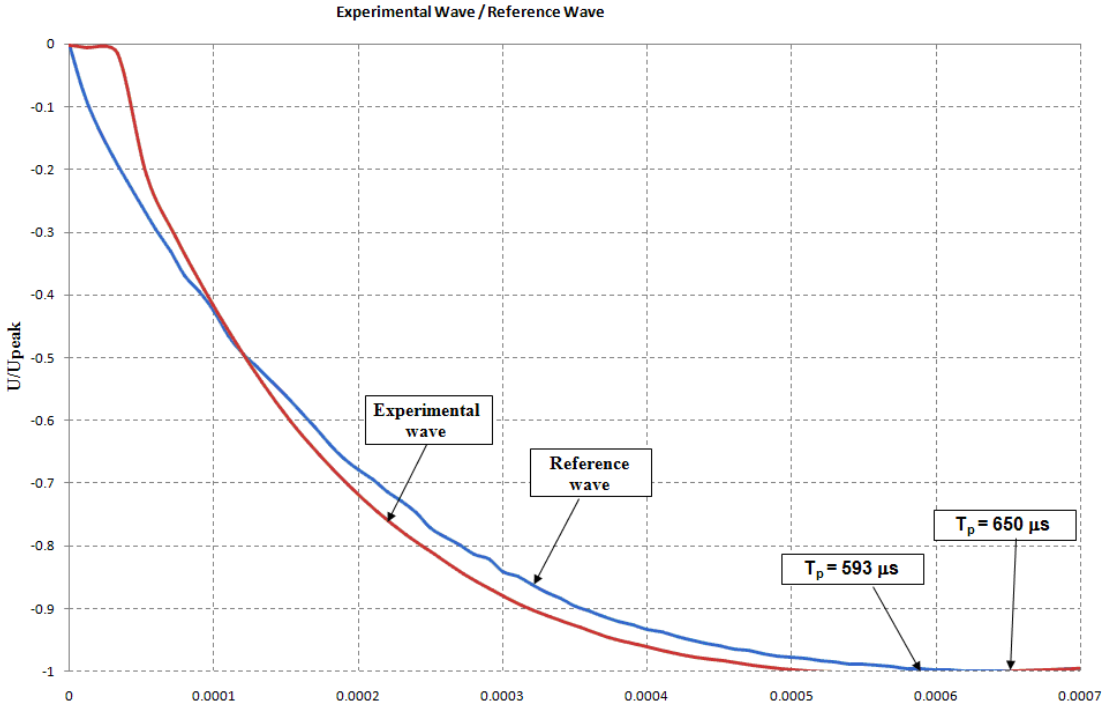
Impulse no.	T_B µs	Impulse no.	T_B µs	Impulse no.	T_B µs
1	413	41	362	80	333
2	464	42	315	81	328
3	369	43	341	82	361
4	361	44	313	83	376
5	535	45	429	84	331
6	491	46	313	85	342
7	325	47	447	86	375
8	303	48	253	87	372
9	252	49	414	88	307
10	279	50	480	89	336
11	378	Second	series	90	320
12	382	51	317	91	391
13	365	52	308	92	354
14	368	53	348	93	353
15	332	54	326	94	373
16	404	55	429	95	449
17	278	56	363	96	361
18	257	57	300	97	371
19	492	58	391	98	315
20	367	59	340	99	365
21	255	60	353	100	362
22	425	61	332		
23	390	62	330		
24	306	63	307		
25	259	64	442		
26	456	65	351		
27	339	66	378		
28	277	67	498		
29	403	68	320		
30	428	69	478		
31	298	70	295		
32	384	71	319		
33	391	72	423		
34	262	73	319		
35	527	74	349		
36	283	75	433		
37	306	76	283		
38	341	77	315		
39	390	78	379		
40	308	79	328		

T_B : Break-down time

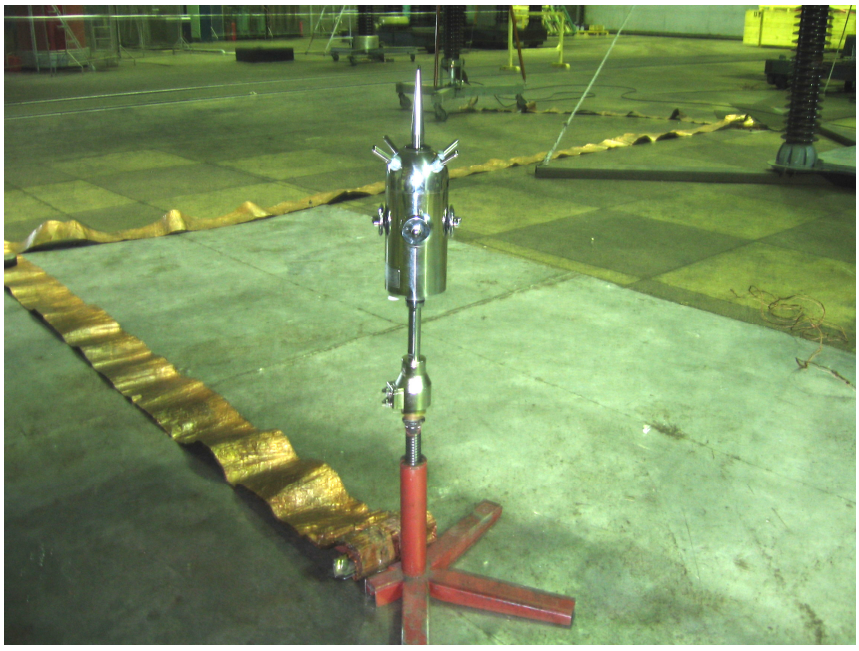
Test on ESELC type *FOREND – EU*

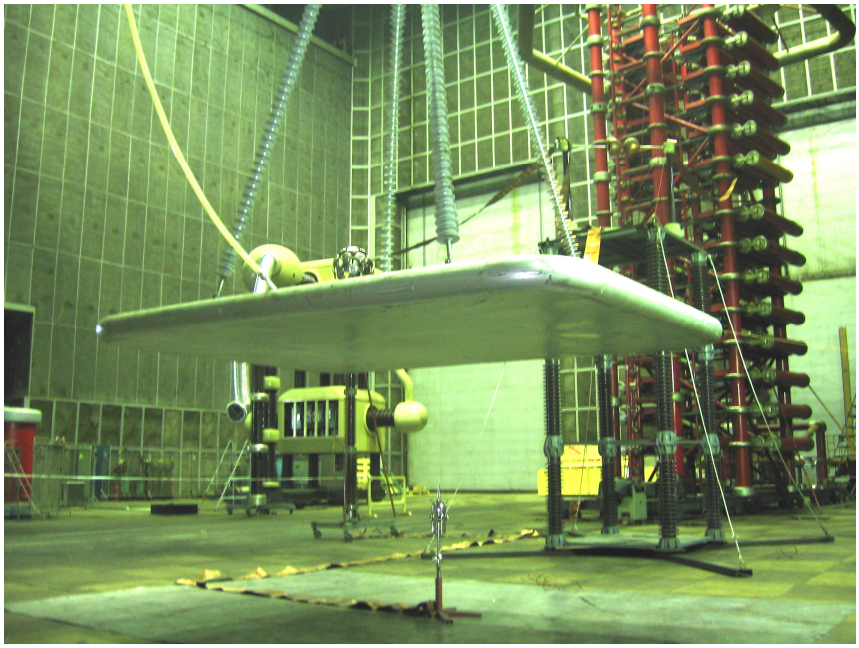
Impulse no.	T_B µs	Impulse no.	T_B µs	Impulse no.	T_B µs
1	329	41	373	80	353
2	275	42	311	81	381
3	416	43	289	82	283
4	271	44	320	83	309
5	388	45	389	84	336
6	330	46	266	85	453
7	400	47	328	86	243
8	331	48	397	87	361
9	395	49	274	88	283
10	283	50	316	89	291
11	390	Second	series	90	320
12	241	51	297	91	369
13	245	52	259	92	339
14	260	53	220	93	324
15	581	54	263	94	246
16	248	55	346	95	319
17	286	56	358	96	284
18	349	57	283	97	315
19	248	58	297	98	321
20	311	59	361	99	365
21	254	60	294	100	280
22	277	61	279		
23	390	62	296		
24	248	63	334		
25	340	64	393		
26	327	65	334		
27	238	66	326		
28	275	67	348		
29	389	68	308		
30	394	69	302		
31	348	70	380		
32	263	71	390		
33	420	72	366		
34	260	73	290		
35	328	74	301		
36	364	75	373		
37	297	76	301		
38	287	77	340		
39	357	78	300		
40	405	79	294		

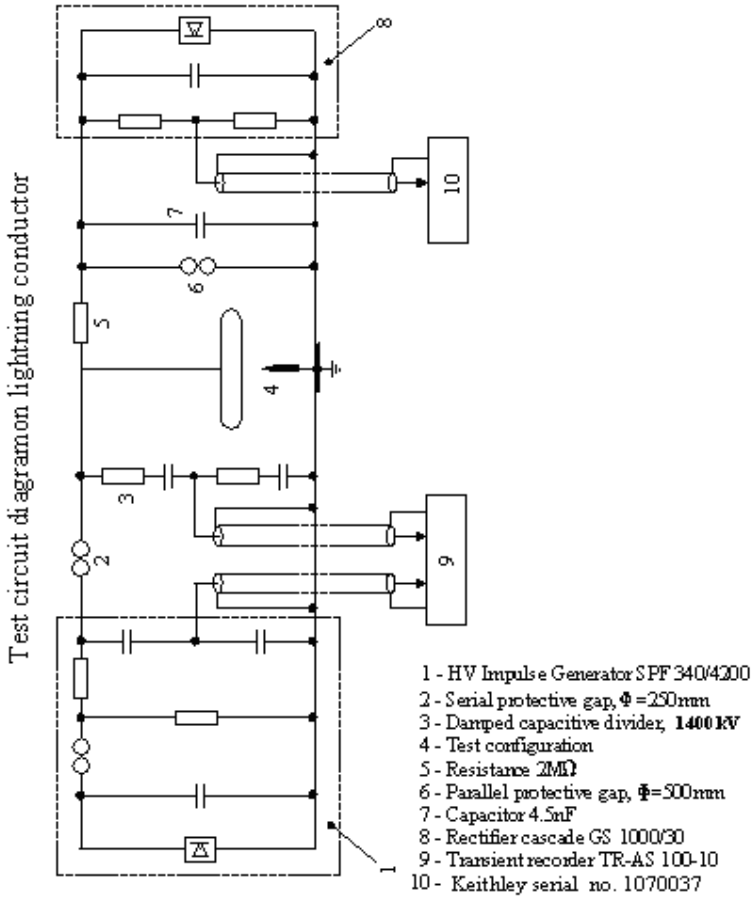
T_B : Break-down time

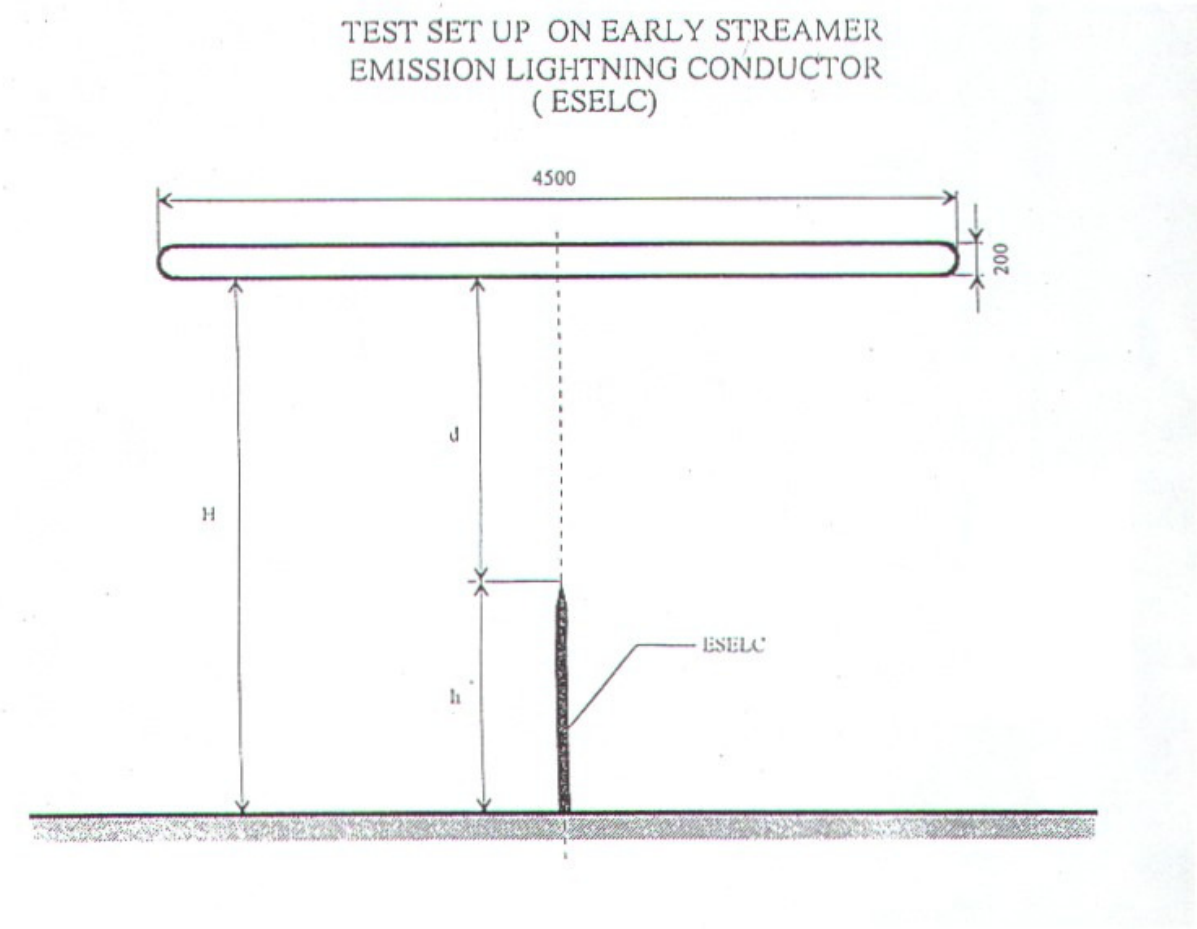


T'_{PTS} = 360.16 µs
T'_{PDA} = 322.66 µs
T_{PTS} = 439.91 µs
T_{PDA} = 376.21 µs
$\Delta T = T_{PTS} - T_{PDA}$ = 63.70 µs






Test circuit diagram on lightning conductor
1 - HV Impulse Generator SPF 340/4200
2 - Serial protective gap, Φ =250mm
3 - Damped capacitive divider, 1400 kV
4 - Test configuration
5 - Resistance 2MΩ
6 - Parallel protective gap, Φ=500mm
7 - Capacitor 4.5nF
8 - Rectifier cascade GS 1000/30
9 - Transient recorder TR-AS 100-10
10 - Keithley serial no. 1070037


TEST SET UP ON EARLY STREAMER
EMISSION LIGHTNING CONDUCTOR
(ESELC)
4500
200
d
H
h
ESELC