STRI

TEKNISKT MEDDELANDE UTM12-472

Till	Avd	Datum	Projnr	Sida
Jerol Industri AB	R	2012-08-14	84646	1(1)
	Från, tfn Göran Olsson, 0240-795 32			
Kopior till				

Växelspänningsprov utförda på en kompositstolpe från Jerol Industri AB

1 Inledning

Detta meddelande sammanfattar innehållet i STRI-rapporten
T12-2092 AC withstand voltage tests on Jerol Distribution poles.

Kund: Jerol Industri AB, Box 62, SE-815 22 Tierp, Sverige.

Provperiod: 21 -22 maj 2012.

2 Provföremål

Toppdel av en Jerol Distribution Pole med diameter 219 mm.
Ritning: Jerol J 6072. Rev 1.

3 Växelspänningsprov enligt SS-EN 61057 och IEC 61057, avsnitt 8.5.1.1

Provsträckans längd	**Provspänning, provtid och maximal läckström**		
	Nivå 1	**Nivå 2**	**Nivå 3**
	142 kV. 1 min	**283 kV. 1 min**	**425 kV. 10 sek**
5 m	80 µA	140 µA	220 µA
4 m	80 µA	190 µA	330 µA
3 m	125 µA	270 µA	675 µA
	84 kV. 1 min	**168 kV. 1 min**	**283 kV. 10 sek**
2 m	80 µA	170 µA	290 µA

Högsta tillåtna läckström vid Nivå 1 och 2 är enligt standard är 1 µA/kV. För Nivå 3 finns inget krav, värdena ges här endast som information.

Detta prov avslutades med att hela sträckan på 5 m delades i 8 st 600 mm långa sektioner och provades med 80 kV växelspänning under 1 minut. Inget överslag inträffade och maximal läckström översteg ej 150 µA.

4 Växelspänningsprov med regn enligt SS-EN 61057 och IEC 61057, avsnitt 8.2

Tre st 1 m långa sektioner monterade i 45 ° vinkel provades med 80 kV växelspänning i regn och under 60 minuter.

Vid proven skedde inget elektriskt överslag och inte heller kunde någon påtaglig temperaturökning uppmätas hos de tre provföremålen.

STRI

TEST REPORT issued by an Accredited Testing Laboratory

SWEDAC ACKREDITERING 1534 ISO/IEC 17025

STRI Project no.	Report No.	Page
84646	**T12-2092**	1 (24)

Title of the report	**AC withstand voltage tests on Jerol Distribution poles**
Customer	Jerol Industri AB, Box 62, SE-815 22 Tierp, Sweden
Test object	Top section of a Jerol Distribution Composite Pole, Diameter 219 mm
Test period	21 – 22 May 2012
Tests	Dry power frequency withstand voltage test at 425 kV_{rms} and 252 kV_{rms}, 50 Hz, 1 minute, with measurement of leakage current. Wet power frequency withstand voltage test, level 80 kV_{rms}, 50 Hz, 60 minutes.
Standards/ Specifications	IEC 60060-1, 1989, IEC 61057, 1991 and SS-EN 61057, 1994.
Test result	The test object fulfilled the requirements for a test at dry conditions in accordance with the standards for a tested length of minimum 3 meters at 245 kV system voltage and for a minimum length of 2 m at 145 kV system voltage. The test objects also fulfilled the requirements for a wet test with 80 kV during 1 hour applied to a test section of 1 m. No flashover occurred. No tracking, cracking or treeing on the external coating. No visible erosion. The measured leakage current levels were all under the specified limits.
Scope of accreditation	See clause 2 in this report.

Ludvika 6 July 2012

STRI AB
Testing

Dan Windmar
Manager High Voltage Technology and Testing

Igor Djurdjevic
Test Engineer

1.3

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Table of Contents

1 Test object

Test object:	Jerol Distribution Poles, Top Section	
Type:	Top section of Jerol N to Jerol S, Diameter 219 mm	
Dimension drawing:	J 6072	Rev. 1

2 Tests

The tests were performed in the sequence below.

- Dry power frequency withstand voltage test, with measurement of leakage current.
- Wet power frequency withstand voltage test.

The laboratory is accredited (no: 1534) by SWEDAC.

Measurement uncertainties (valid for tests covered by the STRI accreditation) are included in clause 8.

2.1 Dry power frequency withstand voltage test

Standard reference: SS-EN 61057 and IEC 61057, cl 8.5.1.1.

The procedure for this test is based on the specification for the test on an insulating boom used for live working. The test levels are based on the maximum operating voltage line to ground (U_d) for the boom. In this case tests were performed for 245 kV and 145 kV system voltage, corresponding to 142 kV and 84 kV line to ground voltages respectively. The specified test procedure consists of tests at three voltage levels:

1 minute at 1 x U_d
1 minute at 2 x U_d
10 sec at 3 x U_d

Measurement of leakage current shall be performed at the two first levels. The maximum allowed current is 1 μA per kV test voltage.

The test was performed on a vertically mounted Jerol distribution pole. The first test was, for 245 kV, performed with the electrodes set up such that the pole length was 5 metres. The test was repeated with the electrodes adjusted so that the effective length of the distribution pole was decreased to 4 metres and subsequently to 3 metres. Finally, a test for 145 kV was performed on a 2 m long section.

The leakage current measurement results are presented in section 6.1

Tests for 245 kV system voltage, corresponding to 142 kV phase to ground.

Distribution pole length (m)	Test level	Test voltage (kV_{rms})	Maximum leakage current (µA)	Time (seconds)	Remarks
5	1	142	80	60	Withstood
5	2	283	140	60	Withstood
5	3	425	(220)	10	Withstood
4	1	142	80	60	Withstood
4	2	283	190	60	Withstood
4	3	425	(330)	10	Withstood
3	1	142	125	60	Withstood
3	2	283	270	60	Withstood
3	3	425	(675)	10	Withstood

Requirement: Maximum leakage for current for test level 1 and 2 is 1 µA per kV test voltage. Values for level 3 are given for information purpose only.

Tests for 145 kV system voltage, corresponding to 84 kV phase to ground.

Distribution pole length (m)	Test level	Test voltage (kV_{rms})	Maximum leakage current (µA)	Time (seconds)	Remarks
2	1	84	80	60	Withstood
2	2	168	170	60	Withstood
2	3	283	(290)	10	Withstood

Requirement: Maximum leakage current for test level 1 and 2 is 1 µA per kV test voltage. Values for level 3 are given for information purpose only.

Following these tests the entire 5 metre distribution pole was tested, segment by segment, with the segment length of 600 mm. This resulted in 8 sections being tested at 80 kV_{rms}. The leakage current was measured at each segment during the withstand test. The withstand test lasted 1 minute per segment. Each of the segments withstood the test without flashover and with a maximum leakage current of < 150 µA.
The leakage current measurement results are presented in section 6.2.

No flashover occurred and the leakage current levels are all below the specified limits.

The test object fulfilled the requirements in accordance with the standards for a tested length of minimum 3 meters at 245 kV system voltage and for a minimum length of 2 m at 145 kV system voltage.

2.2 Wet power frequency withstand voltage test

Standard reference: SS-EN 61057 and IEC 61057, cl 8.2.

The test was performed with 3 samples of distribution poles. The distribution poles were 1 metre in length. The distribution poles were mounted at a 45 degree angle and precipitation was sprayed onto them. Temperature measurements were taken on the surface of the distribution pole at 3 different locations (close to the high voltage electrode, in the middle of the distribution pole and close to the earth electrode), immediately after the 60 minute withstand test.

Test level: 80 kV_{rms}, 50 Hz, 60 minutes.

Results:

Test voltage kV_{rms}	Time (min)	Sample number	Temp. at HV electrode	Temp. in middle	Temp. at earth	Remarks
80	60	1	21,0	20,8	20,8	Withstood
80	60	2	22,0	21,8	21,8	Withstood
80	60	3	20,8	20,8	20,6	Withstood

The ambient temperature during testing was 20,3 ºC.

The test object fulfilled the requirements in accordance with the standards.
No flashover occurred.

Precipitation rate during the test:

Vertical component: 1.1 mm/min
Horizontal component: 1.0 mm/min

Resistivity: 99 Ωm

3 Atmospheric conditions and correction factors

Correction factors for external insulation calculated according to:
IEC 60060-1:1989 cl. 11.

Correction factor for the air density: k_1
Correction factor for the humidity: k_2
Correction factor for dry tests: $K_t=k_1*k_2$
Correction factor for wet tests: $K_t=k_1$

Dry power frequency withstand voltage test
The voltage used for the calculations: 425 kV.
Arcing distance used for the calculations: 5000 mm.

The atmospheric conditions during the test:

t=20,3°C	b=1002 mbar	h=4.73 g/m^3
k_1=1.00	k_2=1.00	K_t=1.00

The voltage used for the calculations: 425 kV.
Arcing distance used for the calculations: 4000 mm.

The atmospheric conditions during the test:

t=20,3°C	b=1002 mbar	h=4.73 g/m^3
k_1=1.00	k_2=1.00	K_t=1.00

The voltage used for the calculations: 425 kV.
Arcing distance used for the calculations: 3000 mm.

The atmospheric conditions during the test:

t=20,3°C	b=1002 mbar	h=4.73 g/m^3
k_1=1.00	k_2=0.99	K_t=0.99

The voltage used for the calculations: 252 kV.
Arcing distance used for the calculations: 2000 mm.

The atmospheric conditions during the test:

t=20,3°C	b=1002 mbar	h=4.73 g/m^3
k_1=1.00	k_2=0.99	K_t=0.99

Wet power frequency withstand voltage test
The voltage used for the calculations: 80 kV.
Arcing distance used for the calculations: 1000 mm.

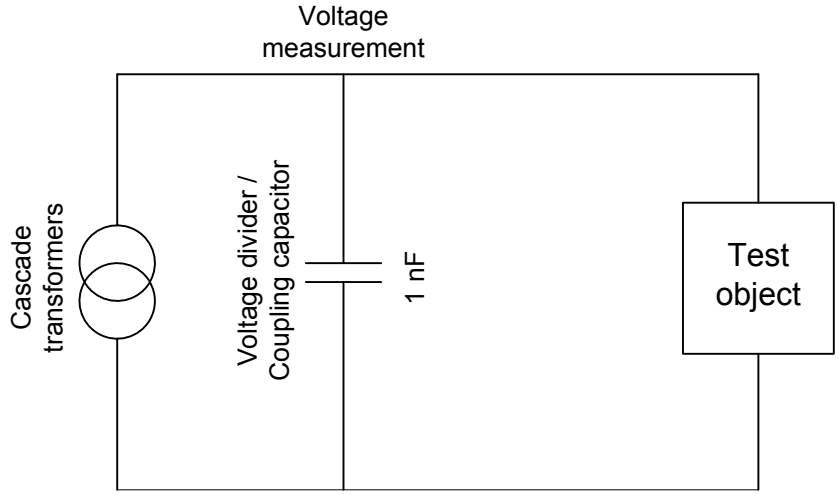
The atmospheric conditions during the test:

t=20,3°C	b=1002 mbar	h=4.73 g/m^3
k_1=1.00	k_2=1.00	K_t= k_1=1.00

K_t=1.00 applied in all the tests.

4 Test circuit

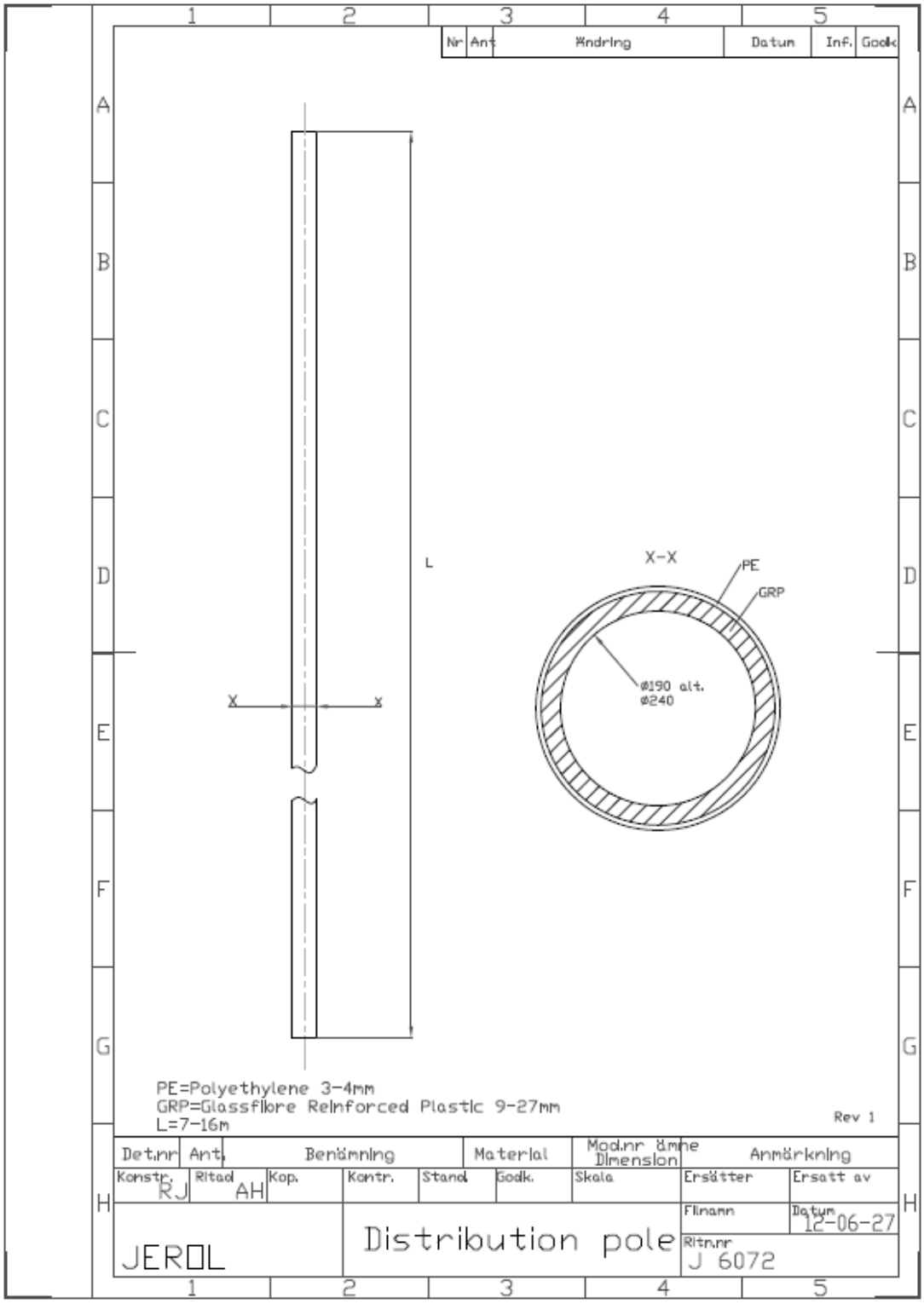
4.1 Dry and wet power frequency withstand voltage test



Equipment:

ABB 550 kV test transformer, serial number 7853 048.
Haefely coupling capacitor/voltage divider, KK 600.
IMC leakage current measurement system, T-258.
Control desk 2.

5 Dimension drawing

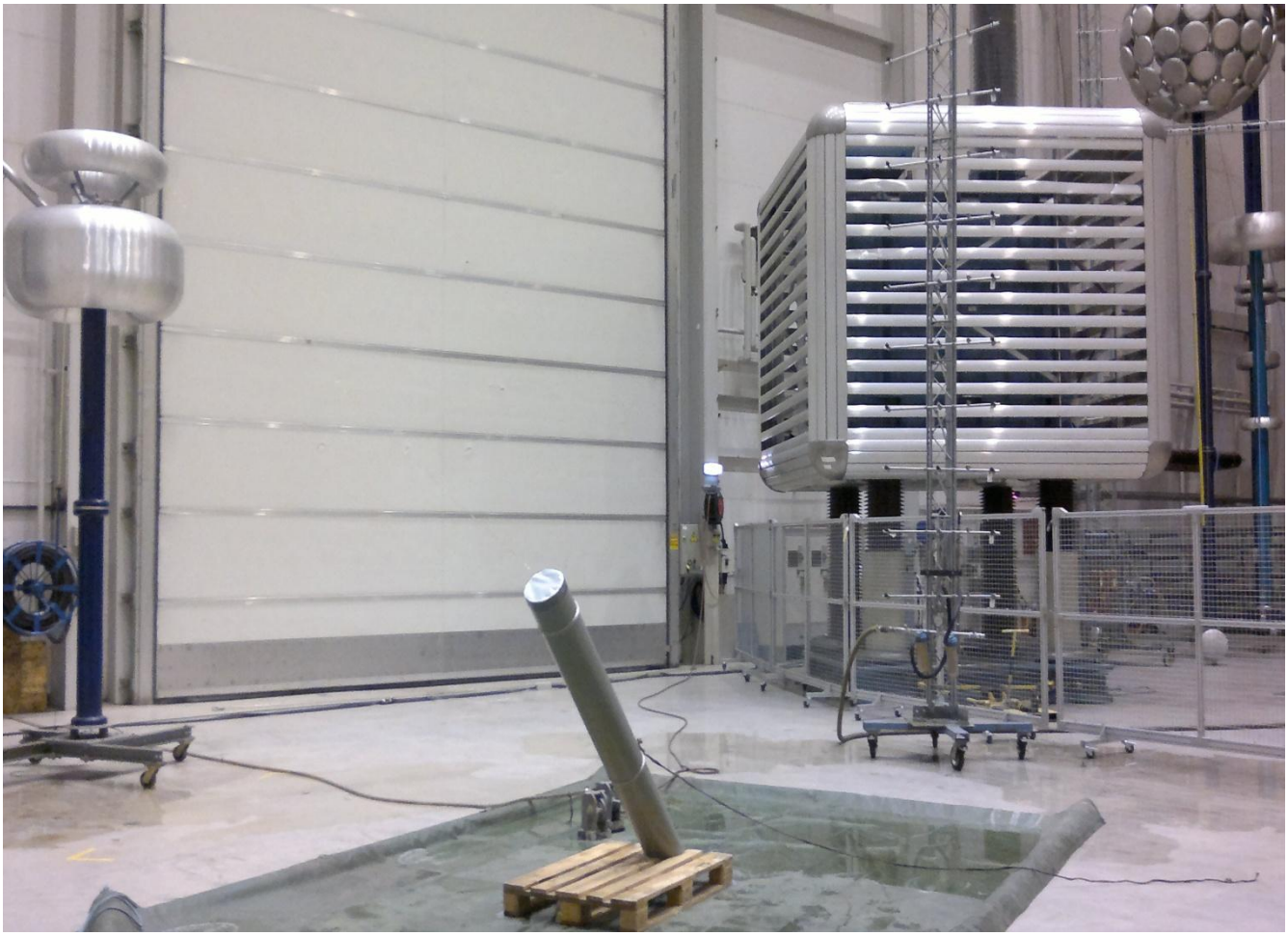


6 Photos of the test object during testing

5 metre section dry test

Dry AC withstand test of one 600 mm section

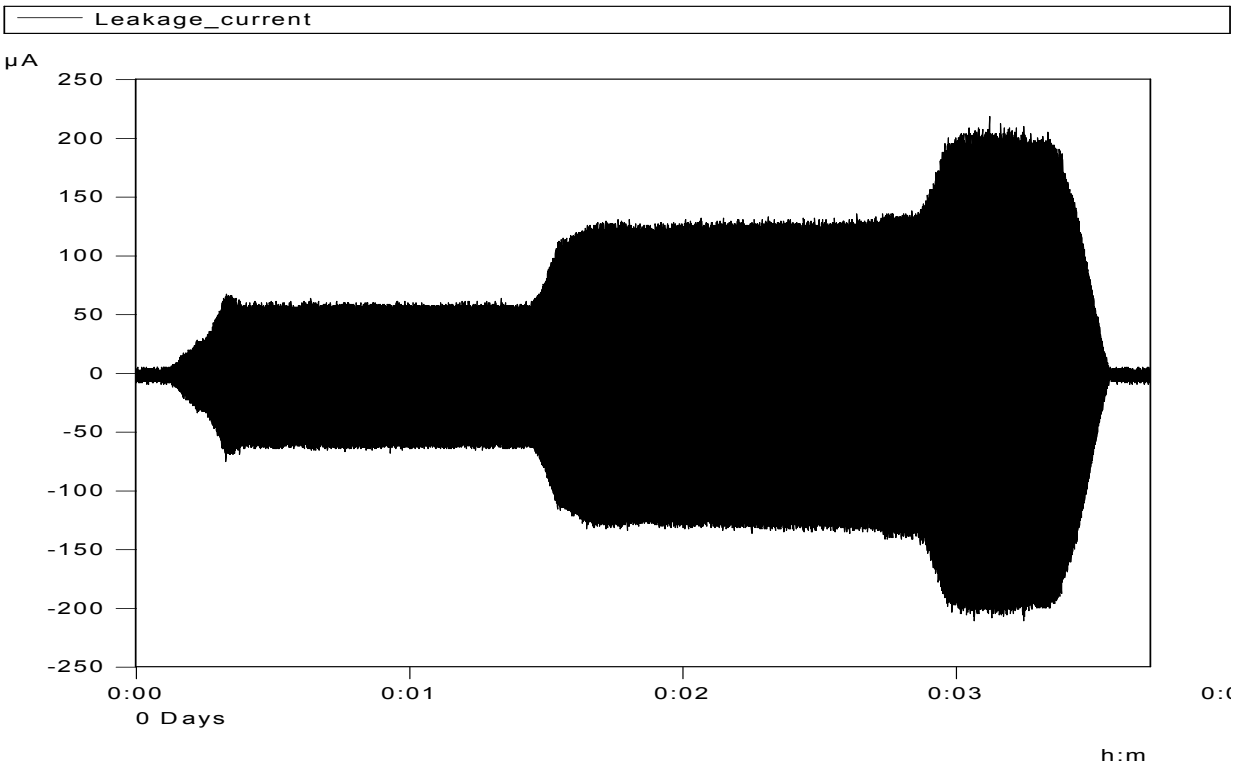
Wet AC withstand test of a 1 metre inclined section

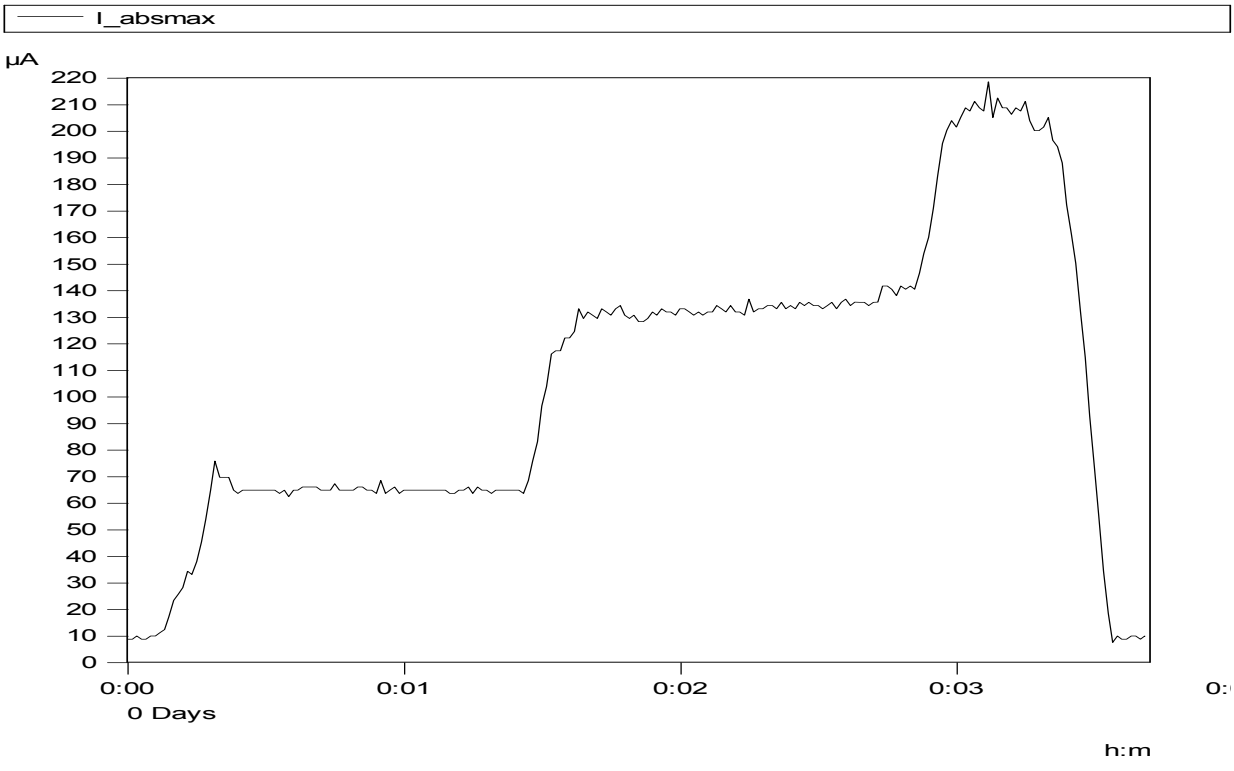


7 Leakage current measurement graphs

7.1 Leakage current measurement of vertically tested poles under dry AC voltage

The results are displayed firstly as current change over time and secondly as an absolute value of the current over time.





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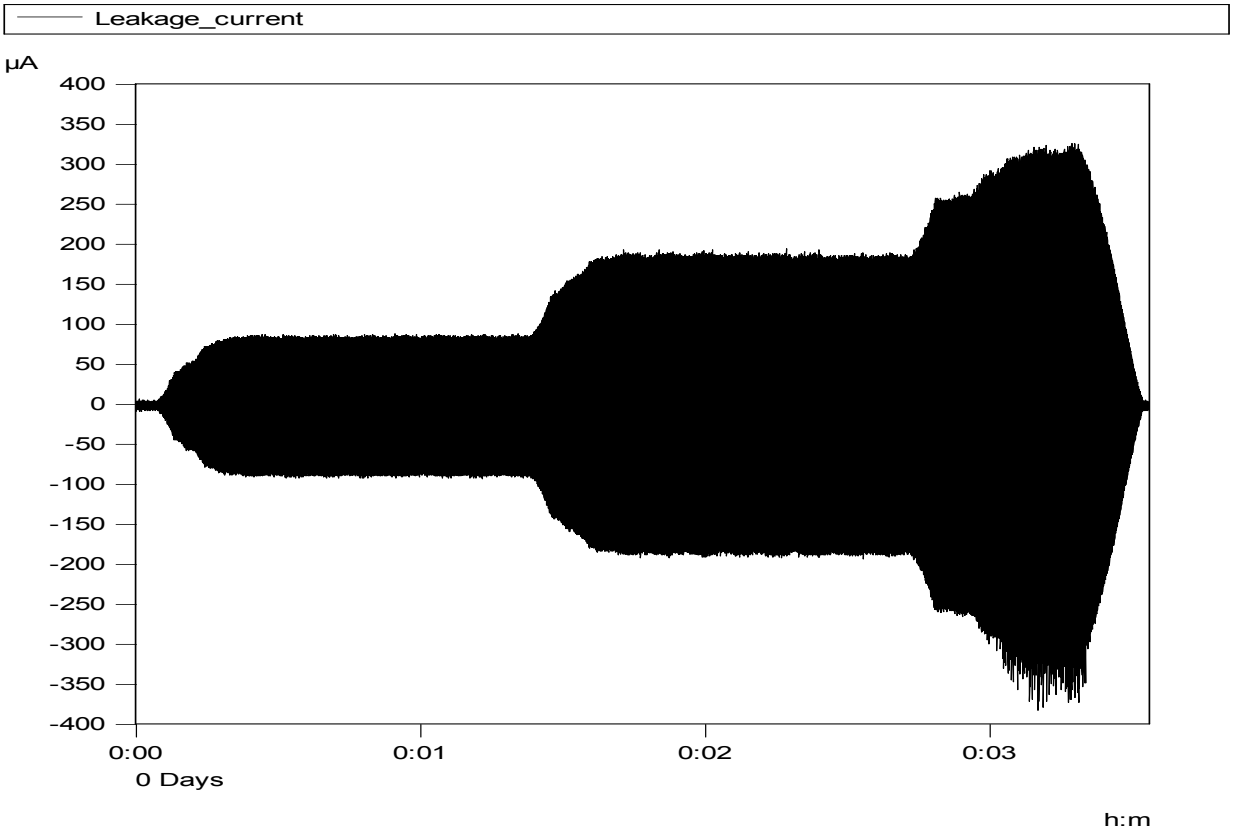
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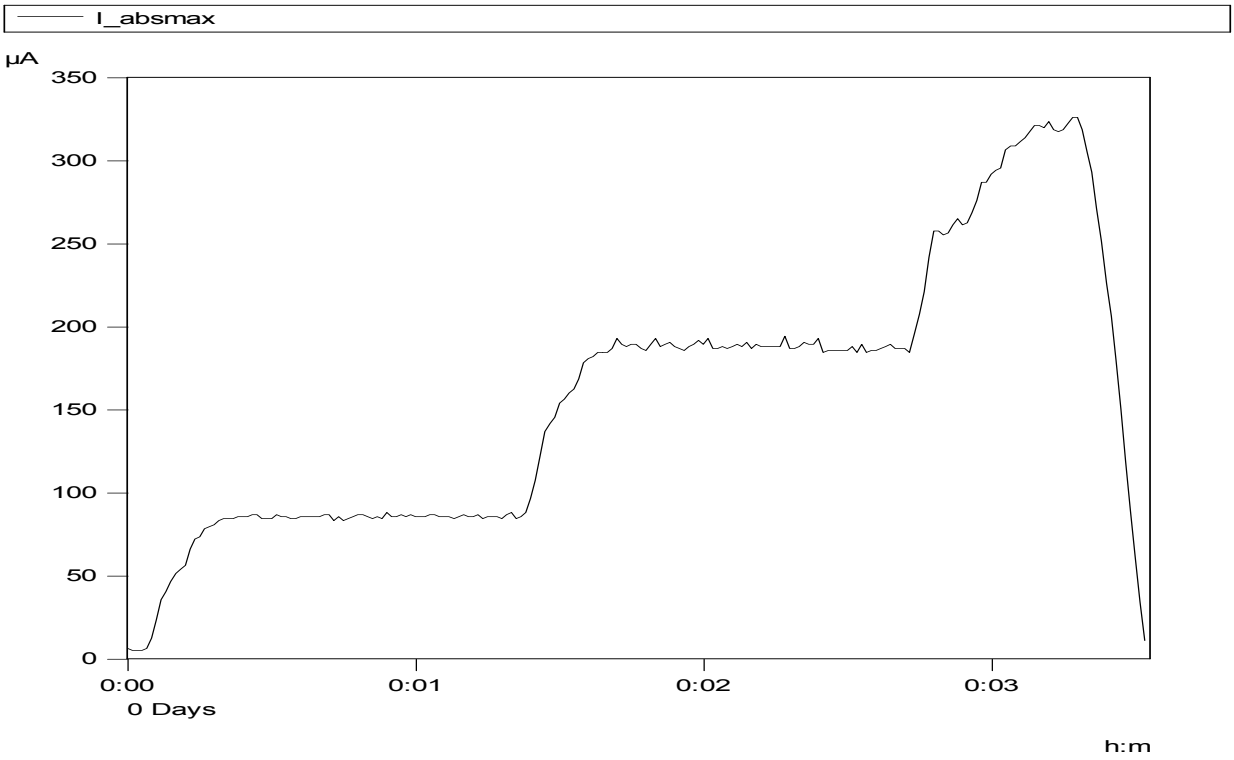
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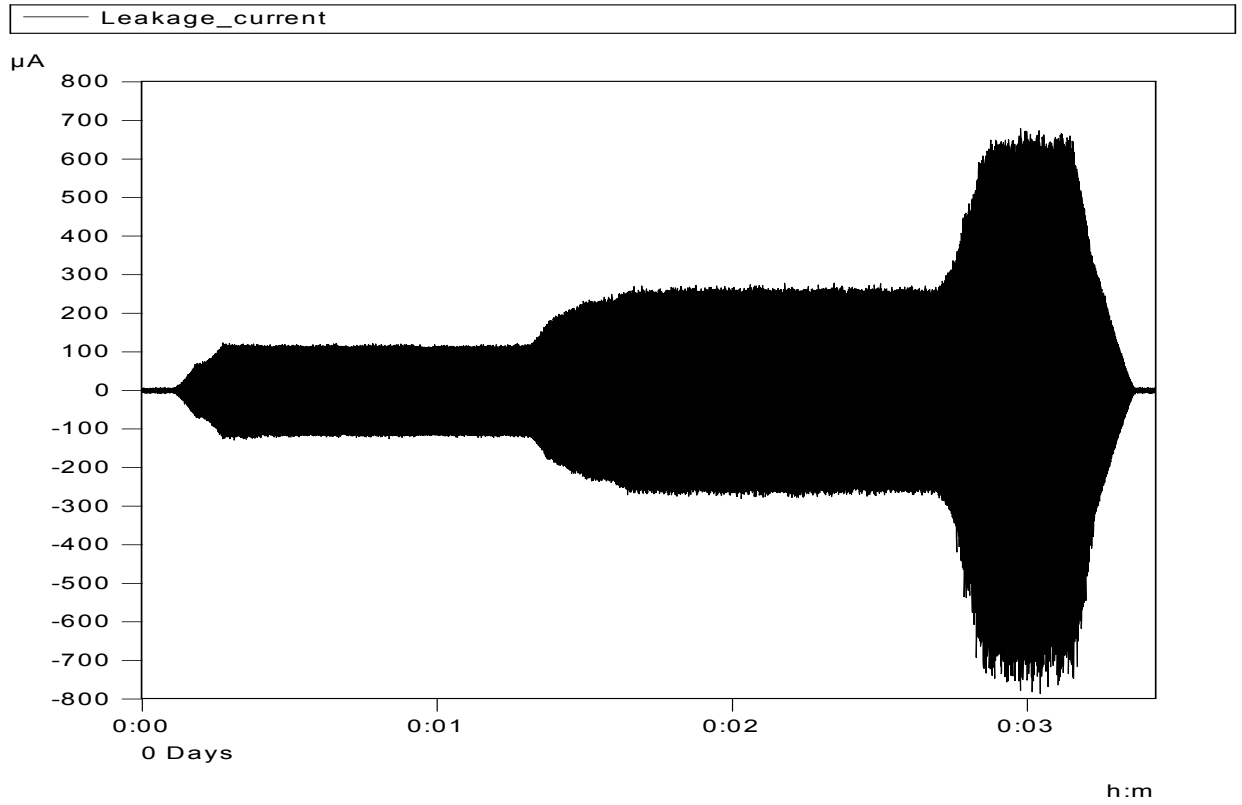
4 metres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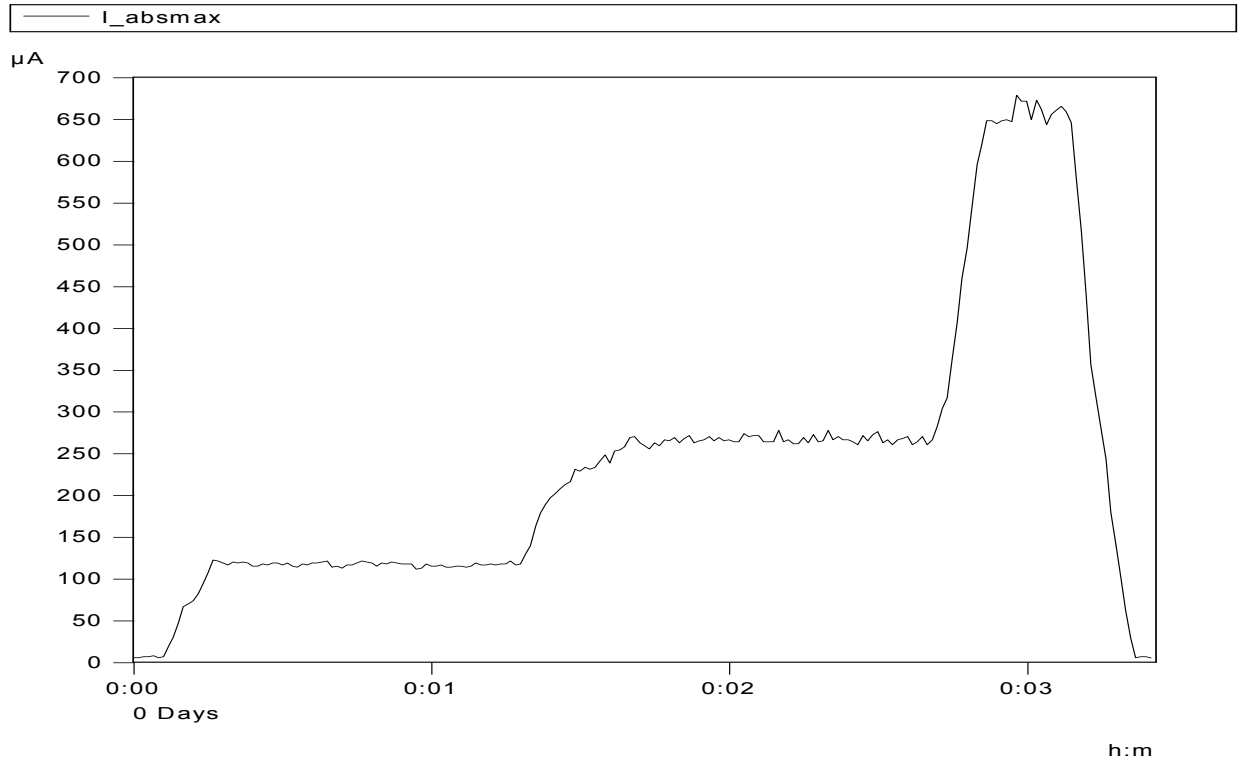
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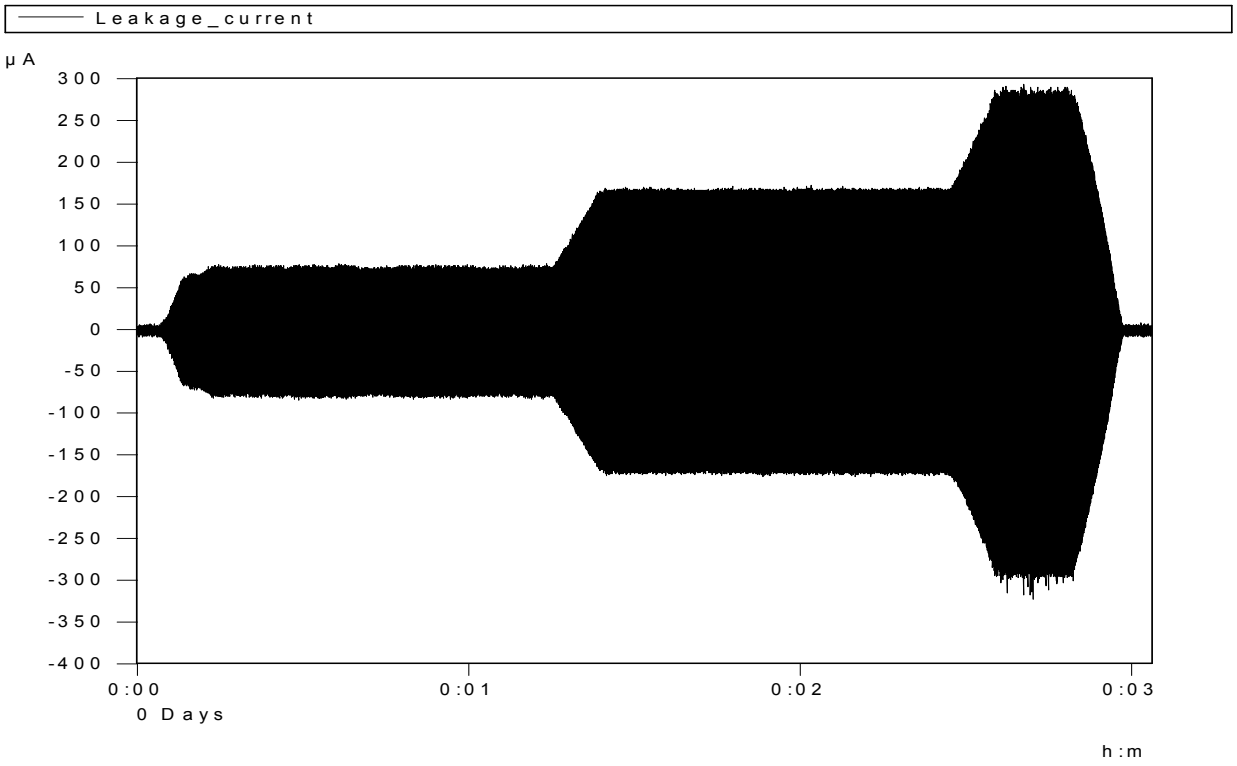
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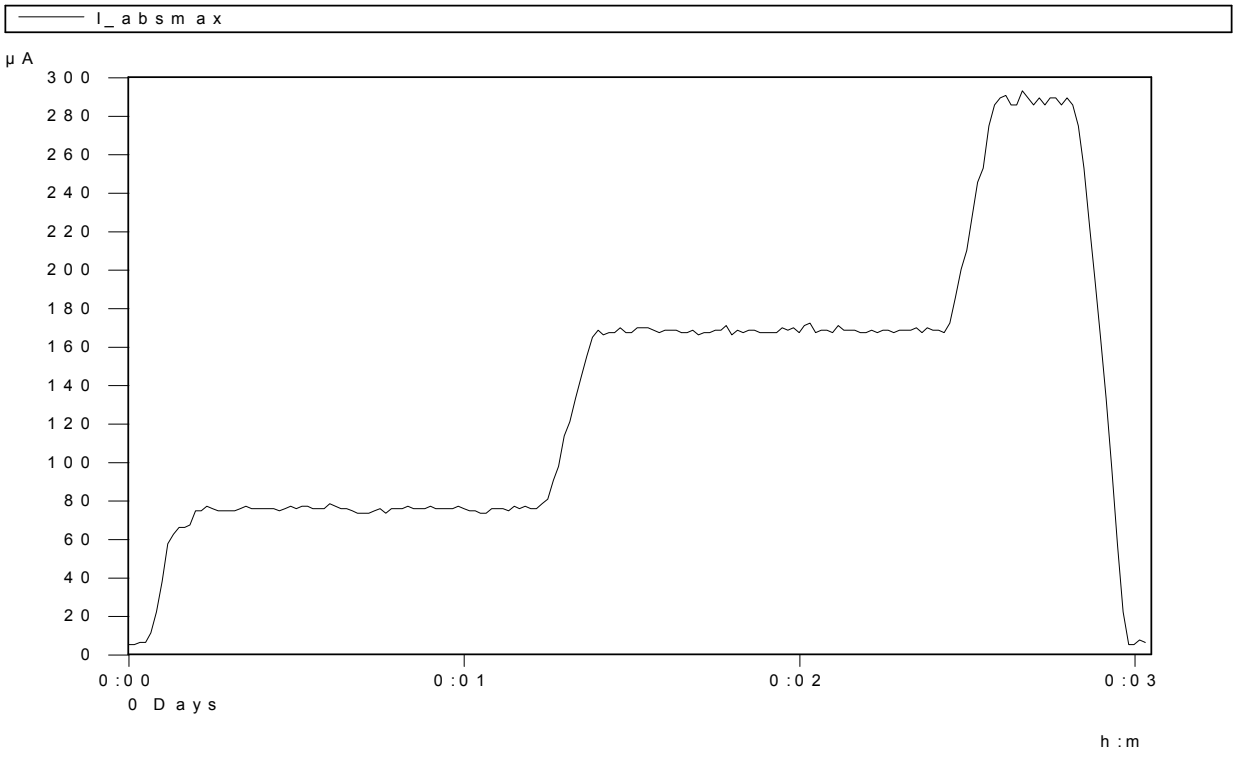
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2 metres

7.2 Leakage current measurement of 600 mm sections

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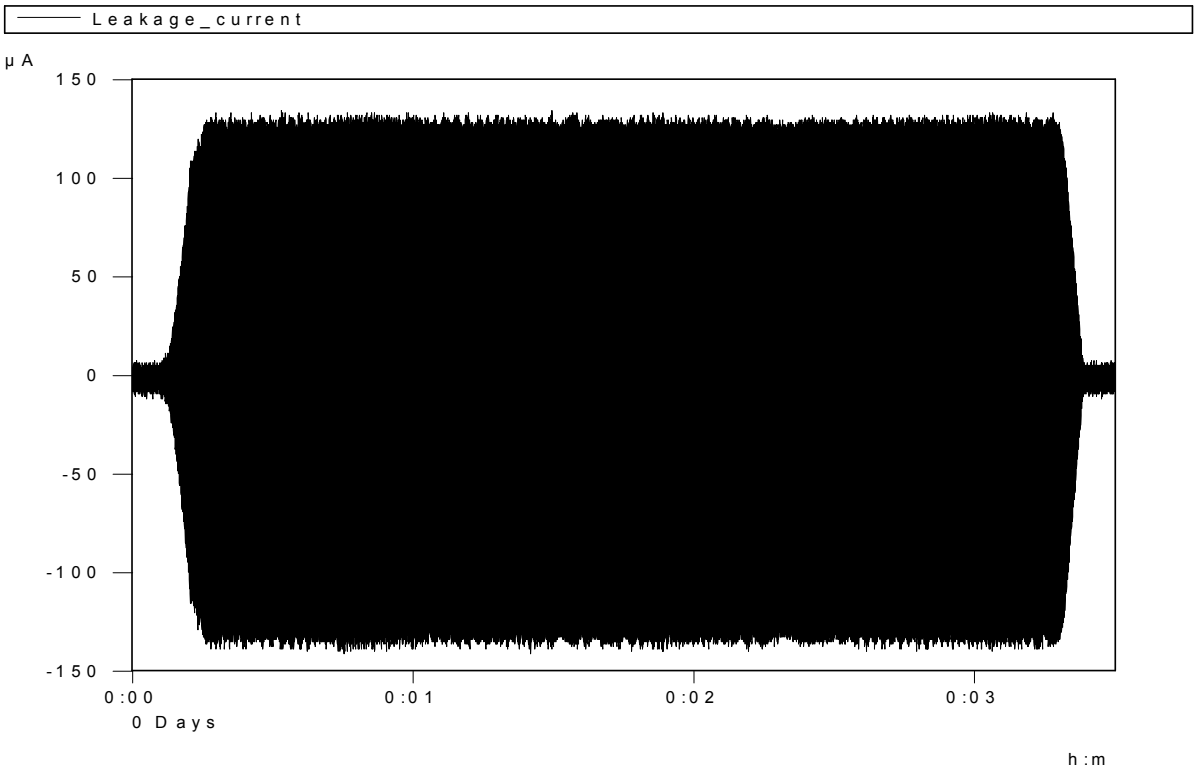

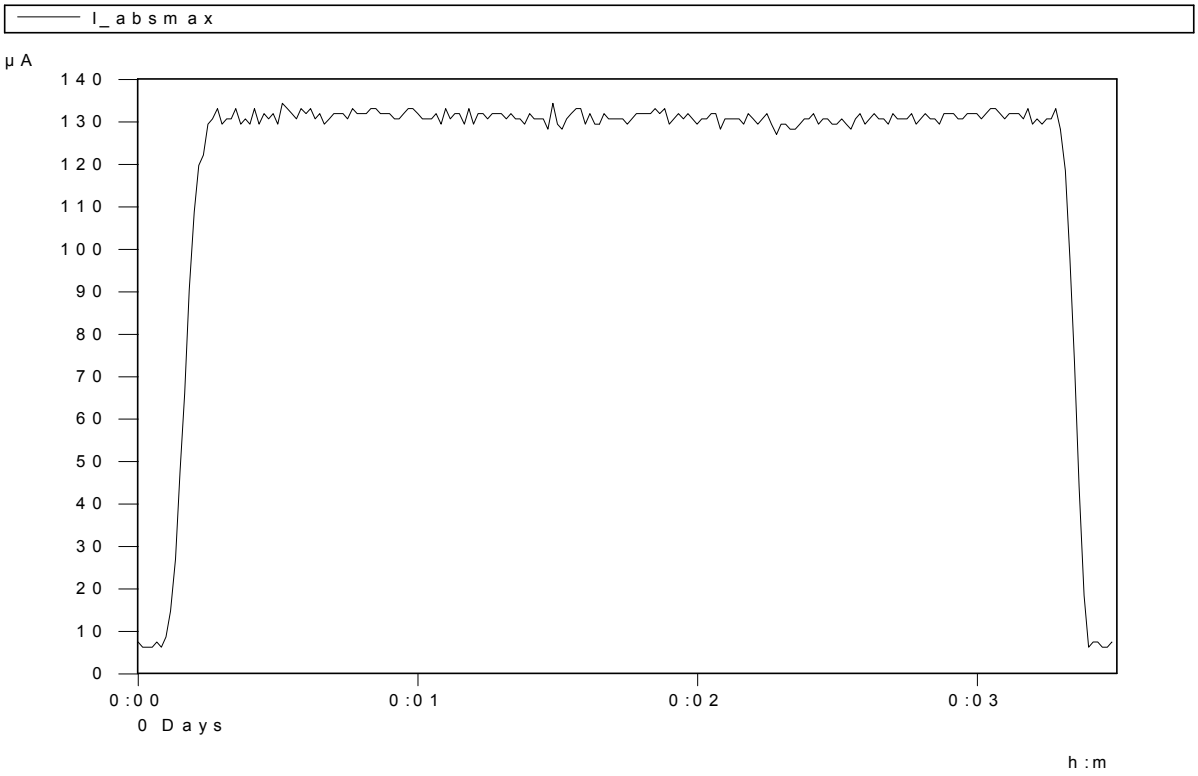

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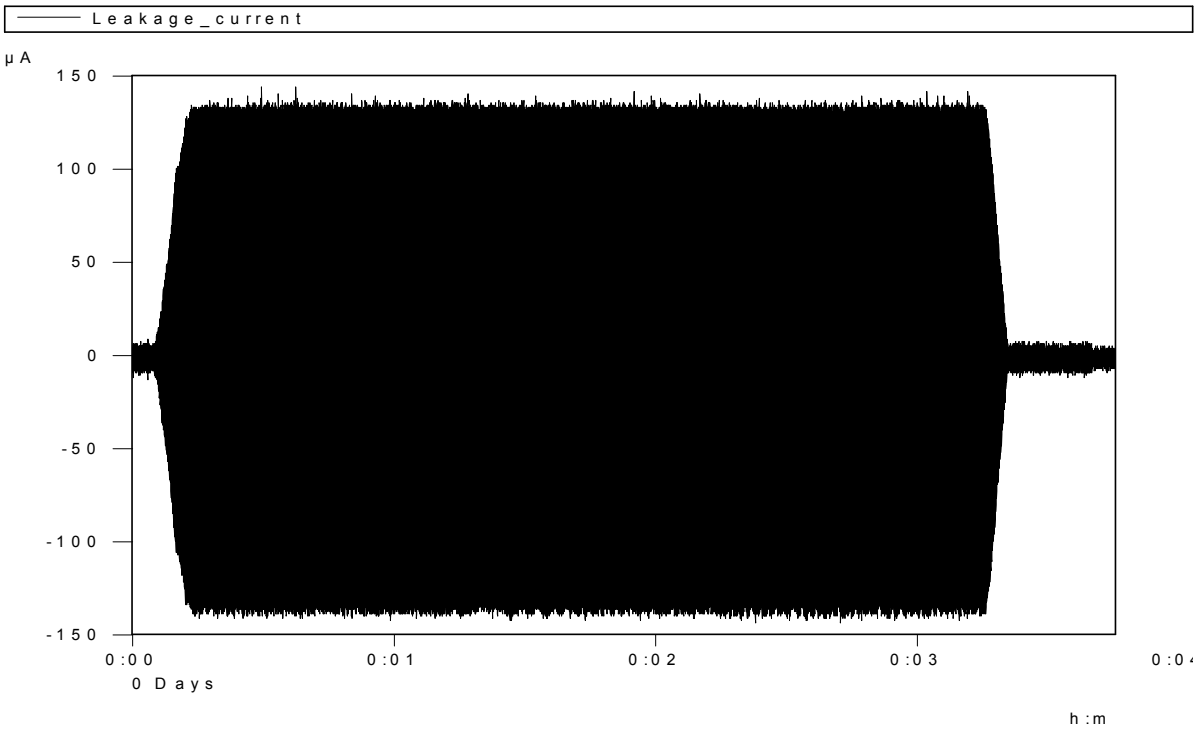
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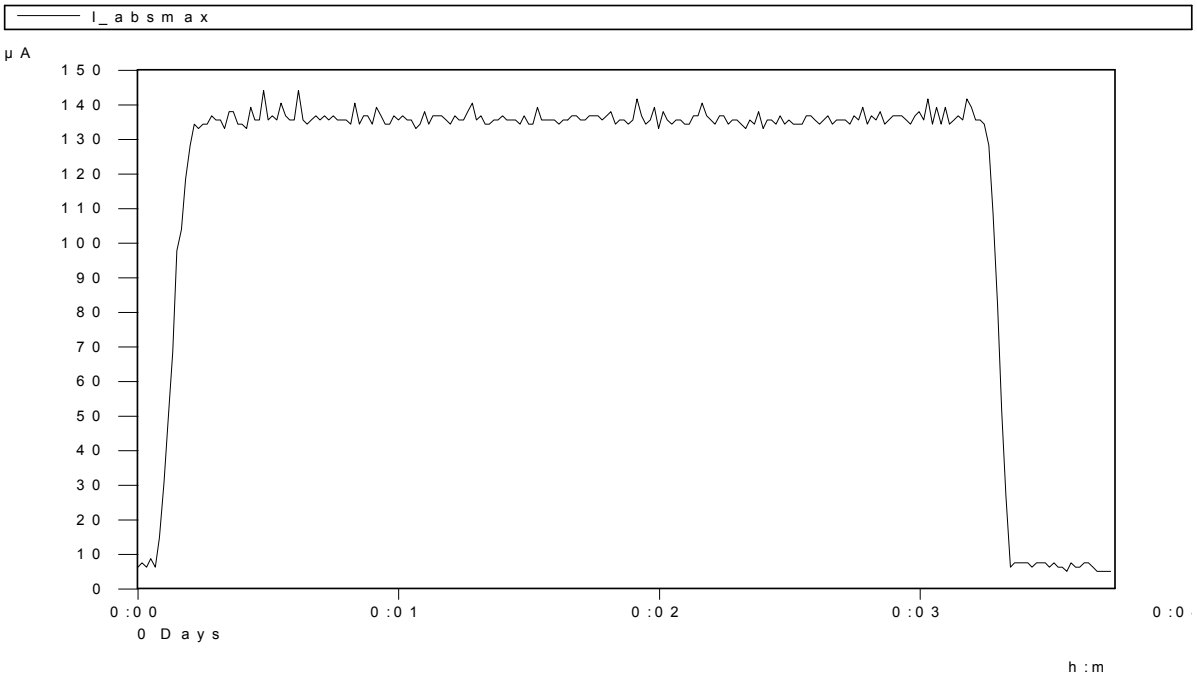
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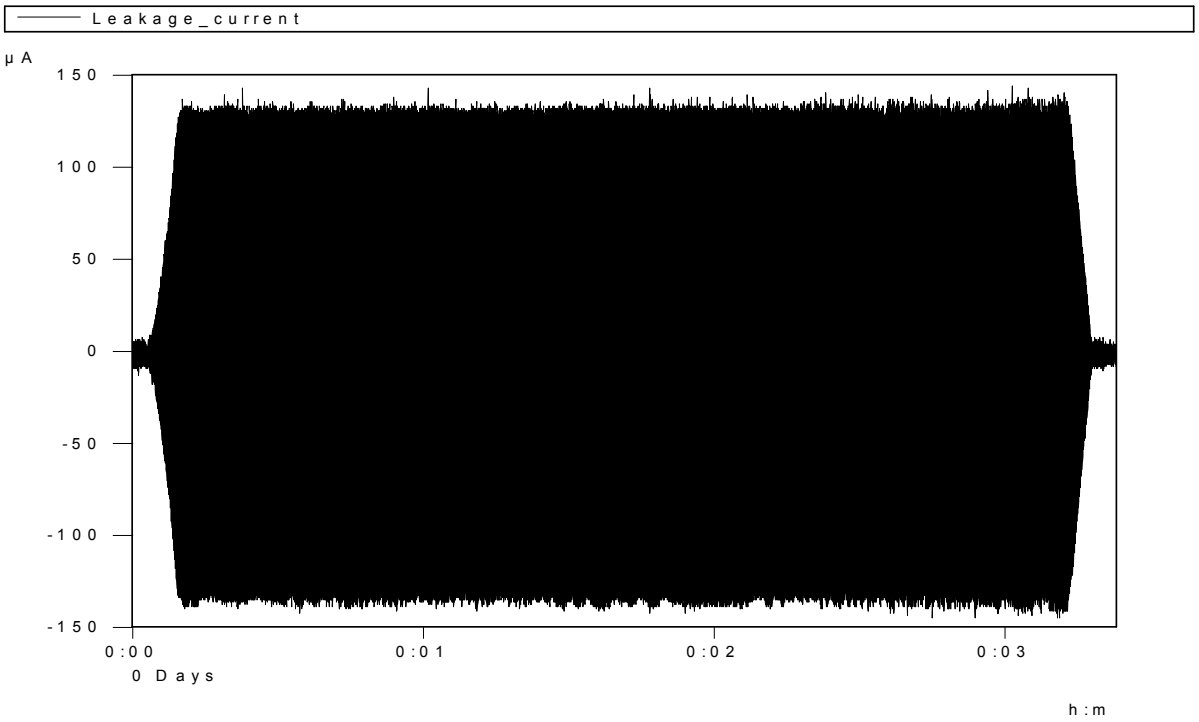
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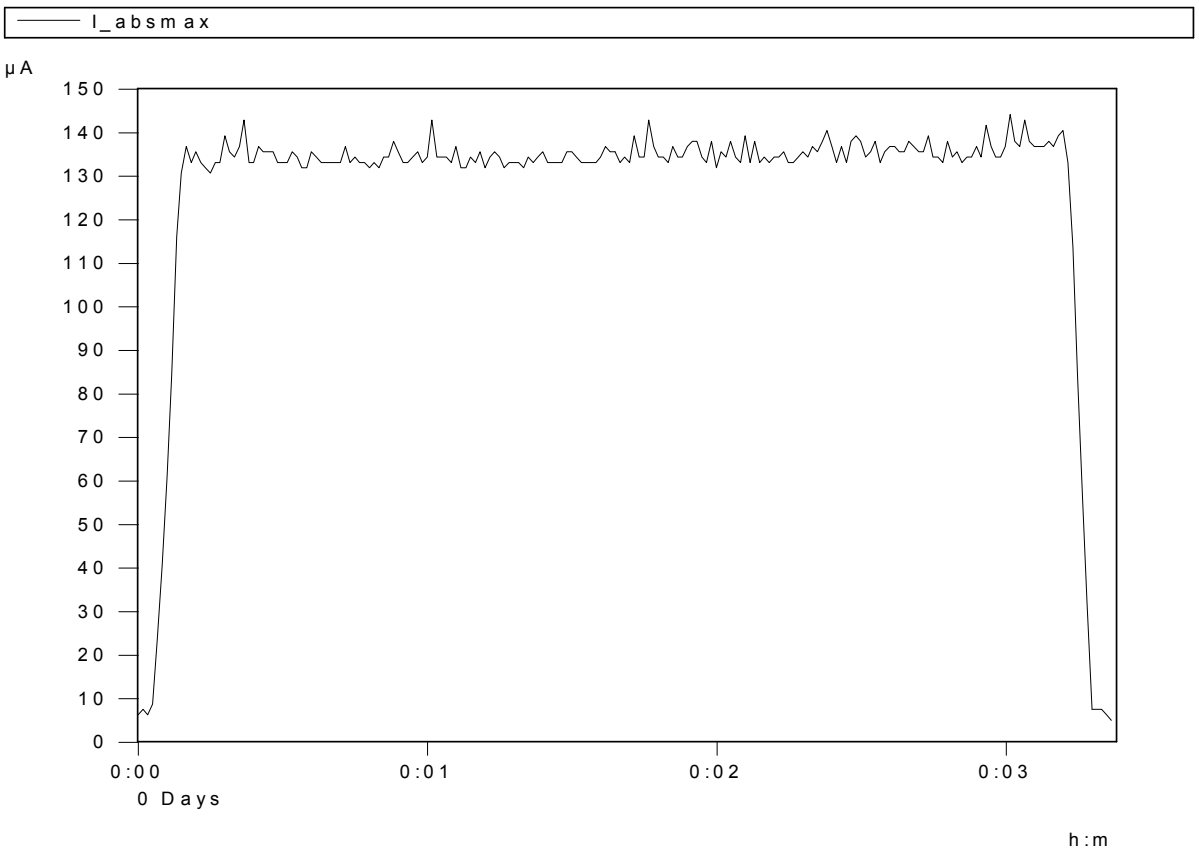
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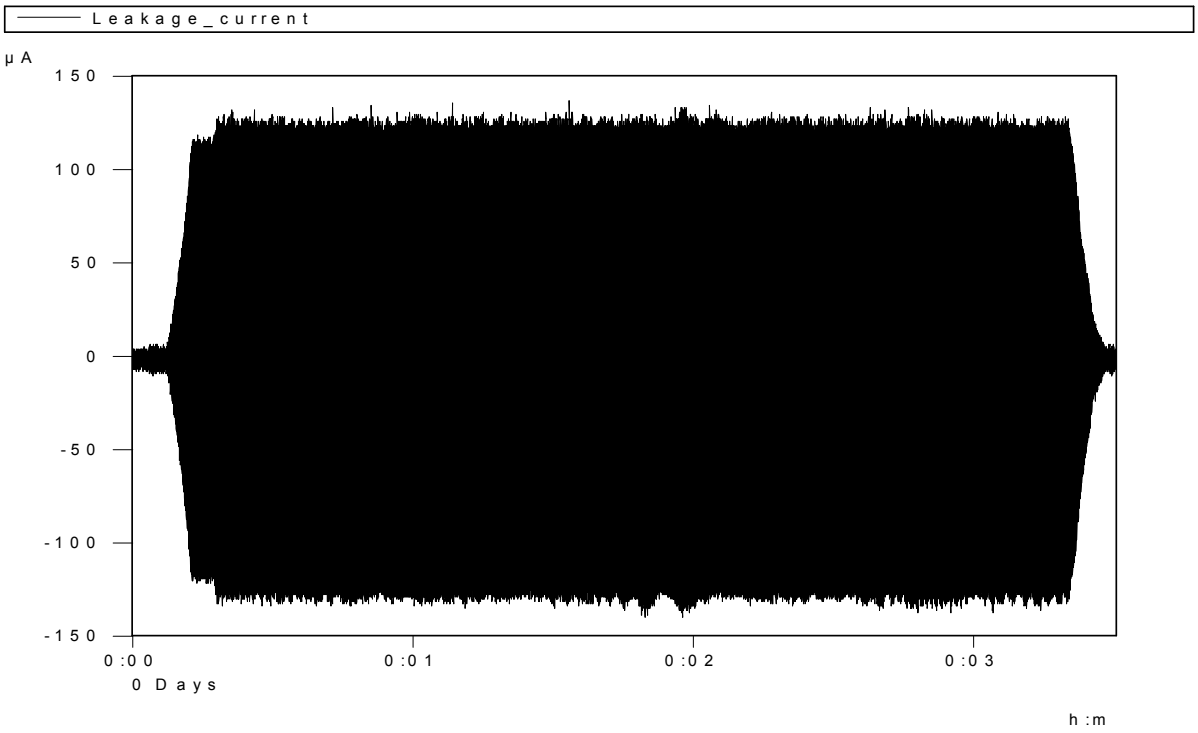
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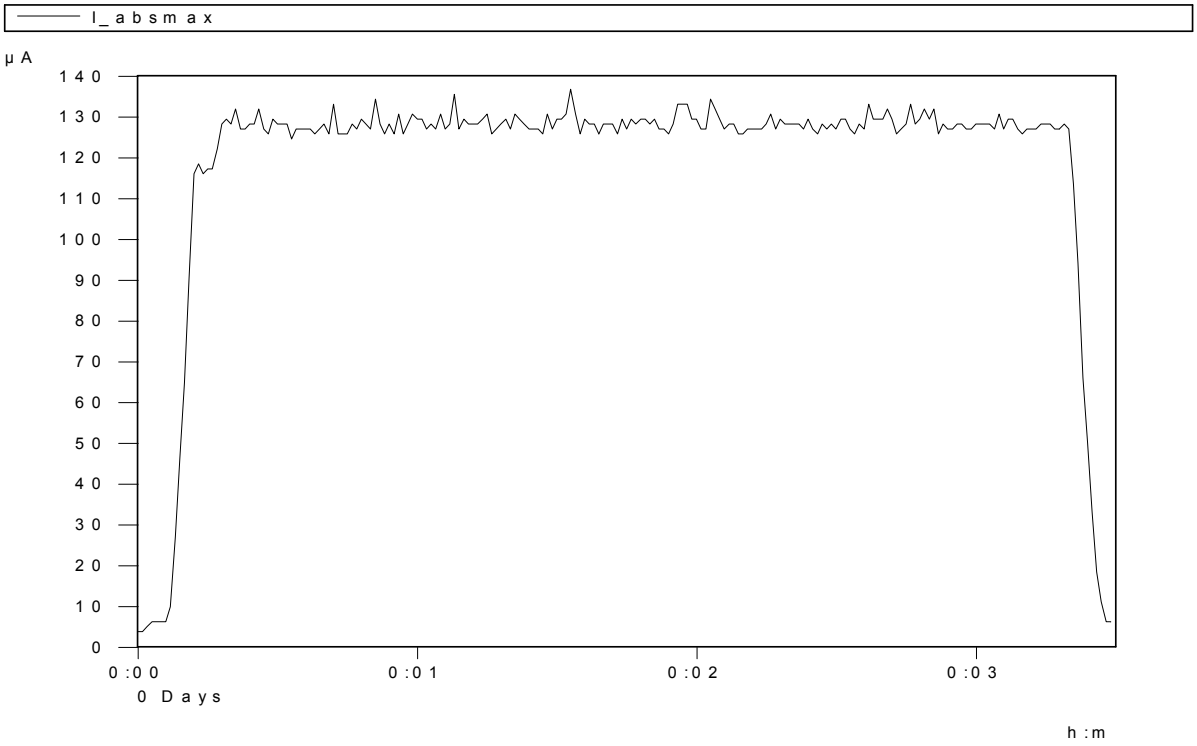
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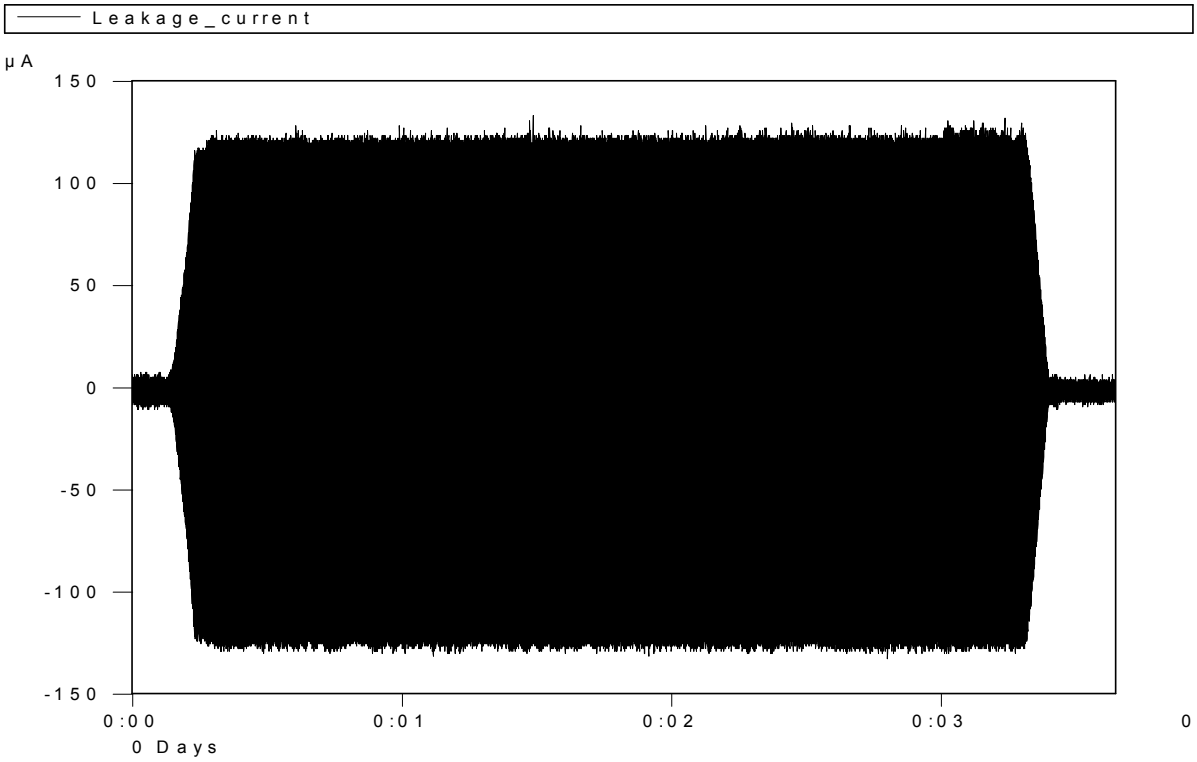
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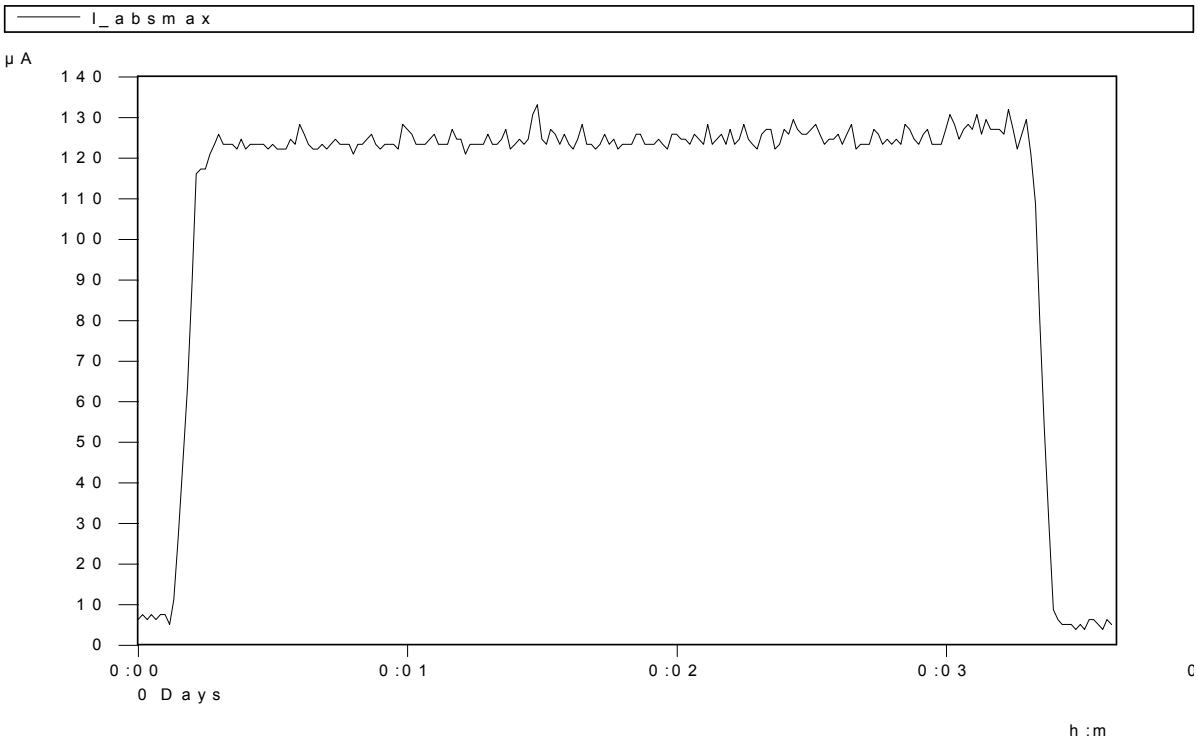
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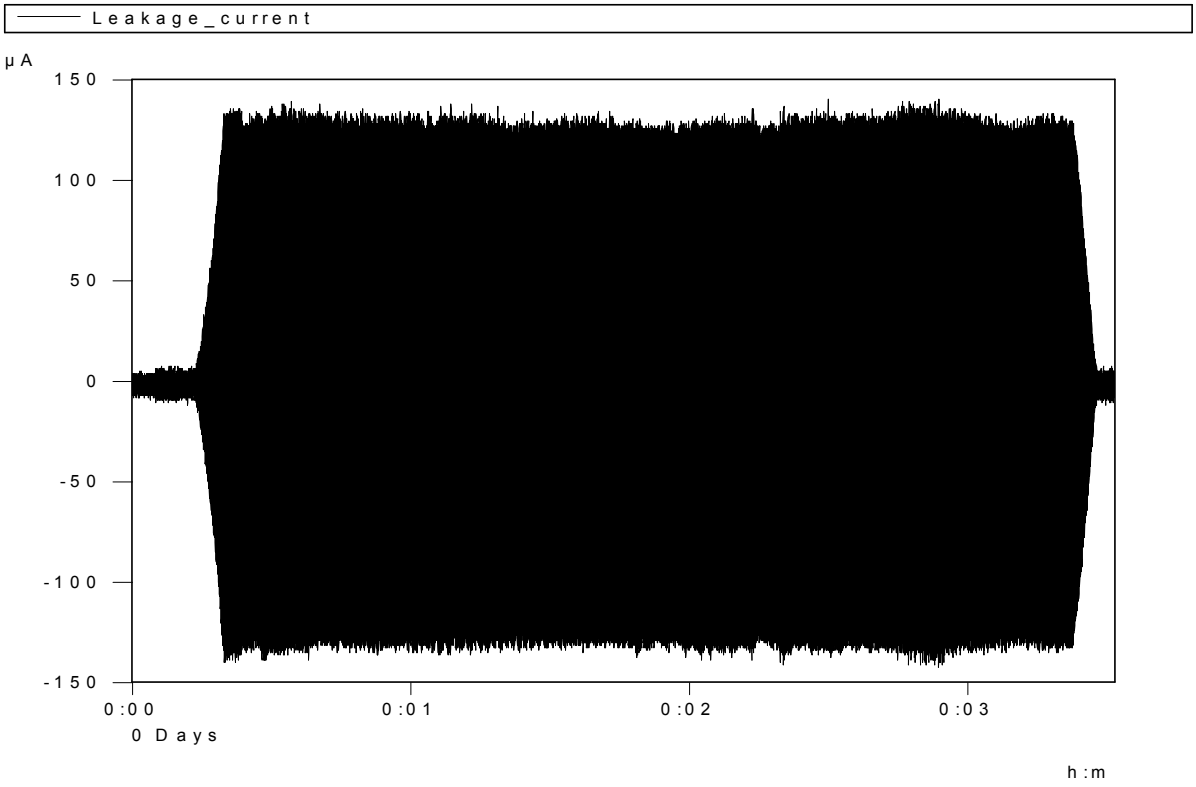
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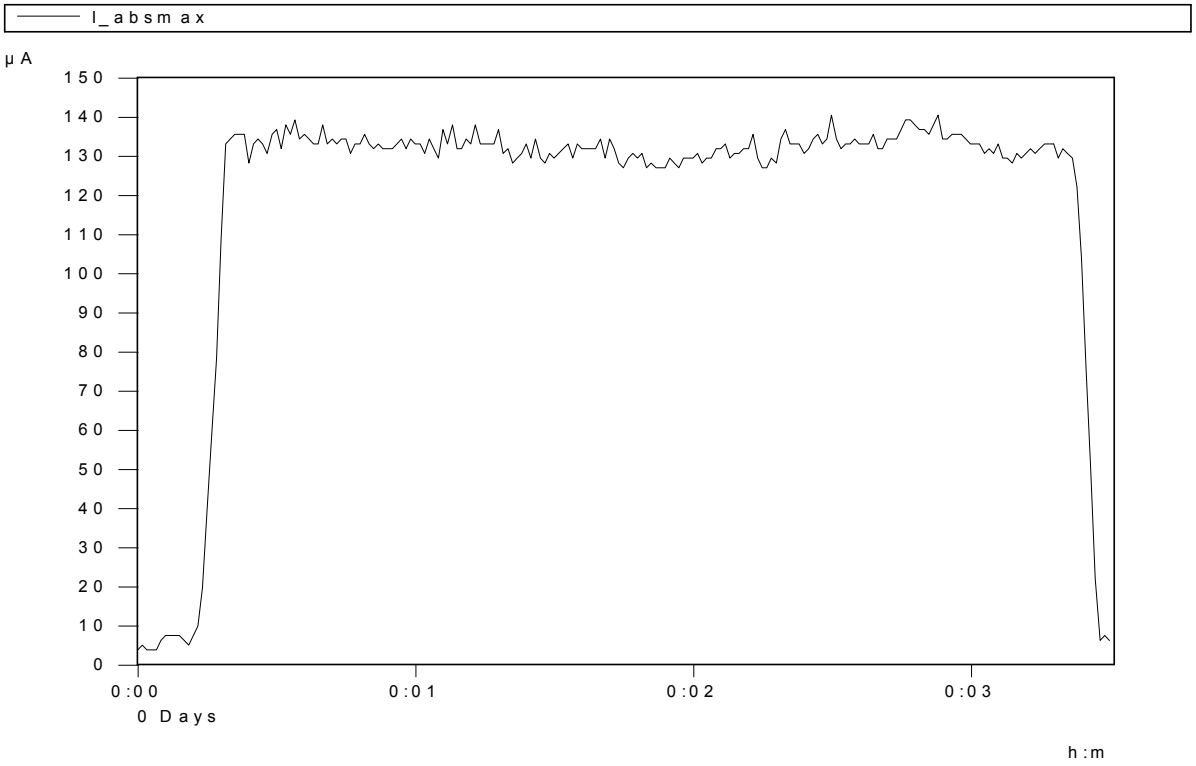
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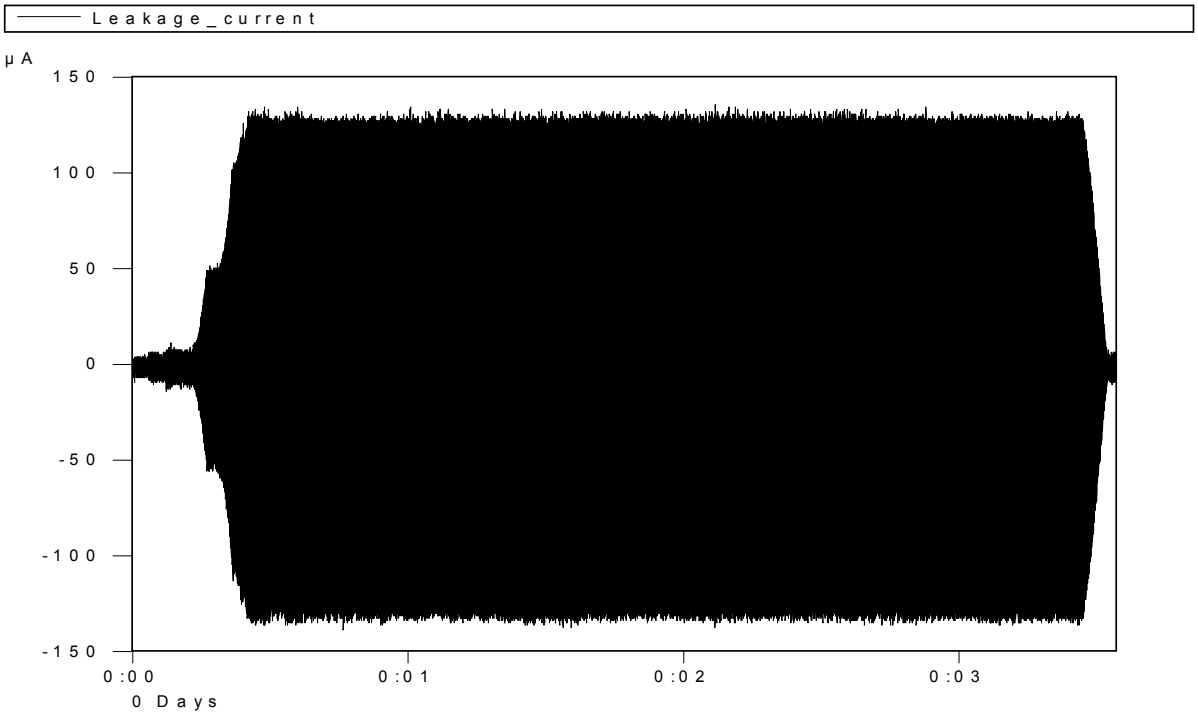
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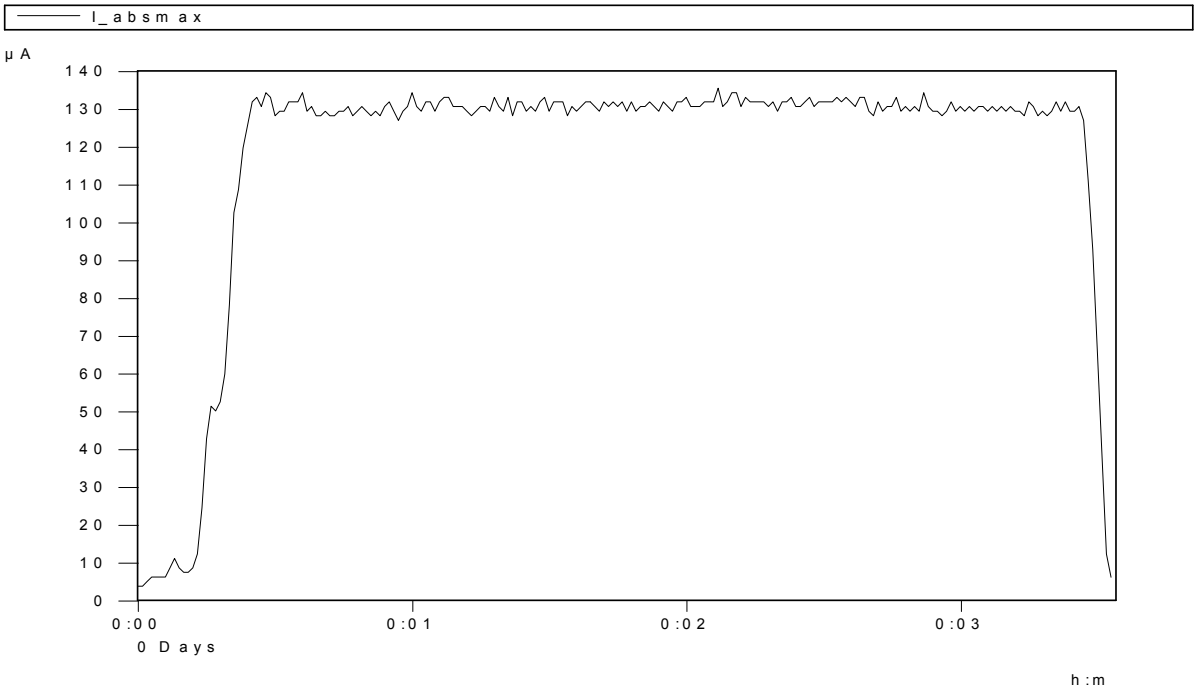
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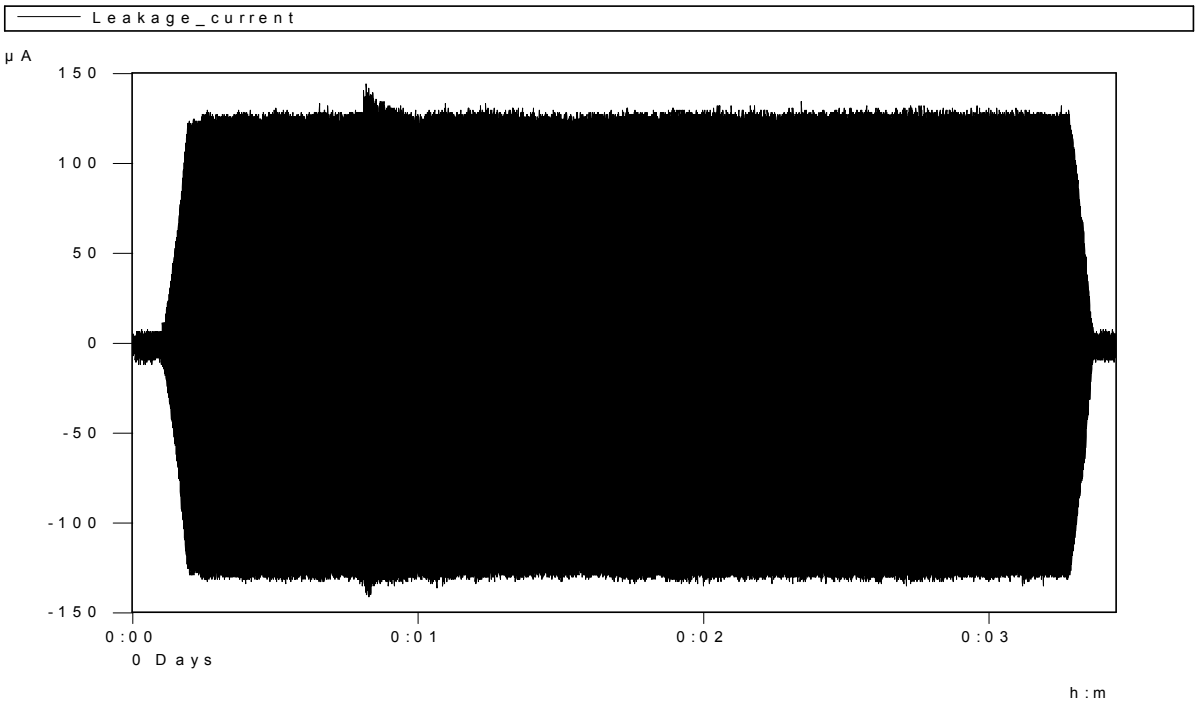
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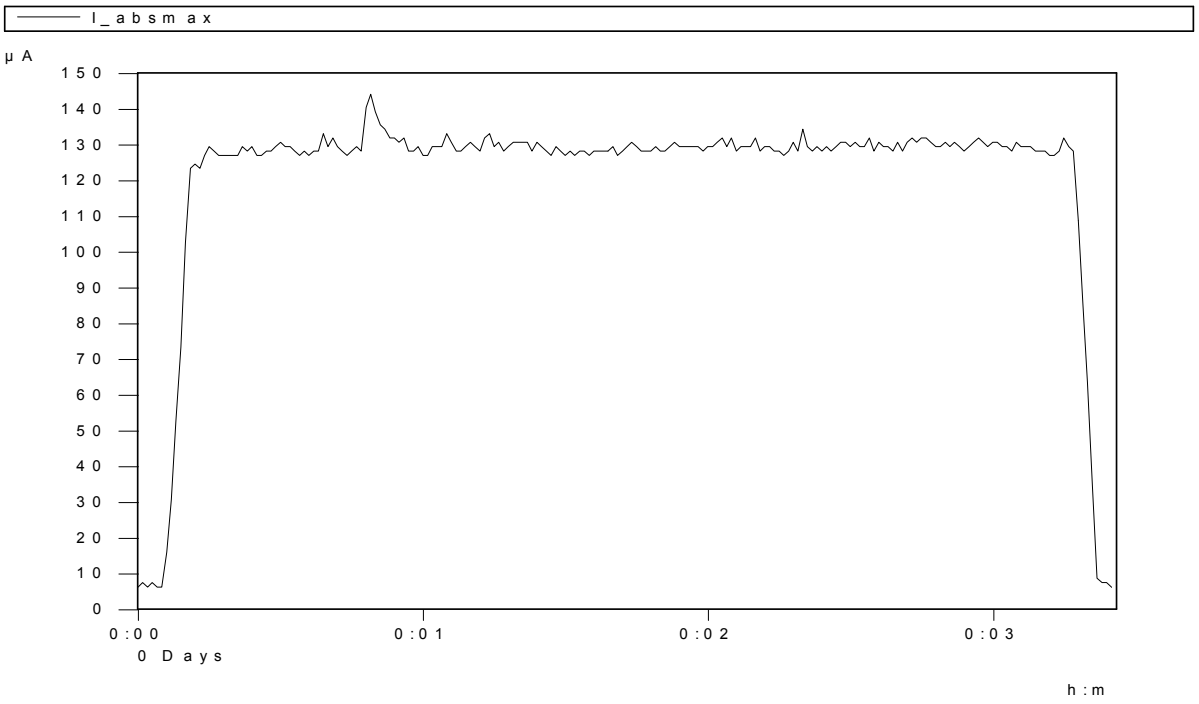
0 Days
h:m


I_absmax
µA
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
0:00
0:01
0:02
0:03
0 Days
h:m

Section 8

8 Measurement uncertainty during accredited tests

The measurement uncertainties stated in the tables below is valid for tests covered by the STRI accreditation

When not otherwise stated the measurement uncertainty of a measurement is better or equal to the values stated in the tables below. The coverage factor k is equal to 2, which implies a confidence interval B equal to 95%.

Table 1: Measurement uncertainties of the primary measuring system

Type	Range	Measurement uncertainty		IEC-requirement
AC	10 – 1050 kV	Peak/√2: 3.0 % RMS: 2.0 %		3 %
DC	40 – 1200 kV	0.94 %		3 %
LI	40 – 2600 kV	Peak value: 2.5 % Front time: 10 % Half value: 5.7 %		3 % 10 % 10 %
SI	100 – 1750 kV	Peak value: 1.4 % Time to peak: 5.9 % Half value: 3.9 %		3 % 10 % 10 %
PD	1 pC – 2 nC	Omicron	10.4 %	-
		LDIC	<18 pC: ±1.5 pC	
			≥18 pC: 9.1 %	
Cap	20 pF – 1 µF	0.1 %		-
Tan δ	>0.1 %	5.6 % of reading		-
	>0.02 %	15.2 % of reading		-
	>0.005 %	59.2 % of reading		-
RIV	~0 – 5000 µV	2.8% ±1.0 µV		-
Temp. rise test	-40 – +125°C 800 – 4000 $A_{AC, rms}$ Contact resistance 10 - <50 µOhm 50 - <100 µOhm 100 - <500 µOhm	Temperature: ±1.4°C Current: 1.6 % 16.9% 4.4% 2.5%		- - - - -

Table 2: Measurement uncertainty of secondary measuring systems

Type	Range	Measurement uncertainty	IEC-requirement
Temperature – air	max 45°C	2.0 % ±1°C	-
Temperature – fluid	0 – 100°C	3.0 % ±1°C	-
Relative air humidity	0 – 100 %	4.0 %	1 g/m^3
Pressure – air	970 – 1030 hPa	2.0 %	-
Conductivity	0 – 1999 mS/cm	2.5 %	-
Weight	~0 – 0.5 g	1.4 %	-
	>0.5 – 200 g	8.3 %	-
	~0 – 20 kg	0.1 %	-
	>20 – 60 kg	0.2 %	-