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RESEARCH DEVELOPMENT AND TESTING NATIONAL INSTITUTE FOR ELECTRICAL ENGINEERING

I C M E T CRAIOVA

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TEST REPORT
No. 43637 / 10.01.2013

1.CUSTOMER: SCHIRTEC AG
Ignaz – Köck Strasse 10 A – 1210 Wien, Austria

2.MANUFACTURER: SCHIRTEC AG
Ignaz – Köck Strasse 10 A – 1210 Wien, Austria

3. TESTED PRODUCT: Early Streamer Emission (E.S.E.) Lightning Conductor type
SCHIRTEC – A (S-A)

4. REFERENCE STANDARDS: NFC 17-102 : 2011, Annex C
UNE 21186 : 1996 / 1M: 2009, Anexo C

5. TEST PERFORMED: - Determination of the initiation advance of the E.S.E. lightning conductor

6. TEST DATE: 10.01.2013

7. TEST RESULTS: There are presented the measurements results.

8. The report contains: 14 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 DIVIZIA DE ÎNALTĂ TENSIUNE CRAIOVA

HEAD OF LABORATORY
Eng. BADEA Ion

1. *Results refer to the tested product only.*
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3. *All signatures of the present report are original ones.*

Content **page**

1. Identification of the test product:

Type: SCHIRTEC – A

Serial / year: - / -

Technical Specification / Drawing: - / SCH.101

Contract // Test order: 7946 / 20.09.2012 // 22016 / 03.10.2012

Product receiving date: 07.01.2013

Product condition at receiving: New

2. Test program: - Determination of the initiation advance of the E.S.E. lightning conductor

3. Responsible for test: Eng. M. Boruz

4. Opinions and interpretation (if necessary):

5. Present at the test:

1. Tested material

Early Streamer Emission (E.S.E.) Lightning Conductor type SCHIRTEC – A.
See photo on page 11 and drawing on page 13.

2. Type of tests

A switching impulse and a DC voltage both having negative polarity were applied on the upper metallic plane.

3. Specification

NFC 17-102 : 2011, Annex C
UNE 21186 : 1996 / 1M: 2009, Anexo C

4. Test equipment

Laboratory inner dimensions: 48 m x 32 m x 27 m (height)

Altitude:	100 m above sea 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
Keithley	Digital multimeter, serial no. 1070037 – USA.

5. Test circuit

See the test circuit diagram on page 12.
The measuring system consists of:

- 1400 kV damped capacitive divider, calibration certificate no. 223 / 2010-05 DKD – K – 18701;
- Transient recorder, TR-AS 100-10/4 calibration certificate no. 633 D – K – 15205-01-00 / 2012.05;
- DC measuring system that consists of DC resistive divider and digital multimeter type Keithley, calibration certificate no. 211 / 2010-06 DKD – K – 18701.

Expanded uncertainty of measurements parameter inside of limits, prescribed by IEC 60060 – 2 / 2010 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 tested lightning conductor is set 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 to the high voltage.

7. Test procedure

A DC voltage was applied on the upper square metallic plane for polarization.
The negative impulse wave was adjusted to obtain a flashover.
The height of the lightning conductor (h) and the distance between the ground and the square plane (H) were measured at the beginning of each test.
The atmospheric conditions were taken before and after each test.
The peak value (Up) of the impulses and the triggering time (T_B) were recorded for each impulse.
One hundred significant impulses were applied on the lightning conductor.
The early streamer emission lightning conductor (ESELC) was compared with a simple rod lightning conductor (SRLC).
Tests were performed in 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:	1203 mm
Distance between ground / square plane (H) adjusted to:	2450 mm
h / H:	0.491
Polarization voltage:	55 kV
Peak time / Rise time of the full wave:	475 µs / 246 µs
Time interval between consecutive impulses:	2 min

8. TEST ON SRLC BEFORE AND AFTER TEST OF ESELC type SCHIRTEC – A

8.1. Test date: 10.01.2013

8.2. Atmospheric conditions

	FIRST SERIES	SECOND SERIES
BEFORE TEST	p = 999 mb t = 11 ^{0}C hr = 62.6 %	p = 999 mb t = 10.5 ^{0}C hr = 62.9 %
AFTER TEST	p = 999 mb t = 10.9 ^{0}C hr = 62.4 %	p= 999 mb t = 10.4 ^{0}C hr = 63 %

8.3. Results

See tables from page 8

Number of significant impulses: 100

Average of significant T_B:

- calculated from the experimental wave T'_{PTS} = 320.5 μs Stdev: 19.81 %
- transferred on the reference waveform: T_{PTS} = 444.97 μs

See curves from page 10

9. TEST ON ESELC type SCHIRTEC – A

9.1. Reception date: 07.01.2013

9.2. Test date: 10.01.2013

9.3. Atmospheric conditions

BEFORE TEST	p = 999 mb t = 10.8 ^{0}C hr = 63.5 %
AFTER TEST	p= 999 mb t = 10.5 ^{0}C hr = 63.5 %

9.4. Results

See tables from page 9

Number of significant impulses: 100

Average of significant T_B:

- calculated from the experimental wave T'_{PDA}= 267.9 μs Stdev: 13.16 %
- transferred on the reference waveform: T_{PDA} = 379.39 μs

See curves from page 10

Measuring uncertainty for ΔT is 5.7 %.
The uncertainty stated is the 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: $\Delta T = T_{PTS} - T_{PDA}$ = 444.97 – 379.39 = 65.58 μs ± 3.7 μs

Test on SRLC before and after test on ESELC type SCHIRTEC – A

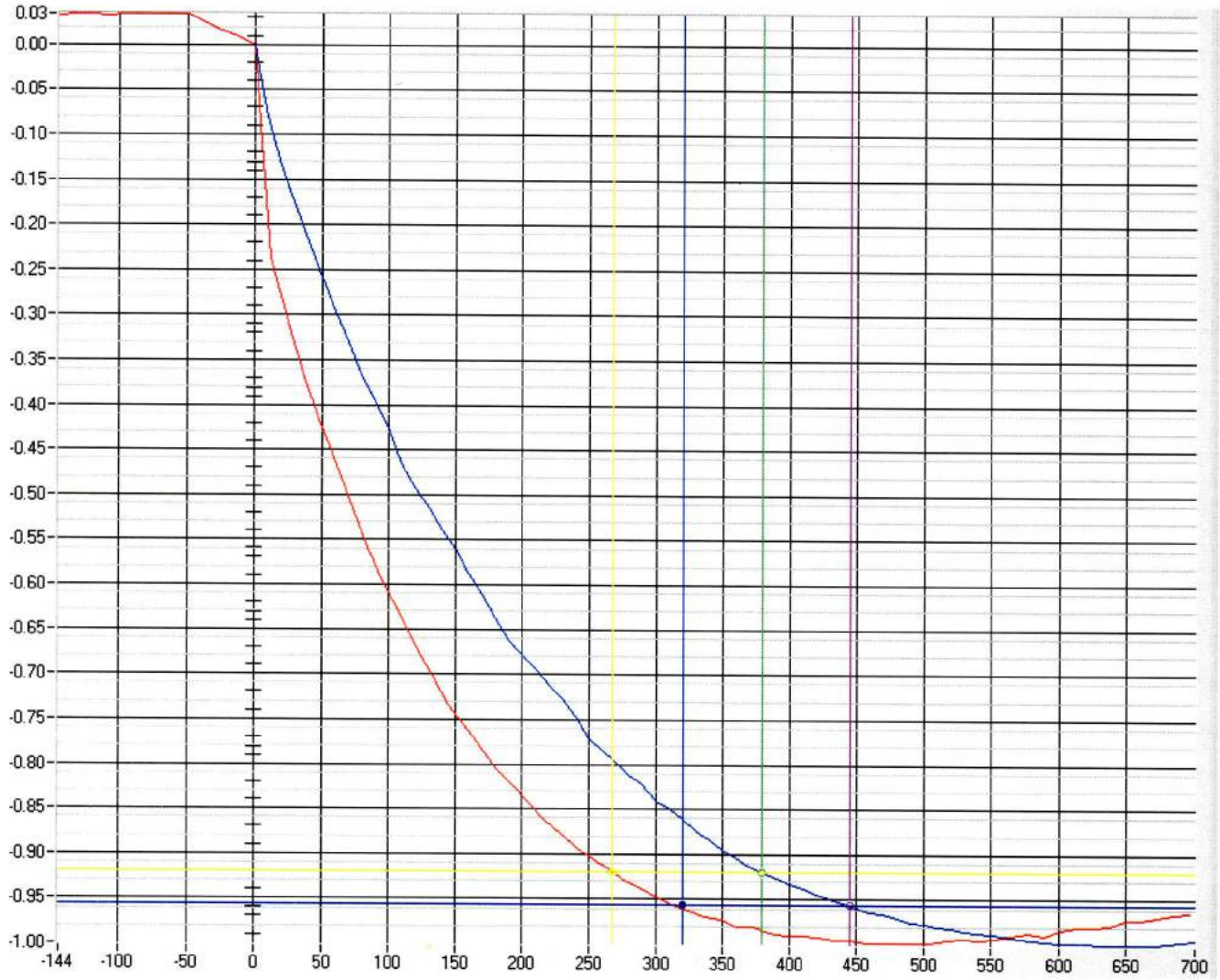
Impulse no.	T_B µs	Impulse no.	T_B µs	Impulse no.	T_B µs
1	381	41	353	80	282
2	298	42	273	81	287
3	364	43	318	82	384
4	279	44	309	83	268
5	454	45	290	84	377
6	342	46	369	85	318
7	264	47	297	86	301
8	247	48	344	87	320
9	340	49	271	88	330
10	416	50	288	89	327
11	250	Second	series	90	270
12	295	51	419	91	389
13	443	52	338	92	335
14	304	53	314	93	281
15	356	54	535	94	200
16	365	55	320	95	211
17	228	56	414	96	201
18	359	57	351	97	270
19	313	58	234	98	343
20	276	59	234	99	335
21	382	60	422	100	210
22	350	61	356		
23	280	62	331		
24	251	63	322		
25	357	64	282		
26	285	65	389		
27	286	66	330		
28	294	67	398		
29	292	68	497		
30	357	69	381		
31	477	70	278		
32	311	71	217		
33	320	72	257		
34	302	73	263		
35	295	74	314		
36	326	75	262		
37	357	76	254		
38	224	77	300		
39	298	78	349		
40	397	79	323		

T_B : Break-down time

Test on ESELC type SCHIRTEC – A

Impulse no.	T_B µs	Impulse no.	T_B µs	Impulse no.	T_B µs
1	275	41	216	80	238
2	301	42	275	81	242
3	306	43	218	82	234
4	235	44	281	83	250
5	295	45	291	84	238
6	265	46	356	85	230
7	290	47	294	86	225
8	345	48	225	87	235
9	270	49	252	88	241
10	312	50	328	89	276
11	219	Second	series	90	342
12	294	51	289	91	265
13	286	52	249	92	242
14	286	53	247	93	249
15	254	54	348	94	252
16	377	55	259	95	248
17	252	56	290	96	247
18	284	57	279	97	259
19	263	58	243	98	255
20	299	59	269	99	254
21	304	60	269	100	257
22	269	61	258		
23	361	62	286		
24	265	63	246		
25	342	64	251		
26	258	65	291		
27	239	66	264		
28	279	67	240		
29	319	68	257		
30	269	69	274		
31	244	70	252		
32	293	71	215		
33	271	72	212		
34	339	73	230		
35	242	74	218		
36	259	75	274		
37	233	76	245		
38	214	77	278		
39	222	78	290		
40	273	79	249		

T_B : Break-down time



Where:

- On OX axes there is represented time in μs;
- On OY axes there is represented amplitude U / U_{peak};
- Red line is the experimental wave form;
- Blue line represents the standard waveform.

T'_{PTS} = 320.5 μs
T'_{PDA} = 267.9 μs
T_{PTS} = 444.97 μs
T_{PDA} = 379.39 μs
$\Delta T = T_{PTS} - T_{PDA}$ = 65.58 μs

Photo 1

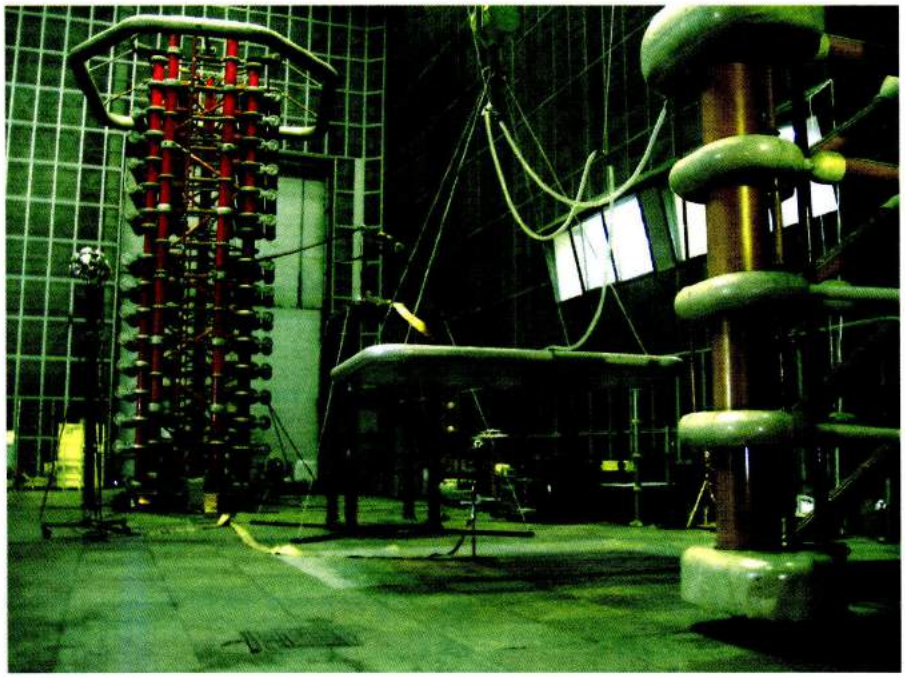
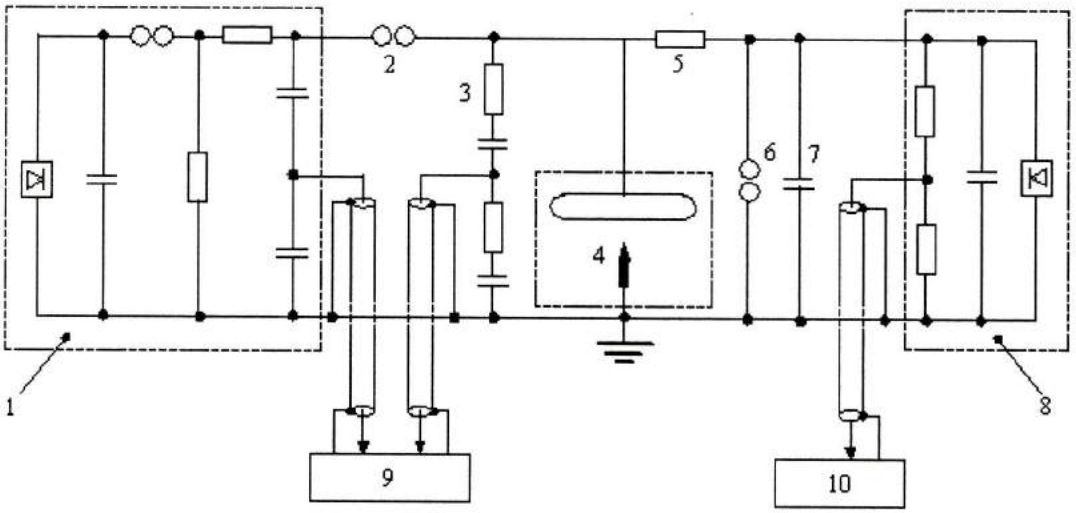


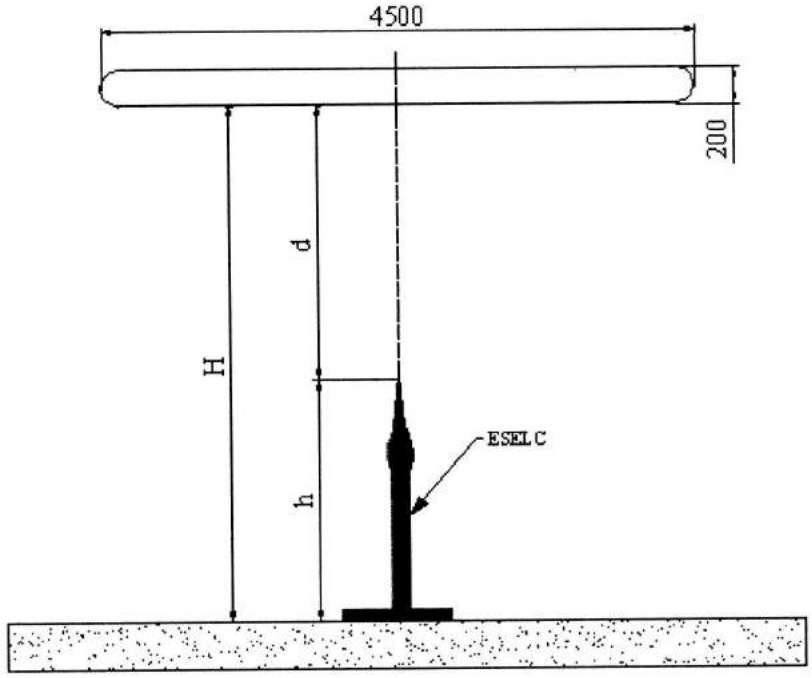
Photo 2

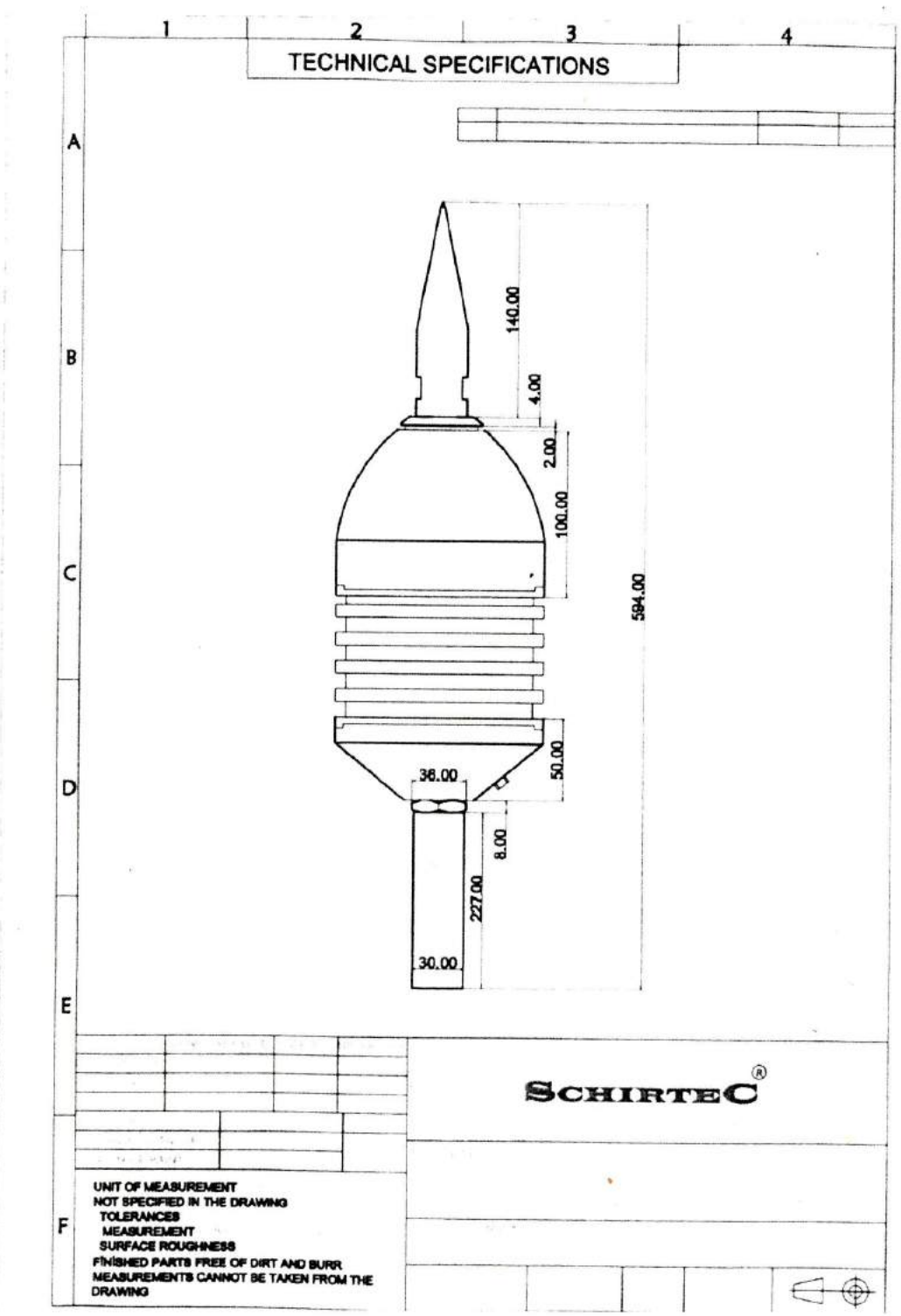
Test circuit diagram on lightning conductor



1 - HV Impulse Generator 4.2MV-336kWs
2 - Serial protective gap, ϕ=250mm
3 - Damped resistive-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 - Digital multimeter KETHLEY serial no.1070037

TEST SET UP ON EARLY STREAMER
EMISSION LIGHTNING CONDUCTOR

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2
3
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