П Р И Л О Ж Е Н И Е № 5 –

Приложения към приложение № 2

за участие в открита процедура за възлагане на обществена поръчка с предмет:

„Подмяна на маслонапълнена кабелна електропроводна линия 110 kV „Зенит" от линеен ножов разединител 110 kV на ПС „Хаджи Димитър" до линеен ножов разединител 110 kV в ПС „Подуяне", реф. № РРС 17 – 169

Техническо предложение

Техническа документация
Приложение № 1 към Предложение за изпълнение на поръчката по т.15.1. от Техническото предложение – Заверени копия на документи за Ограничител на пренапрежение (вентилен отвод) за нова КЕЛ 110 kV: • Приложение № 1.1. към т.15.1.1. от Техническото предложение – Заверено/и копие/я на протокол/и от типови изпитвания, проведени от независима изпитвателна лаборатория, с приложен списък на отделните изпитвания на български език

000118

ABB Power Technology Products

Författare - Author

Lennart Stenström

Godkännare - Approved by

Gunnar Persson

Uppdragsgivare - Requested by

Titel - Title

Moisture ingress test on surge arrester PEXLIM P120-XH145

Rapport
Report

R HVP/AK 01-06 rev.1

Reg.

Från - From
PTHVP/AKB

Datum - Date
2001-12-20

Sida - Page
1(3)

[ ] Utredning teoretisk undersökning - Analysis, theoretical investigation

[X] Provning, experim. undersökning - Test experimental investigation

Ordernr - Ref. No.

Debiteras ordernr - Debit Order No.

[ ] Delrapport
Partial report

PkI/AkI

[X] Slutrapport
Final report

Antal textsidor - No. of text pages
3

Provning/undersökning avslutad
Test/investigation finished
01-11-19

Antal bilagesidor - No. of supplem. pages
4

Sammanfattning - Summary

TEST METHOD

Moisture ingress test in accordance with IEC 60099-4, Amendment 2 of 2001-10, Clause 9.7.9
(Same requirements as per earlier IEC Committee Draft for Vote 37/231/CDV, Clause 9.7.8)

TEST OBJECT

Surge arresters PEXLIM P120-XH145 according to dimension drawing 1HSA303 000-CA (enclosed)

TEST PROCEDURE

Initial measurements of power losses, residual voltage and partial discharge level according to Clause 9.7.9.1 as well as check of reference voltage.

Preconditioning according to Clause 9.7.9.2

Water immersion according to Clause 9.7.9.3

Verification tests including visual inspection, measurements of power losses, residual voltage and partial discharges according to Clause 9.7.9.4 as well as check of reference voltage.

TEST RESULT

The surge arresters passed the test successfully.

Ludvika 2001-12-20

ABB Power Technology Products AB
High Voltage Products/Surge Arresters
Quality Department

на основание чл. 2 от ЗЗЛД

Kurt Jansson

ABB Power Technology Products AB QA QUALITY

000119

ВЯРНО С ОРИГИНАЛА

"ТРАСИН" СМОЛЯН ООД

1. TEST METHOD

Moisture ingress test in accordance IEC 60099-4, Amendment 2 of 2001-10, Clause 9.7.9 (Same requirements as per earlier IEC Committee Draft for Vote 37/231/CDV, Clause 9.7.8)

2. TEST OBJECT

Two surge arresters PEXLIM P120-XH145 serial No. P-X16 and P-X17 according to dimension drawing 1HSA303 000-CA (enclosed)

3. TEST PROCEDURE

3.1
Initial measurements of power losses, residual voltage and partial discharge level (PD) according to Clause 9.7.9.1 as well as check of reference voltage with results as follows:

Test object	P-X16	P-X17	
Reference voltage-kVrms	129.6	129.4	at 3 mA resistive current
Residual voltage-kVpeak	254.8	254.9	at 3 kApeak
PD level-pC	0.3	0.4	at 108 kVrms
Power losses-W	4.1	4.1	at 92 kVrms

3.2
Preconditioning according to Clause 9.7.9.2
(Performed by ABB Power Technology Products, Dept. ASS/SPL. See enclosed test report SPL 01-226)

Bending moment 2500 Nm
Load direction no. 1 for 24 hours in +60 °C
Load direction no. 2 for 24 hours in -25 °C
Load direction no. 3 for 24 hours in +45 °C
Load direction no. 4 for 24 hours in -40 °C

3.3
Water immersion according to Clause 9.7.9.3
(Performed by ABB Power Technology Products, Dept. ASS/SPL. See enclosed test report SPL 01-226)

Immersed in boiling water with 1 g NaCl per liter for 42 h from 01-11-16 to 01-11-18. Thereafter the arrester remained in the water, which was cooled down to 50 °C, until 8 o'clock in the morning of 01-11-19.

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ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

3.4
Verification tests including visual inspection, measurements of power losses, residual voltage and partial discharges according to Clause 9.7.9.4 as well as check of reference voltage.

Test object	P-X16	P-X17	
Reference voltage-kVrms	129.1	129.0	at 3 mA resistive current
Residual voltage-kVpeak	254.3	254.1	at 3 kApeak
PD level-pC	0.4	0.5	at 108 kVrms
Power losses-W	4.0	4.0	at 92 kVrms

Verification tests were finished 01-11-19 at 3 o'clock p.m. within 8 hours after the arresters were taken out of the water at 50 °C.

4. TEST RESULTS

The surge arresters passed the test successfully.
The permanent deflection after the thermomechanical conditioning was 3 mm in load direction no. 1 for P-X16 and 1 mm for P-X17
(See enclosed test report SPL 01-226)

Deviation in electrical data before and after the test:

P-X16

	Before	After	Deviation
Reference voltage	129.6 kVrms	129.1 kVrms	-0.4 %
Residual voltage	254.8 kVpeak	254.3 kVpeak	-0.2 %
PD level	0.3 pC	0.4 pC	+0.1 pC
Power losses	4.1 W	4.0 W	-2.4 %

P-X17

	Before	After	Deviation
Reference voltage	129.4 kVrms	129.0kVrms	-0.3 %
Residual voltage	254.9 kVpeak	254.1 kVpeak	-0.3 %
PD level	0.4 pC	0.5pC	+0.1pC
Power losses	4.1 W	4.0 W	-2.4 %

000121

ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

Report

R **SPL 01-226**

Author	From	Date	Reg.	Page
M.Lausch	**PTASS/SPL**	**01-12-03**	**5680**	**1**
Approved by	Test performed by		Ref.No.	
H.Persson	**T.Lillqvist**		**L.15151814**	
Requested by			Project account	
PTHVP/AKK				
Title	☐ Interim Report		Pkl/Akl	
Conditioning for moisture ingress test on surge arrester units type PEXLIM P120-XH145. Serial number P-X16 and P-X17.	☒ Final Report		No.of pages of text **2**	
	Analysis/test finished **01-11-18**		No. of appendix **1**	

Summary

PURPOSE Thermomechanical preconditioning and water immersion of surge arrester units prior to moisture ingress test.

TEST OBJECTS

Two surge arrester units type PEXLIM P120-XH145 with serial number P-X16 and P-X17.

TEST PROCEDURE

Test procedure according to IEC Committee Draft for Vote 37/231/CDV, clause 9.7.8.2 precondition and 9.7.8.3 water immersion test.

Terminal torque preconditioning, clause 9.7.8.2.1.
The terminal was subjected to a torque of 100 Nm during 30 s.

Thermomechanical preconditioning, clause 9.7.8.2.2.
The test object was subjected to a bending moment of 2 500 Nm in four perpendicular directions at different ambient temperatures. The bending direction was changed at +20°C.

Load direction no.	Temperature °C
1	+60
2	-25
3	+45
4	-40

Each load direction was tested 24 hours.

Distribution
SPL-arkiv, PTHVP/AKK, Roger Siljeholm

Page 1 only
SPL-arkiv,

Keywords	Other references	File
Conditioning		☐ 1 year
Surge arrester units type PEXLIM P-X		☐ 2 year
		☒ > 3 years

000122

ВЯРНО С ОРИГИНАЛА

СМОЛЯН ООД

The temperatures during the test are shown in appendix 1.

The permanent deflection in load direction number 1 was measured.

Water immersion test, clause 9.7.8.3.
The test object was immersed in boiling deionized water with 1 g/l of NaCl for 42 hours.
The test was finished at 17.00, 2001-11-18. Thereafter the surge arresters remained in the water, which was cooled down to 50 °C, until 8.00, 2001-11-19.

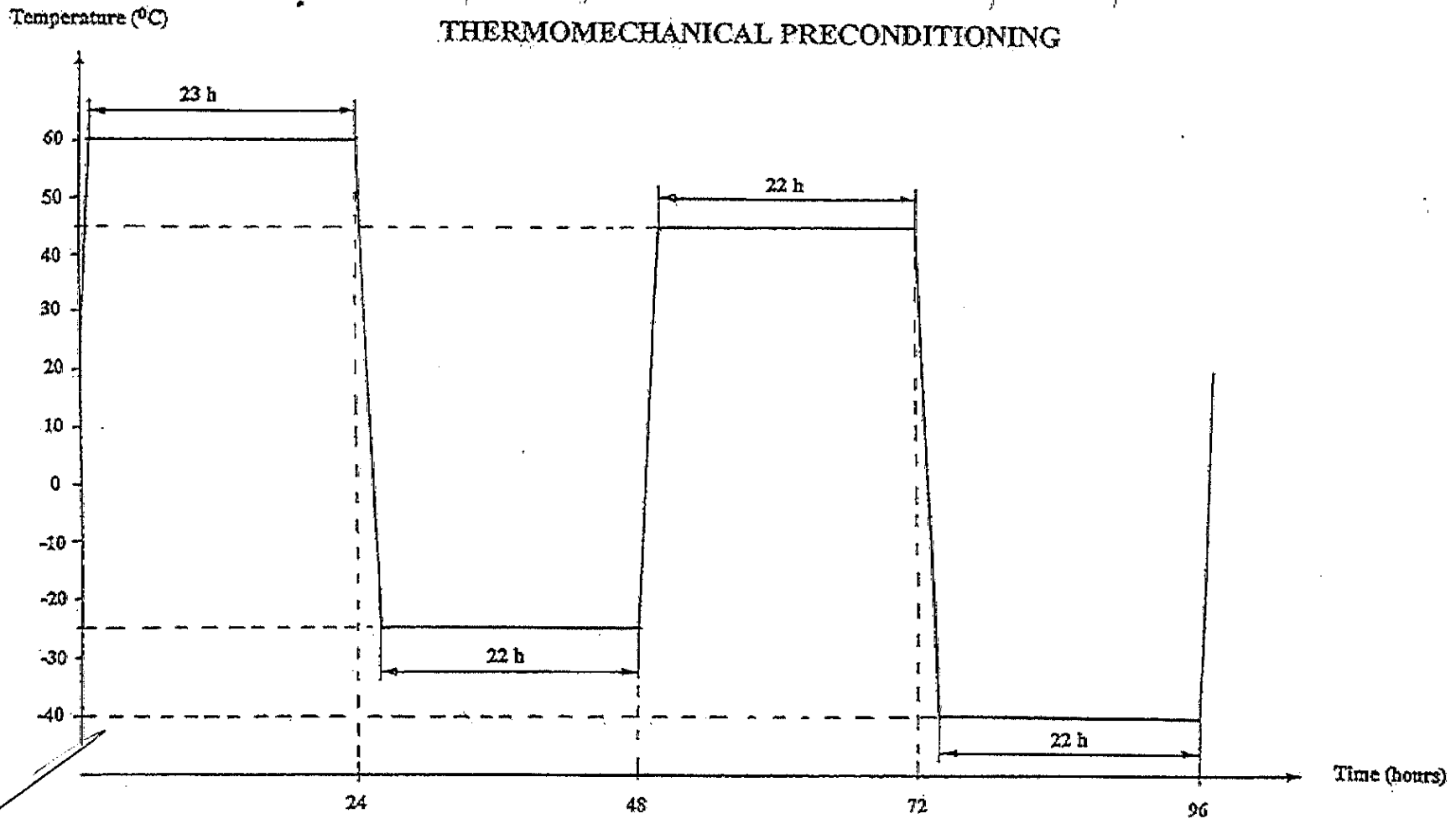
TEST RESULTS

There was no visual damage on the test objects.

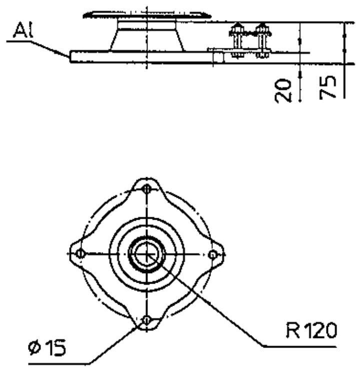
After the thermomechanical test, the permanent deflection in load direction number 1 was 3 mm on P-X16 and 1 mm on P-X17.

000123

THERMOMECHANICAL PRECONDITIONING



DRILLING PLAN



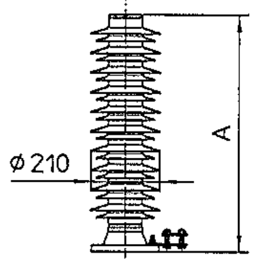


fig. 1

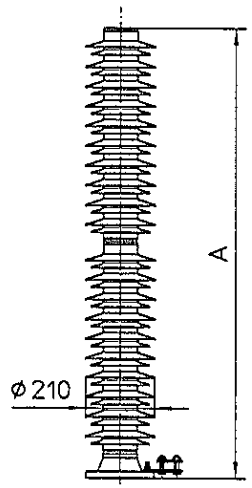


fig. 2

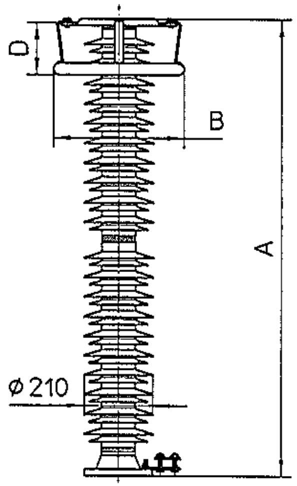


fig. 3

Surge arrester type PEXLIM P-X

System voltage range 12 - 170 kV

Rated voltage kV	System voltage kV		A mm	B mm	C mm	D mm	Creepage distance mm	1) Mass kg	fig.
012-018	XV	012	481				1363	19	1
021-024	XV	024	481				1363	18	1
030-036	XV	036	481				1363	18	1
039			736				2270	29	1
042-072	XV	052	736				2270	29	1
054-072	XV	072	736				2270	28	1
075-084			1080				3625	43	
075-096	XV	100	1080				3625	43	1
090-120	XH	123	1080				3625	42	1
090-144	XV		1397				4540	53	2
150			1486				4988	54	
108-120	XH	145	1080				3625	41	1
108-144	XV		1397				4540	52	2
150			1486				4988	54	
162-168			1741				5895	65	
132-144	XH	170	1417	400		160	4540	52	3
150			1506				4988	56	
132-192	XV		1761				5895	69	

1) Including line terminal, earth terminal and grading ring arrangement.

Accessories on drawing 1HSA301 000-D
Surge counter on drawing 1HSA440 000-A
Surge arrester monitor on drawing 1HSA440 000-B

Prepared	Responsible department	Title	
I Dahlbom 2001-09-28	PTHVP/AKK	DIMENSION DRAWING	Language en
Approved R Siljeholm 2001-11-28	Take over department PTHVP/AF	SURGE ARRESTER	Sheet 1
Revision -			
ABB	ABB Power Technology Products	Document no. 1HSA303 000-CA	Cont -

Design checked by | Form No. | Rev Ind | Dept | Year Week | Cont | Sheet

000125

ABB Power Technology Products AB

Rapport
Report

R HVP/AK 01-07

Reg.

Författare - Author

Roger Silieholm

Godkännare - Approved by

Lennart Stenström

Från - From: HVP/AK

Datum - Date: 2001-12-10

Sida - Page: 1

Uppdragsgivare - Requested by

Gunnar Persson

Titel - Title

Bending fatigue test on surge arrester type PEXLIM P120-XH145

☐ Utredning teoretisk undersökning - Analysis, theoretical investigation

☐ Provning, experim. undersökning - Test experimental investigation

☐ Delrapport
Partial report

☒ Slutrapport
Final report

Provning/undersökning avslutad
Test/invetigation finished

Ordernr - Ref. No.

Debiteras ordernr - Debit Order No.

Pkt/Akt

Antal textsidor - No. of text pages: 1

Antal bilagesidor - No. of supplem. pages: 4

PURPOSE

The purpose was to verify the bending fatigue strength of the arrester type PEXLIM P-X.

TEST OBJECT

Two arresters of type PEXLIM P120-XH145 with rated voltage 120 kV, serial numbers P-X22 and P-X24 were tested. The arresters comprise the longest mechanical sections used for the arrester type PEXLIM P-X.

TEST PERFORMED

The modules were subjected to a cyclic bending test consisting of 1000 cycles at a bending moment level of 2500 Nm at the frequency 0.3 Hz. See report SPL 01-218.

RESULT

The test objects withstood the test without any damage. See report SPL 01-218.
Before and after the mechanical test the modules were electrically routine tested, result as per Table 1. No significant changes in the electrical characteristics were observed.

Arrester	Reference Voltage (Uref) at 3 mA resistive current		Partial discharge level at 0.9*Uref		Power losses at 0.8*Uref	
	Before test kV	After test kV	Before test pC	After test pC	Before test W	After test W
P-X22	129.5	129.2	<5	<5	4.2	4.0
P-X24	128.9	128.8	<5	<5	4.4	4.2

Table 1. Electrical routine tests.

Ludvika 2001-12-10

ABB Power Technology Products AB
High Voltage Products/Surge Arresters
Quality Department

на основание чл. 2 от ЗЗЛД

Kurt Jansson

ABB Power Technology Products AB QA QUALITY

"КРАСИМ" СМОЛЯН

ЗЯРНО С ОРИГИНАЛА

000126

ABB

ABB Power Technology Products AB

	Report		R SPL 01-218	
Author	**From**	**Date**	**Reg.**	**Page**
M.Lausch	SEASS/SPL	01-12-03	5680	1
Approved by	**Test performed by**		**Ref. No.**	
H.Persson	T.Lillqvist		L-15151814	
Requested by			**Project account**	
PTHVP/AKK				
Title	☐ **Interim report**		**Pkl/Akl**	
Bending fatigue test of surge arrester units type PEXLIM P120-XH145	☒ **Final report**		**No. of pages of text**	
			1	
	Analysis/test finished		**No. of appendix**	
	01-11-16		4	

Summary

PURPOSE

To test the ability of PEXLIM P120-XH145 modules to withstand 1 000 cycles at a load of 2 500 Nm, with a frequency of 0,3 Hz.

TEST OBJECTS

Two PEXLIM P120-XH145 modules with serial number P-X22 and P-X24, see drawing appendix 1.

TEST PROCEDURE

The PEXLIM modules were mounted in a universal-testing machine. The load was applied by a hydraulic cylinder connected to the top of the module (see appendix 2). The horizontal displacement at a height of 1 100 mm was registered by a position transducer connected to a strip chart recorder.
The module was subjected to an alternating bending load of 2 500 Nm, referred to the foundation, at the frequency of 0,3 Hz.

TEST RESULTS

The PEXLIM modules withstood 1 000 cycles of 2 500 Nm at 0,3 Hz without visible damage.

The measurement of the horizontal displacements is shown in appendix 3.

Distribution
SPL-arkiv, PTHVP/AKK

Page 1 only
SPL-arkiv,

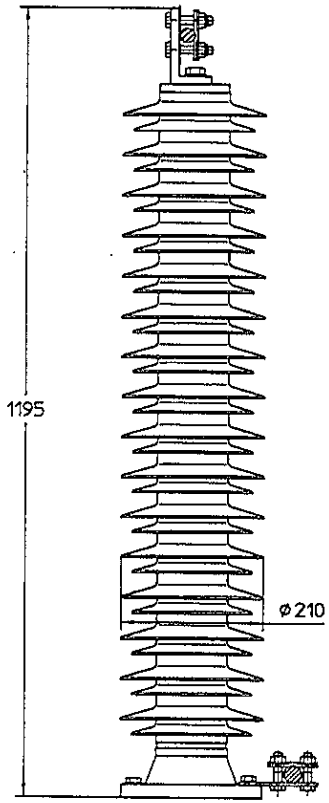
Keywords	**Other references**	File
Bending fatigue test		☐ 1 year
Surge arrester units		☐ 2 years
		☒ > 3 years

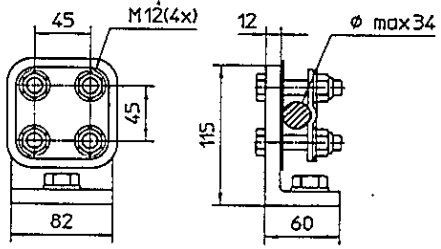
000127

ВЯРНО С ОРИГИНАЛА

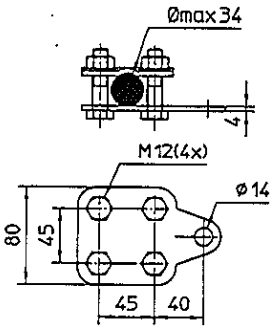
СМОЛЯН ООД

PEXLIM P120-XH145
Creepage distance: 3625 mm
Weight: 44 kg

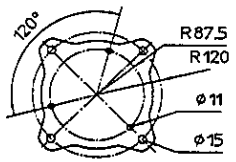




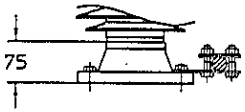
LINE TERMINAL
1HSA410 000-M
(Aluminium)
(Can be adjusted to any angle)



EARTH TERMINAL
1HSA420 000-B
Stainless steel



DRILLING PLAN



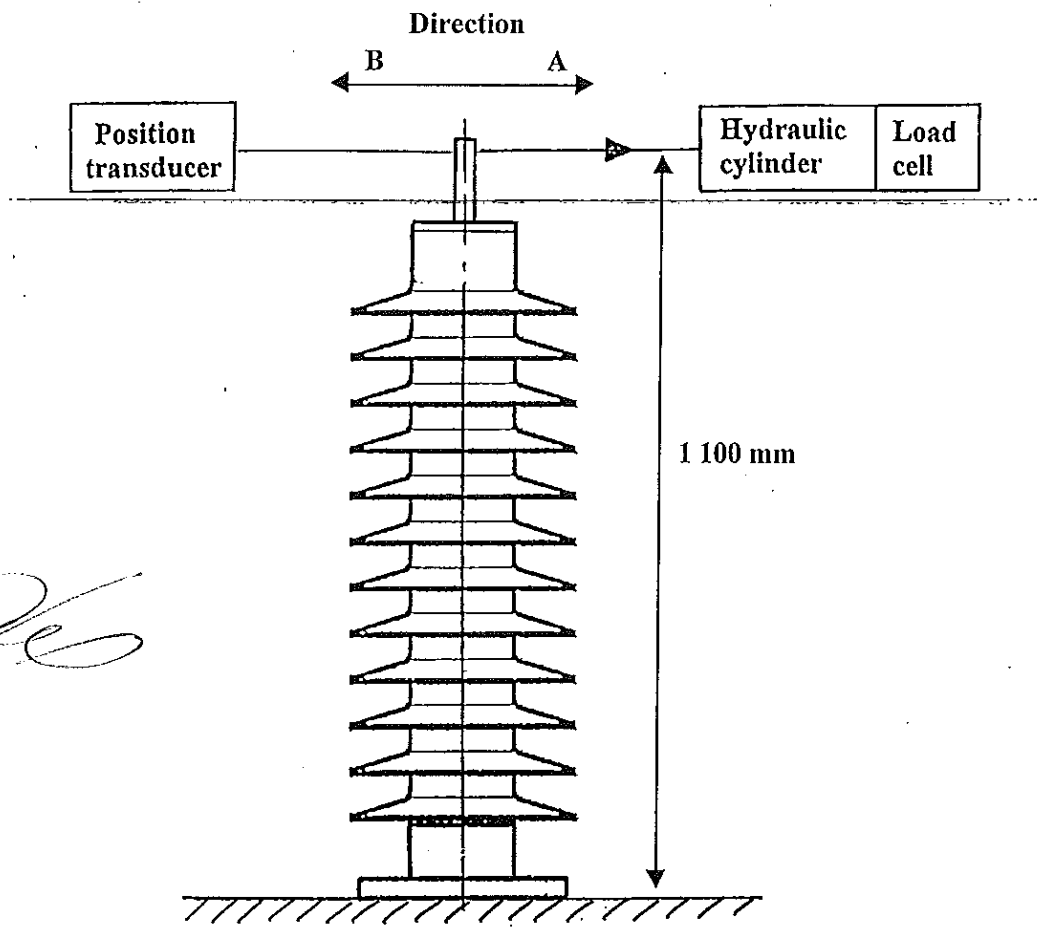
Prepared J Norberg 2001-11-19	Responsible department PTHVP/AKK	Title DIMENSION DRAWING	Language en
Approved R Stjahole 2001-11-20	Taken over department	PEXLIM P120-XH145	Sheet 1
Revision -			Dwg -
ABB Switchgear		Document no. LAK 5862	

SPL01-218
Appendix 1

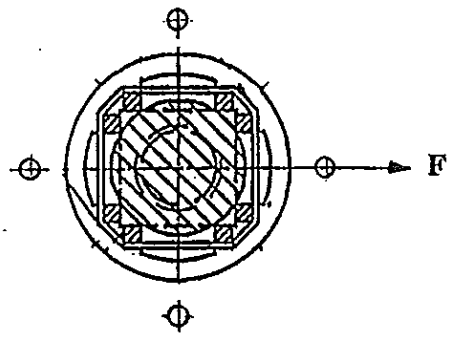
000128

ЗАВЕРЕНО С ОРИГИНАЛА

ООД "КРАСИН" СМОЛЯН



BENDING DIRECTION



000129

ВЯРНО С ОРИГИНАЛА

«КРАСИН» СМОЛЯНИ ООД

P-X22

Bending moment (Nm)	Number of cycles	Displacement dir. A (mm)	Displacement dir. B (mm)
2 500	0	26,3	25,8
2 500	50	26,8	26,1
2 500	100	26,9	26,2
2 500	200	27,0	26,3
2 500	300	27,0	26,3
2 500	400	27,0	26,5
2 500	500	27,0	26,8
2 500	600	27,0	27,0
2 500	700	27,0	27,0
2 500	800	27,1	27,1
2 500	900	27,3	27,2
2 500	1 000	27,7	27,3

P-X24

Bending moment (Nm)	Number of cycles	Displacement dir. A (mm)	Displacement dir. B (mm)
2 500	0	25,9	29,2
2 500	50	26,3	30,0
2 500	100	26,5	30,1
2 500	200	26,9	30,2
2 500	300	27,0	30,8
2 500	400	27,0	30,9
2 500	500	27,0	30,9
2 500	600	27,2	31,0
2 500	700	27,4	31,0
2 500	800	27,5	31,0
2 500	900	27,8	31,3
2 500	1 000	28,0	31,3

000130

ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

ABB Power Technology Products AB

Rapport
Report

R HVP/AK 01-09
Reg. Sida - Page 1

Författare - Author
Roger Silieholm

Godkännare - Approved by
Lennart Stenstrom

Uppdragsgivare - Requested by
Gunnar Persson

Titel - Title
Bending strength test on surge arrester type PEXLIM P120-XH145

Från - From
HVP/AK

Datum - Date
2001-12-10

[ ] Utredning teoretisk undersökning - Analysis, theoretical investigation

[ ] Provning, experim. undersökning - Test experimental investigation

[ ] Delrapport
Partial report

[X] Slutrapport
Final report

Provning/undersökning avslutad
Test/invetigation finished

Ordernr - Ref. No.

Debiteras ordernr - Debit Order No.

Pkl/Akl

Antal textsidor - No. of text pages
1

Antal bilagesidor - No. of supplem. pages
5

PURPOSE

The purpose was to verify a bending strength of 4000 Nm of the arrester type PEXLIM P-X.

TEST OBJECT

Two arresters of type PEXLIM P120-XH145 with rated voltage 120 kV, serial numbers P-X28 and P-X29 were tested. The arresters comprise the longest mechanical sections used for the arrester type PEXLIM P-X.

TEST PERFORMED

The arresters were loaded until failure with rate of 2500 Nm/min. The deflection was measured during the test. See report SPL 01-220.

RESULT

The two arresters failed at 6020 Nm and 5870 Nm respectively. See report SPL 01-220.

Ludvika 2001-12-10

ABB Power Technology Products AB
High Voltage Products/Surge Arresters
Quality Department

на основание чл. 2 от ЗЗЛД

Kurt Jansson

ABB Power Technology Products AB QA QUALITY

КРАСИН СМОЛЯН ООД

000131

ВЯРНО С ОРИГИНАЛА

ABB

ABB Power Technology Products AB

	Report		R SPL 01-220	
Author	**From**	**Date**	**Reg.**	**Page**
M.Lausch	SEASS/SPL	01-12-03	5680	1
Approved by	**Test performed by**		**Ref. No.**	
H.Persson	T.Lillqvist		L-15151814	
Requested by			**Project account**	
PTHVP/AKK				
Title	☐ **Interim report**		**Pkl/Akl**	
Bending strength test of surge arrester units type PEXLIM P120-XH145	☒ **Final report**		**No. of pages of text**	
			1	
	Analysis/test finished		**No. of appendix**	
	01-11-16		4	

Summary

PURPOSE

To determine the bending strength of PEXLIM P120-XH145 arresters.

TEST OBJECTS

Two PEXLIM P120-XH145 arresters with serial number P-X28 and P-X29, see drawing appendix 1.

TEST PROCEDURE

The PEXLIM arresters were mounted in a universal-testing and loaded until break with a loading rate of 2 500 Nm/min machine (see appendix 2).

The deflection, at a height of 1 100 mm from the foundation, was registered by a position transducer connected to a strip chart recorder.

TEST RESULTS

Test object	Bending strength (kNm)	Deflection at break (mm)	Load/deflection
P-X28	6,02	108,5	Appendix 3
P-X29	5,87	110,4	Appendix 4

Distribution
SPL-arkiv, PTHVP/AKK

Page 1 only
SPL-arkiv,

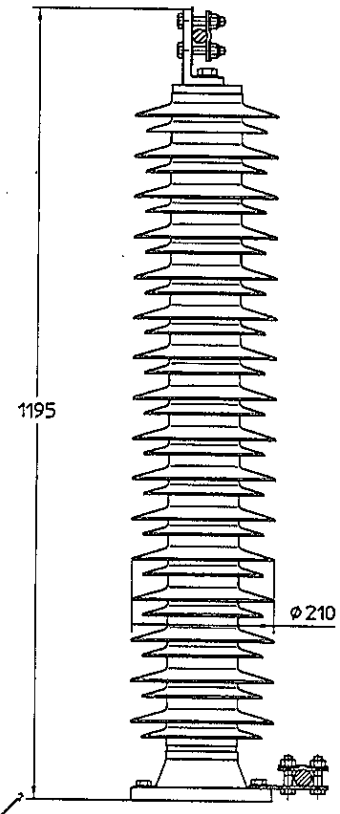
Keywords	Other references	File
Bending strength test Surge arrester units		☐ 1 year ☐ 2 years ☒ > 3 years

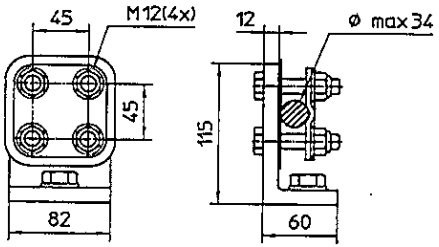
000132

ВЯРНО С ОРИГИНАЛА

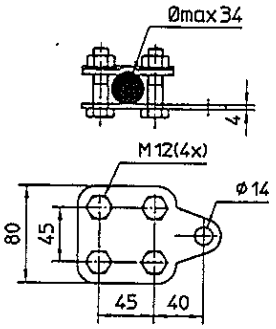
"КРАСИ" СМОЛЯН ООД

PEXLIM P120-XH145
Creepage distance: 3625 mm
Weight: 44 kg

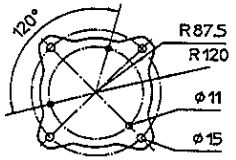




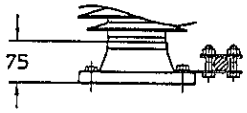
LINE TERMINAL
1HSA410 000-M
(Aluminium)
(Can be adjusted to any angle)



EARTH TERMINAL
1HSA420 000-B
Stainless steel



DRILLING PLAN

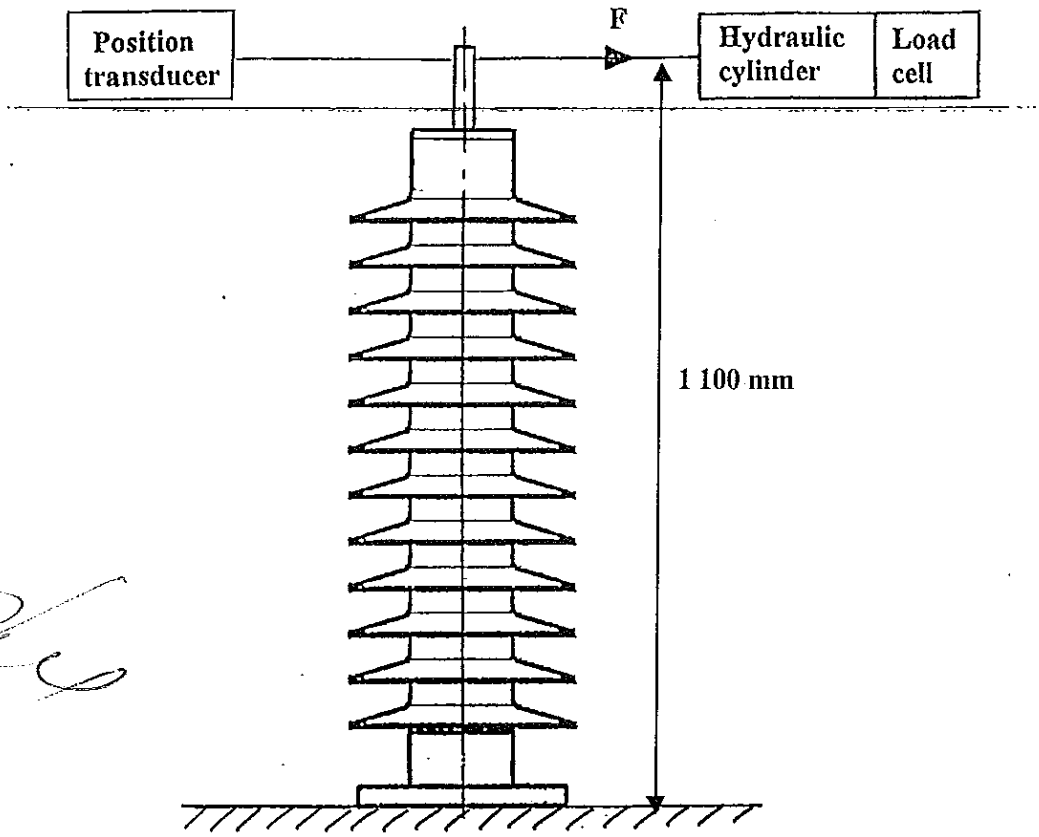


Prepared: J Norberg 2001-11-19	Responsible department: PTHVP/AKK	Title: DIMENSION DRAWING PEXLIM P120-XH145	Language: en
Approved: R Siljefelde 2001-11-20	Time limit department:		Sheet: 1
Revision: -			Size: -
ABB Switchgear		Document no.: LAK 5862	

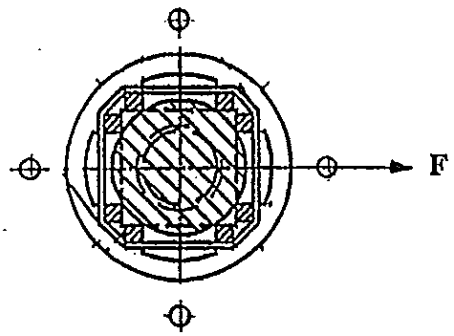
SPL01-220
Appendix 1

0001133

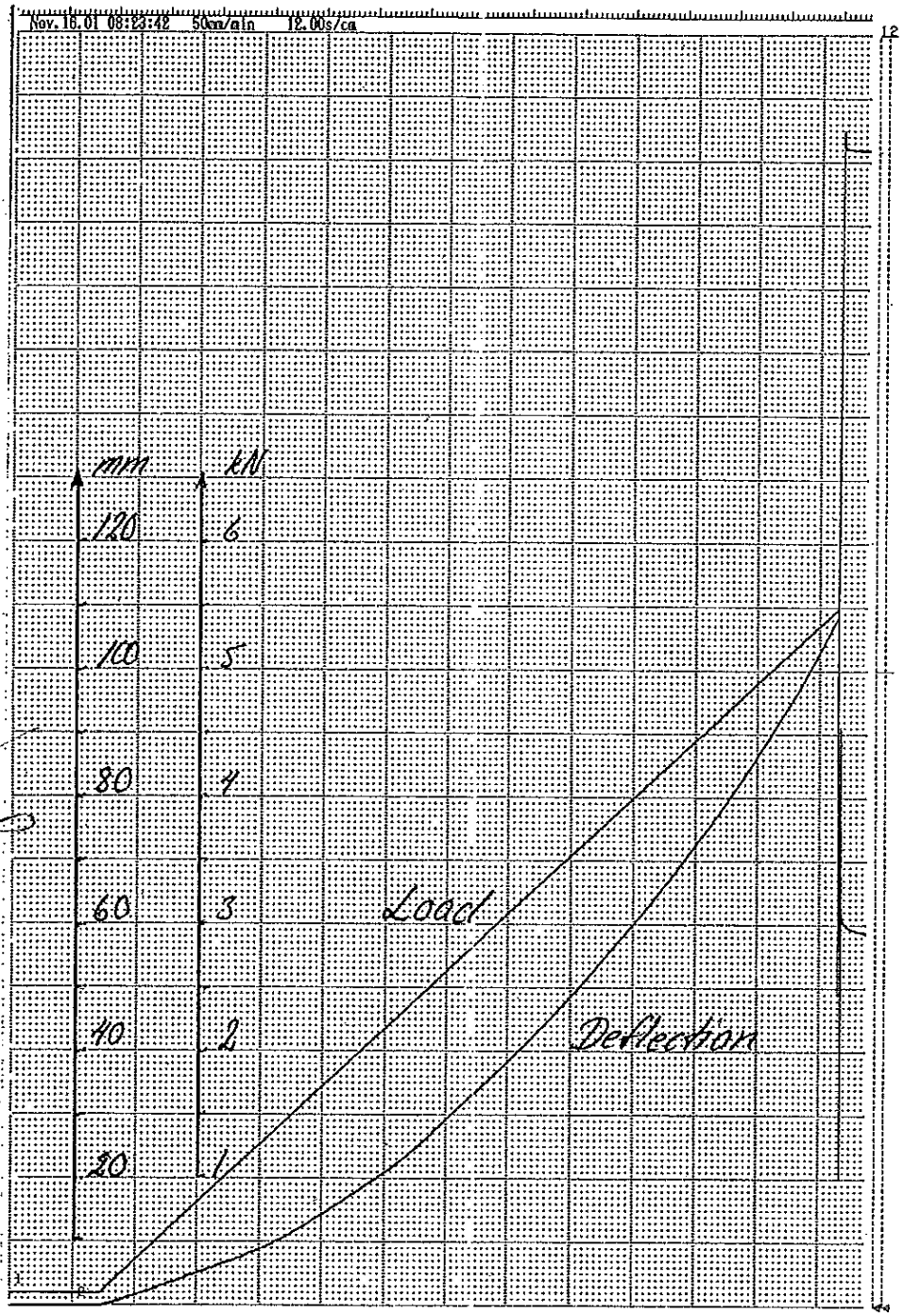
ЗАО "КРАСНИНСКИЙ ОПЫТНЫЙ ЗАВОД" ООП г. СМОЛЯНИНОВО



BENDING DIRECTION



P-X28

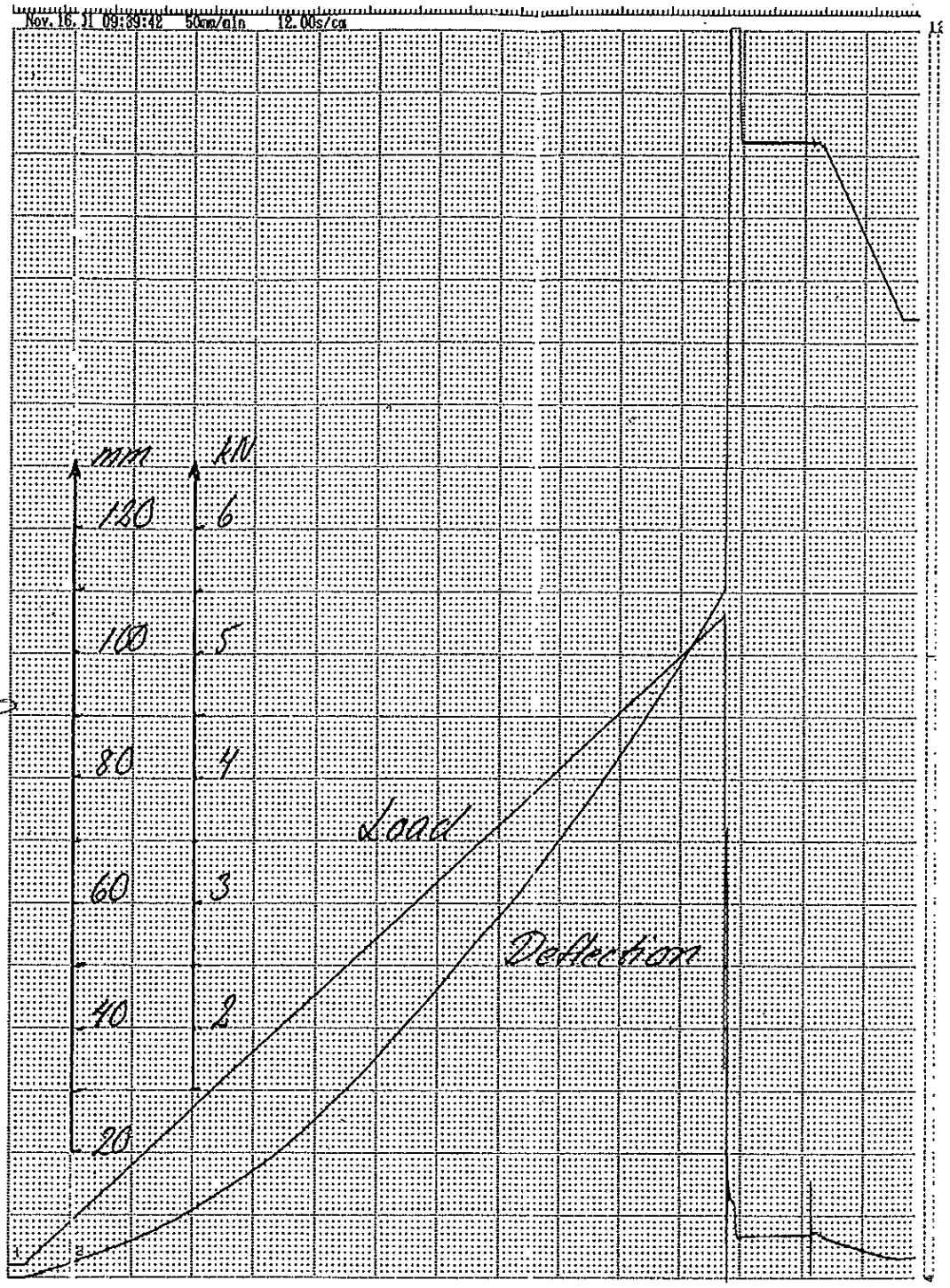


000135

ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

P-X29



000136

Type tests on PEXLIM P Surge Arresters

Test objects: Surge arresters of type PEXLIM P120-XH145
with rated voltage 120 kV.

Standards: IEC 60099-4, Amendment 2 (Annex O) of October 2001
(Same requirements as per earlier IEC document 37/231/CDV)

Tests performed: Pressure relief tests

Current	Report
65 kA	KEMA 566-01 *
25 kA	KEMA 566-01
12 kA	KEMA 566-01
600 A	KEMA 566-01

*) First current peak≥ 2.5 times 65 kA

Validation: The test objects represent the longest electrical and mechanical sections used for PEXLIM P-X surge arresters. The tests therefore verify the performance of all arresters of type PEXLIM P-X.

Tests completed: 2001-11-22

Tests performed at: KEMA Arnhem - High Power Laboratory

Report consists of: 46 pages (KEMA 566-01, 45 pages)

We hereby certify that the objects specified above have successfully passed the test herein reported, thereby verifying guaranteed data.

Ludvika 2002-01-08

ABB Power Technology Products AB
High Voltage Products/Surge Arresters
Quality Department

на основание чл. 2 от ЗЗЛД

Kurt Jansson

ABB Power Technology Products AB

000137

ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

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KEMA

HIGH–POWER LABORATORY
Utrechtseweg 310 – 6812 AR Arnhem – The Netherlands

566–01

REPORT OF PERFORMANCE

CLIENT	ABB Switchgear AB, Ludvika, Sweden
MANUFACTURER	ABB Switchgear AB, Ludvika, Sweden
APPARATUS	One unit of an outdoor metal–oxide polymeric surge arrester
DESIGNATION	PEXLIM P120–XH145

RATINGS ASSIGNED BY THE MANUFACTURER

Prospective fault current	163 kA_{peak} – 65 kA_{rms}	during 0.2 s
Voltage	120	kV
Frequency	50	Hz

The tests have been carried out in accordance with the client's instructions.
Test procedure and test parameters were based on IEC Draft 37/231/CDV.

Date of tests 22nd November 2001

The performance of the apparatus tested and the observations made during the tests have been recorded in the tables with test results and the oscillograms

THIS REPORT CONSISTS OF:

Pages	12 (including this front page)
Circuit diagrams	2
Oscillograms	17
Drawings	1
Photographs	12
Information sheet	B70E

This test falls under the scope of the accreditation certificate L020 of the Dutch Council for Accreditation.
(See information sheet B70E at the back of this document)

KEMA Nederland B.V.

P.G.A. Bus
Manager High–Power Laboratory
Arnhem, 6th December 2001

000138

ВЯРНО С ОРИГИНАЛА

"ВАСИН" СМОЛЯН ООД

The tests were witnessed by:

Name	Company
Ekeroth Reijm, K.	ABB High Voltage Products, Ludvika, Sweden
Andersson, C.	BMB Composites Sweden
Olofson, M.	

The tests were observed by:

Name	Company
Heuts, J.P.	KEMA, Arnhem, The Netherlands

Drawing

The following drawing has been included on request of the client.
KEMA has not verified this drawing.

LAK 5869 Rev. 0

Photographs

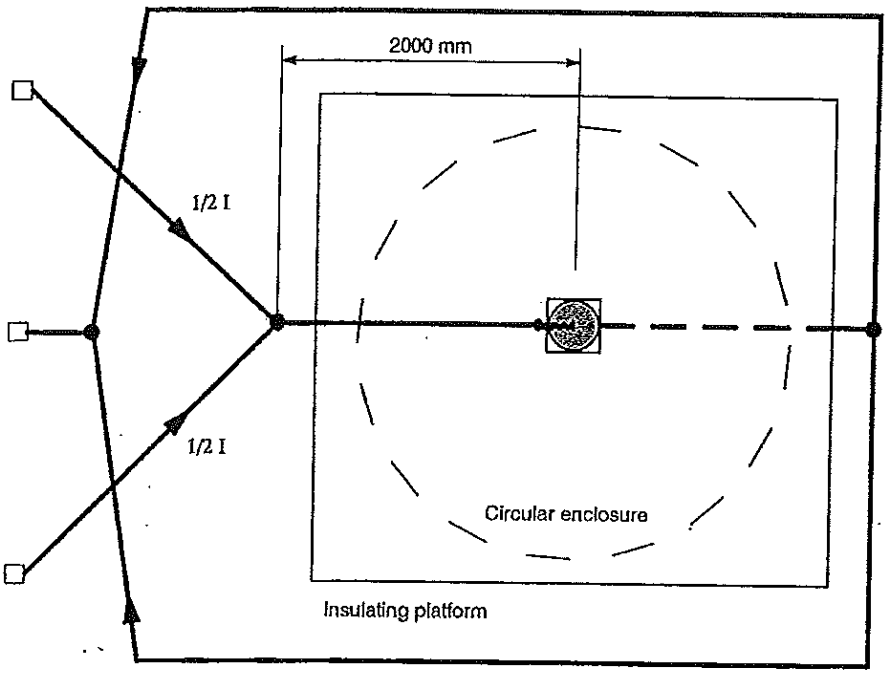
1415201
1415202
1415203
1415204
1415205
1415206
1415207
1415210
1415211
1415212
1415214
1415215

ВЯРНО С ОРИГИНАЛА

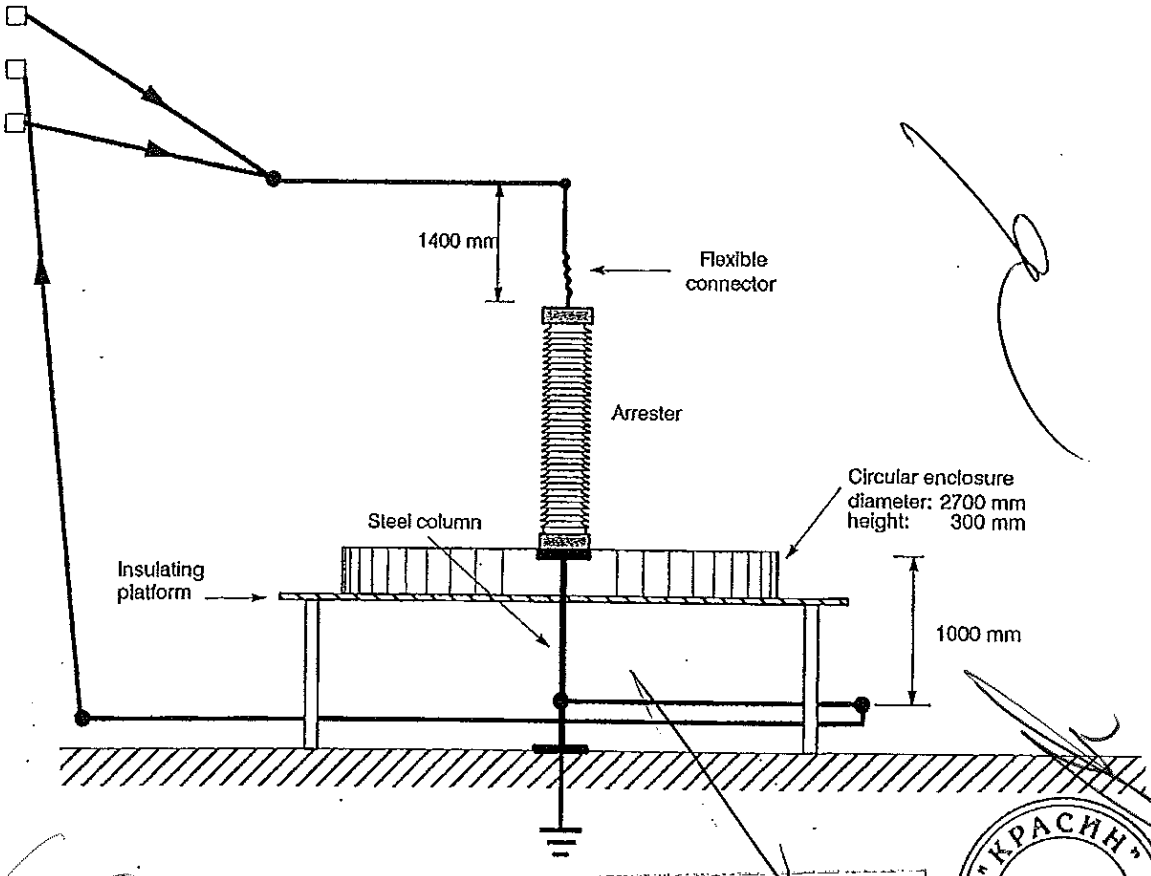
"КРАСИН" СМОЛЯН ООД

TEST ARRANGEMENT

Top view:



Side view:



000140

ЗЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

KEMA

REPORT 566-01			TABLE WITH TEST CIRCUITS				PAGE 3	
TEST CIRCUIT			S01	S02	S03	S04	S05	
Number of phases			1	1	1	1	1	
Power frequency		Hz	50	50	50	50	50	
Generator neutral			not earthed	not earthed	not earthed	not earthed	not earthed	
Transformer connections			single phase	single phase	single phase	single phase	single phase	
Short-circuit point			earthed	earthed	earthed	earthed	earthed	
Circuit impedance		Ω	21.1	0.69	1.80	3.75	0.45	
Power factor			< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	
TRV control elements added	Capacitance in parallel	C_1 µF	0.66	1.83	1.83	1.83	0.66	
	Resistance in series	R_1 Ω	21.5	21.5	21.5	21.5	21.5	
	Resistance in parallel	R_1 Ω						
	Inductance in parallel with R_1	L_1 mH						
	Time delay Capacitance	C_d nF						
Prospective TRV	TRV peak value	u_c kV						
	Time co-ordinate	t_3 µs						
	Time delay	t_d µs						
	Based on	kVrms						
	Depression							
	Rate-of-rise	kV/µs						

C01E

000141

ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

TABLE WITH TEST RESULTS

REPORT 566–01	Checking of the circuit settings for high–current pressure–relief test at rated short–circuit current (Constant voltage method)	TEST CIRCUIT S02 / S01	PAGE 4

Condition before tests: –

Date and test	Test quantities: Applied voltage kV	Peak value of current kA	Symmetrical current: Begin–ning kA	Middle kA	End kA	Average kA	Arc voltage peak value kV	Duration ms	Instant of venting after initiation of current ms	Leakage current I_{pre} mA	Fault current I_{ch} A	Remarks	Physical behaviour: Emission of: Flame	Gas
011122 .4004	48.0	192	68.5	68.9	68.5	68.6		220			29.3	Checking of the prospective rated short–circuit current and the fault current.		
011122 4007	124										29.2	Checking of the overvoltage source and the fault current.		

Condition after tests: –

KEMA

TABLE WITH TEST RESULTS

REPORT 566–01	High–current pressure–relief test at rated short–circuit current (Constant voltage method)	TEST CIRCUIT S01 / S01 / S02	PAGE 5

Condition before tests: Arrester new. Test sample designated P–X4 (120 kV).
Arrester mounted on a pedestal with a height of 30 cm and placed inside a circular enclosure with a diameter of 270 cm and a height of 30 cm.
This complete set–up was placed on top of an insulating platform with a vertical bottom conductor in order to simulate under service conditions.
Top connections made by flexible connectors. Bottom connection fixed on ground–plate.
Photographs 1415201, 1415201.
Ambient temperature: 12 °C.

Pre–failing test:
Arrester pre–failed by a constant voltage source (133 kV) initially with a leakage current of approx. 80 mA. See test 011122–4008.
After 4 min and 35 s when failing is complete, the arrester is subjected to a fault current of approx. 30 A for approx. 4 s. See test 011122–4009.

High–current short–circuit test:
Initially the arrester is subjected to a fault current of approx. 30 A. After 1.5 s the make–switch (MS2) closes, short–circuiting the capacitive impedance leading to the high–current to flow. See test 011122–4010.

Flame detection by means of photo–resistors on top and bottom of arrester.

Date and test	Test quantities: Applied voltage kV	Peak value of current kA	Symmetrical current: Beginning kA	Middle kA	End kA	Average kA	Arc voltage peak value kV	Duration ms	Instant of venting after initiation of current ms	Leakage current I_{pre} mA	Fault current I_{ch} A	Remarks	Physical behaviour: Emission of: Flame	Gas
011122 4008	133									77.0		Pre–fail test.	none	none
4 min 35 s														
011122 4009	133										32.0	Pre–fail test.	none	none
4 min														
011122 4010	49.4	163		72.0			2.82	202	2.26		30.0	High–current test.	heavy	heavy

Condition after tests: The arrester housing cracked open. Photographs 1415203, 145204.
Only small fragments of material (< 10 g) and some larger parts of the polymeric housing found outside the enclosure.

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871001

TABLE WITH TEST RESULTS

REPORT 566–01	Checking of the circuit settings for high–current pressure–relief test at reduced short–circuit current (Constant voltage method)	TEST CIRCUIT S03	PAGE 6

Condition before tests: –

Date and test	Test quantities: Applied voltage (kV)	Peak value of current (kA)	Symmetrical current: Beginning (kA)	Middle (kA)	End (kA)	Average (kA)	Arc voltage peak value (kV)	Duration (ms)	Instant of venting after initiation of current (ms)	Leakage current I_{pre} (mA)	Fault current I_{ch} (A)	Remarks	Physical behaviour: Emission of: Flame	Gas
011122 4013	49.4	71.2		27.6				130			23.5	Checking of the prospective reduced short–circuit current and the fault current.		

Condition after tests: –

0001424

KEMA

TABLE WITH TEST RESULTS

REPORT 566–01	High–current pressure–relief test at reduced short–circuit current (Constant voltage method)	TEST CIRCUIT S01 / S01 / S03	PAGE 7

Condition before tests: Arrester new. Test sample designated P–X5 (120 kV).
Arrester mounted on a pedestal with a height of 30 cm and placed inside a circular enclosure with a diameter of 270 cm and a height of 30 cm.
This complete set–up was placed on top of an insulating platform with a vertical bottom conductor in order to simulate under service conditions.
Top connections made by flexible connectors. Bottom connection fixed on ground–plate.
Photograph 1415205.
Ambient temperature: 12 °C.

Pre–failing test:
Arrester pre–failed by a constant voltage source (133 kV) initially with a leakage current of approx. 80 mA. See test 011122–4014.
After 5 min, when failing is complete, the arrester is subjected to a fault current of approx. 30 A for approx. 3 s. See test 011122–4015.

Reduced high–current short–circuit test:
Initially the arrester is subjected to a fault current of approx. 30 A. After 1.5 s the make–switch (MS2) closes, short–circuiting the capacitive impedance leading to the reduced high–current to flow. See test 011122–4016.

Flame detection by means of photo–resistors on top and bottom of arrester.

Date and test	Test quantities: Applied voltage kV	Peak value of current kA	Symmetrical current: Beginning kA	Middle kA	End kA	Average kA	Arc voltage peak value kV	Duration ms	Instant of venting after initiation of current ms	Leakage current I_{pre} mA	Fault current I_{ch} A	Remarks	Physical behaviour: Emission of: Flame	Gas
011122 4014	133									80		Pre–fail test.	none	none
5 min														
011122 4015	133										32.4	Pre–fail test.	none	none
5 min														
011122 4016	46.3	59.0		27.6				218	2.80		23.0	Reduced high–current test.	heavy	heavy

Condition after tests: The arrester housing cracked open. Photographs 1415206, 1415207.
Only small fragments of material (< 10 g) and some parts of the polymeric housing found outside the enclosure.

TABLE WITH TEST RESULTS

REPORT 566–01	Checking of the circuit settings for high–current pressure–relief test at reduced short–circuit current (Constant voltage method)	TEST CIRCUIT S04	PAGE 8

Condition before tests: –

Date and test	Test quantities: Applied voltage kV	Peak value of current kA	Symmetrical current: Begin–ning kA	Middle kA	End kA	Average kA	Arc voltage peak value kV	Duration ms	Instant of venting after initiation of current ms	Leakage current I_{pro} mA	Fault current I_{ch} A	Remarks	Physical behaviour: Emission of: Flame	Gas
011122 4019	50.4	40.8		14.0				220			24.5	Checking of the prospective reduced short–circuit current and the fault current.		

Condition after tests: –

TABLE WITH TEST RESULTS

REPORT 566–01	High–current pressure–relief test at reduced short–circuit current (Constant voltage method)	TEST CIRCUIT S01 / S01 / S04	PAGE 9

Condition before tests: Arrester new. Test sample designated P–X6 (120 kV).
Arrester mounted on a pedestal with a height of 30 cm and placed inside a circular enclosure with a diameter of 270 cm and a height of 30 cm.
This complete set–up was placed on top of an insulating platform with a vertical bottom conductor in order to simulate under service conditions.
Top connections made by flexible connectors. Bottom connection fixed on ground–plate.
Photograph 1415210.
Ambient temperature: 12 °C.

Pre–failing test:
Arrester pre–failed by a constant voltage source (133 kV) initially with a leakage current of approx. 80 mA. See test 011122–4020.
After 6 min, when failing is complete, the arrester is subjected to a fault current of approx. 30 A for approx. 3 s. See test 011122–4021.

Reduced high–current short–circuit test:
Initially the arrester is subjected to a fault current of approx. 30 A. After 1.5 s the make–switch (MS2) closes, short–circuiting the capacitive impedance leading to the reduced high–current to flow. See test 011122–4022.

Flame detection by means of photo–resistors on top and bottom of arrester.

Date and test	Test quantities: Applied voltage kV	Peak value of current kA	Symmetrical current: Begin–ning kA	Middle kA	End kA	Average kA	Arc voltage peak value kV	Duration ms	Instant of venting after initiation of current ms	Leakage current I_{pre} mA	Fault current I_{ch} A	Remarks	Physical behaviour: Emission of: Flame	Gas
011122 4020	133									84.0		Pre–fail test.	none	none
6 min														
011122 4021	133										32.5	Pre–fail test.	none	none
6 min														
011122 4022	51.0	32.7		13.8			2.49	225	1.30		24.1	Reduced high–current test.	heavy	heavy

Condition after tests: The arrester housing cracked open. Photographs 1415211, 1415212.
Only small fragments of material (< 10 g) and some parts of the polymeric housing found outside the enclosure.

TABLE WITH TEST RESULTS

REPORT 566–01	Checking of the circuit settings for low–current pressure–relief test (Constant voltage method)	TEST CIRCUIT S05	PAGE 10

Condition before tests: –

Date and test	Test quantities: Applied voltage kV	Peak value of current kA	Symmetrical current: Begin–ning kA	Middle kA	End kA	Average kA	Arc voltage peak value kV	Duration s	Instant of venting after initiation of current ms	Leakage current I_{pre} mA	Fault current I_{ch} A	Remarks	Physical behaviour: Emission of: Flame	Gas
011122 4027	123	1.39	0.613	0.608	0.613	0.610		1.00			24.5	Checking of the prospective low short–circuit current and the fault current.		

Condition after tests: –

KEMA

TABLE WITH TEST RESULTS

REPORT 566–01	Low–current pressure–relief test (Constant voltage method)	TEST CIRCUIT S01 / S01 / S05	PAGE 11

Condition before tests: Arrester new. Test sample designated P–X8 (120 kV).
Arrester mounted on a pedestal with a height of 30 cm and placed inside a circular enclosure with a diameter of 270 cm and a height of 30 cm.
This complete set–up was placed on top of an insulating platform with a vertical bottom conductor in order to simulate under service conditions.
Top connections made by flexible connectors. Bottom connection fixed on ground–plate.
Photograph 1415114.
Ambient temperature: 12 °C.

Pre–failing test:
Arrester pre–failed by a constant voltage source (133 kV) initially with a leakage current of approx. 80 mA. See test 011122–4028.
After 7 min, when failing is complete, the arrester is subjected to a fault current of approx. 30 A for approx. 3 s. See test 011122–4029.

Low high–current short–circuit test:
Initially the arrester is subjected to a fault current of approx. 30 A. After 1,5 s the make–switch (MS2) closes, short–circuiting the capacitive impedance leading to the low–current test to flow. See test 011122–4030.

Flame detection by means of photo–resistors on top and bottom of arrester.

Date and test	Test quantities: Applied voltage kV	Peak value of current kA	Symmetrical current: Beginning kA	Middle kA	End kA	Average kA	Arc voltage peak value kV	Duration s	Instant of venting after initiation of current ms	Leakage current I_{pre} mA	Fault current I_{ch} A	Remarks	Physical behaviour: Emission of: Flame	Gas
011122 4028 7 min	131									87.0		Pre–fail test.	none	none
011122 4029 10 min	131										32.8	Pre–fail test.	none	none
011122 4030	122	1.36	0.602	0.605	0.605	0.604	4.10	1.04	4.10		24.1	Low–current test.	heavy	heavy

Condition after tests: The arrester housing cracked open. Photograph 1415215.
Only small fragments of material (< 10 g) and some parts of the polymeric housing found outside the enclosure.

980812

TEST–CIRCUIT DIAGRAM

REPORT No. 566–01		TEST CIRCUIT No. S01

CIRCUIT COMPONENTS

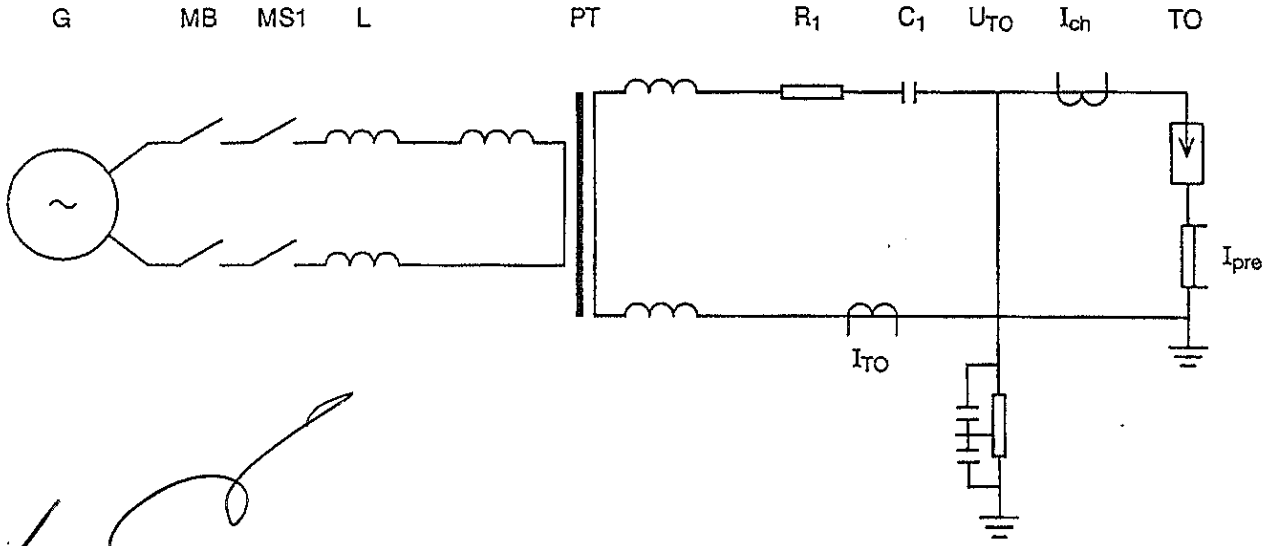
G = Generator
MB = Master Breaker
MS = Make Switch
PT = Power Transformer

R = Resistor
C = Capacitor
L = Inductance

TO = Test Object

MEASUREMENTS

U = Voltage Measurement
I = Current Measurement



KEMA

TEST–CIRCUIT DIAGRAM

REPORT No. 566–01		TEST CIRCUIT No. S02 to S05

CIRCUIT COMPONENTS

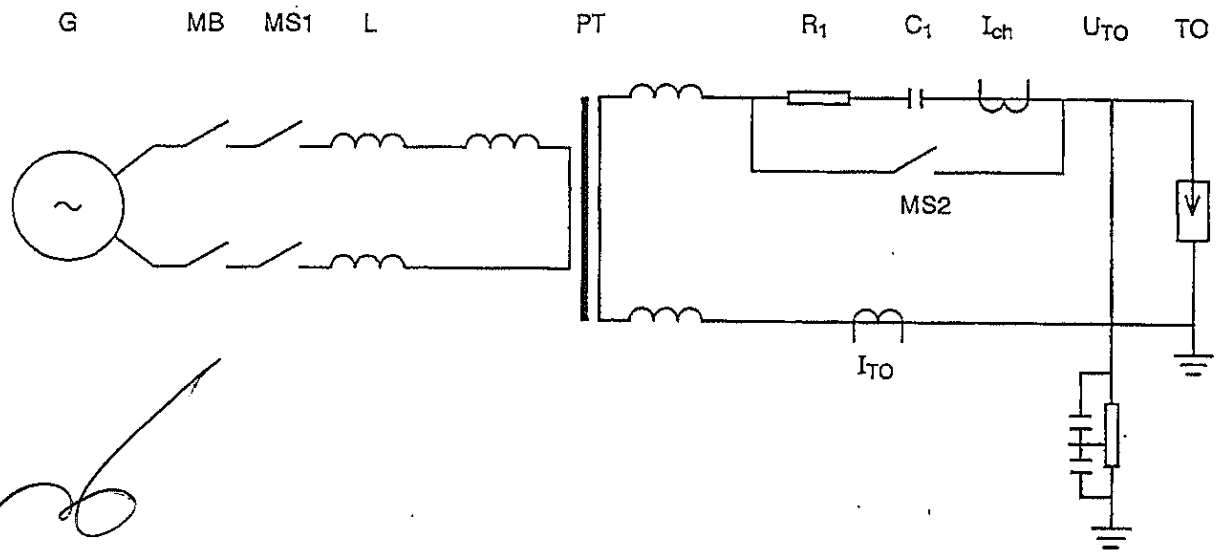
G = Generator
MB = Master Breaker
MS = Make Switch
PT = Power Transformer

R = Resistor
C = Capacitor
L = Inductance

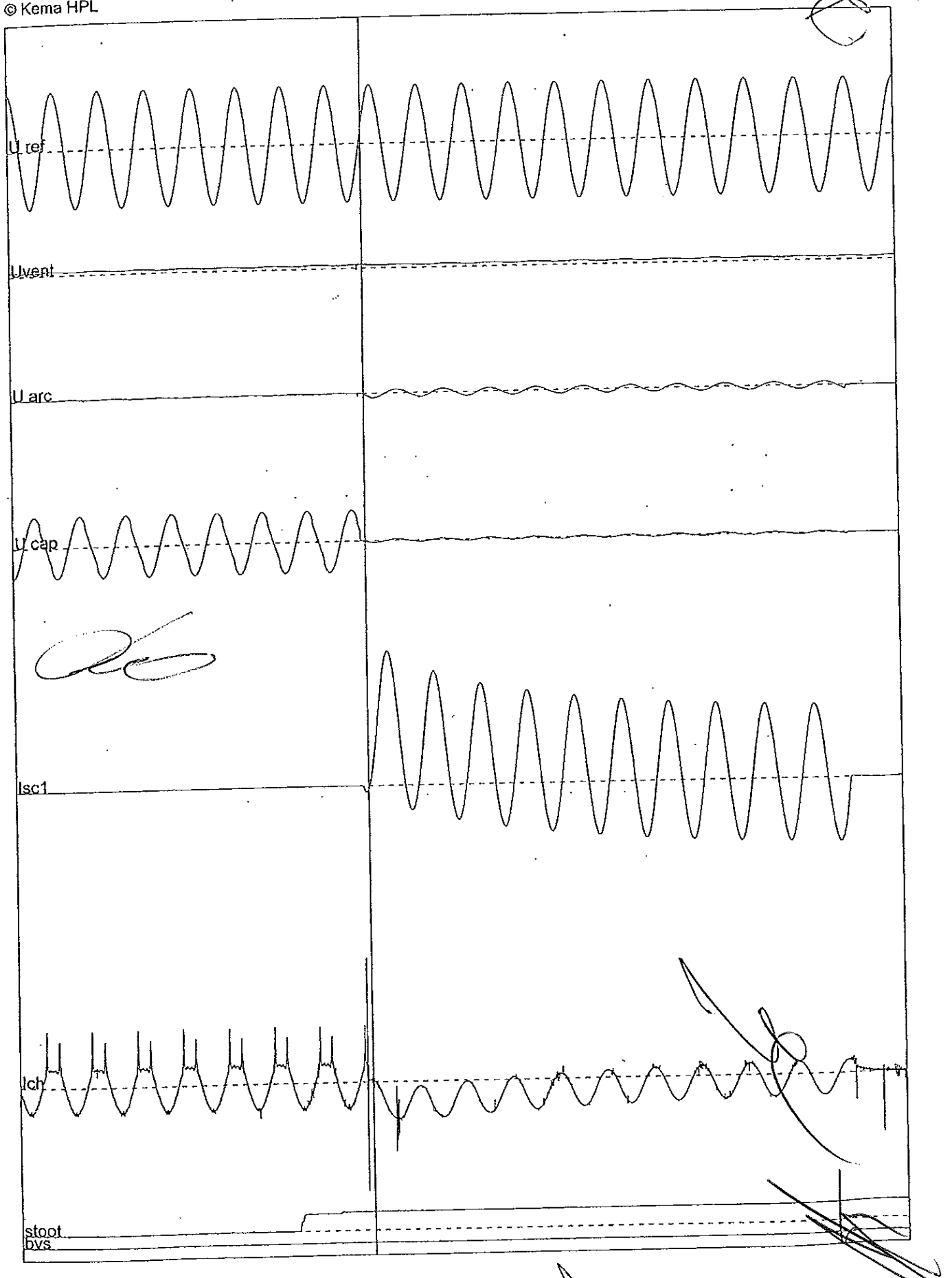
TO = Test Object

MEASUREMENTS

U = Voltage Measurement
I = Current Measurement



Test: 011122-4004

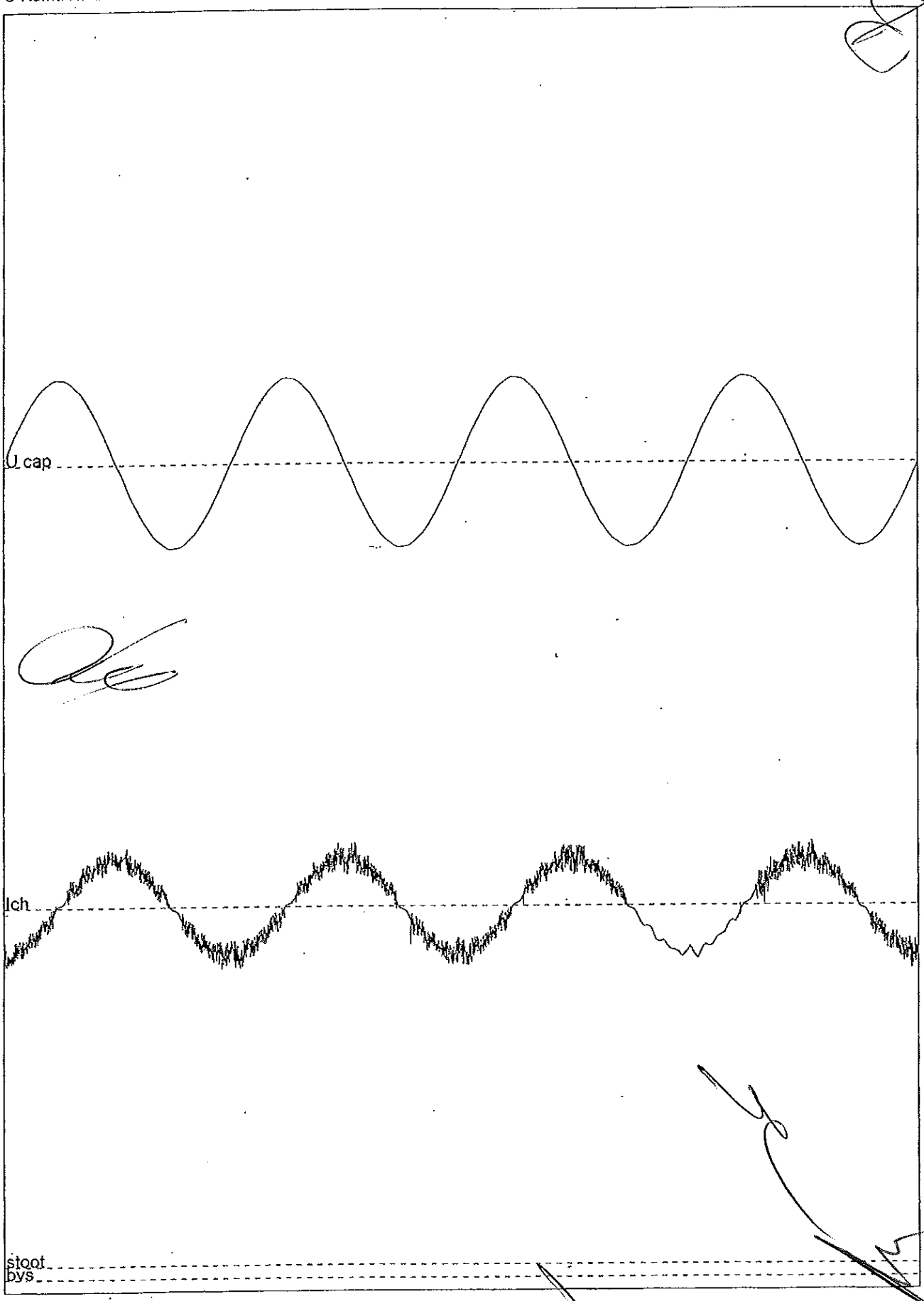


400 ms

Project: 40175147 File: 9.dat

000152

Test: 011122-4007

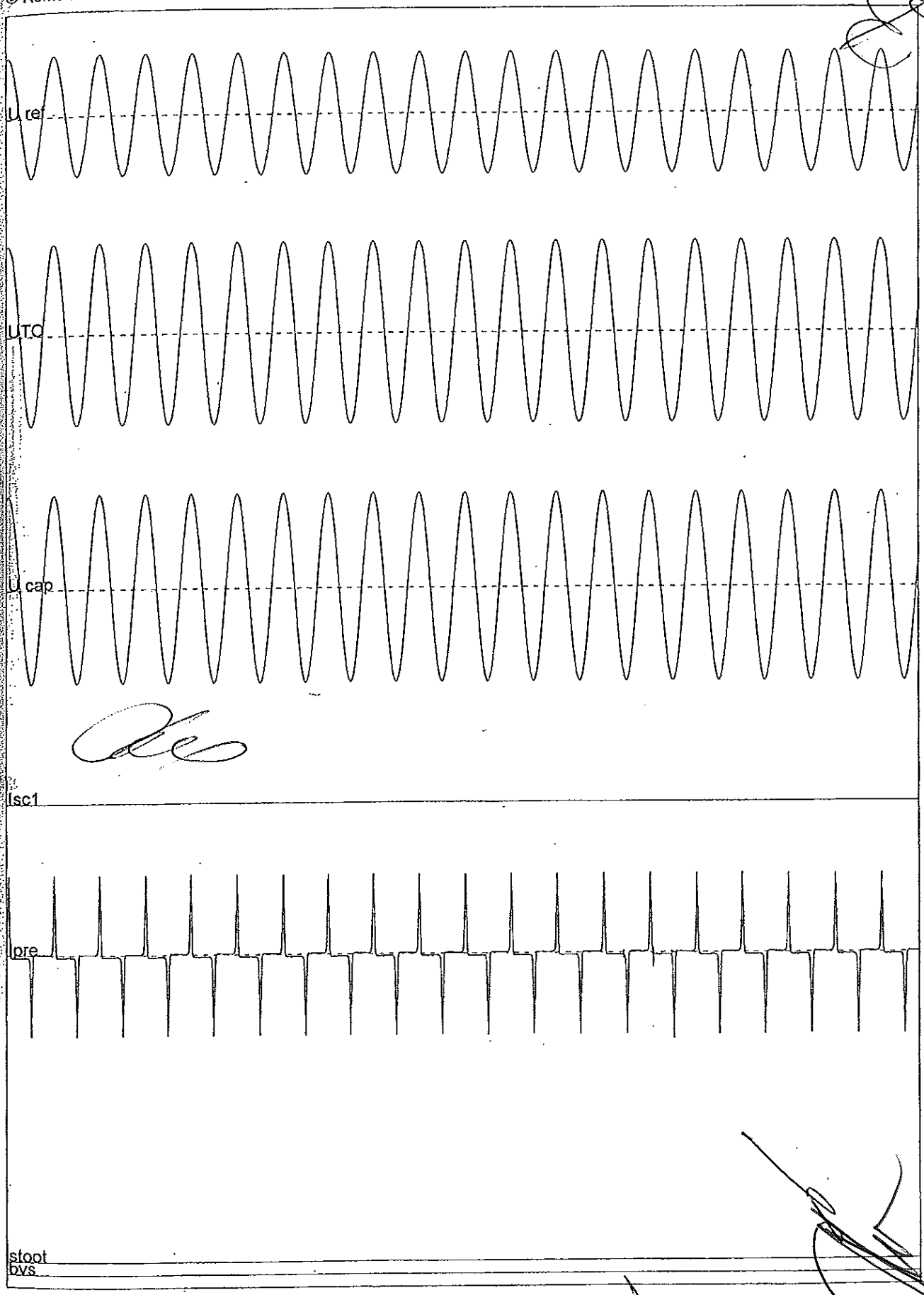


Project: 40175147 File: 12.dat

80.1 ms

000153

Test: 011122-4008



Project: 40175147 File: 13.dat

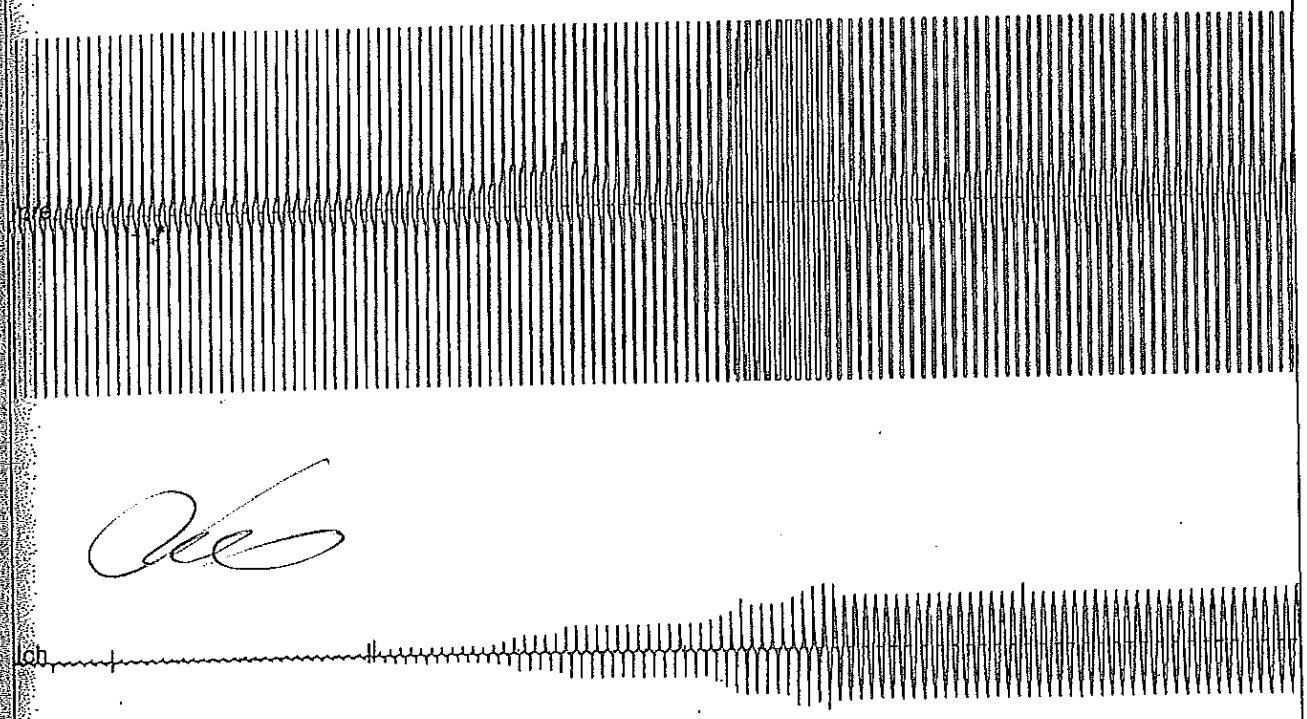
400 ms

000154

ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

Test: 011122-4009



2.50 s

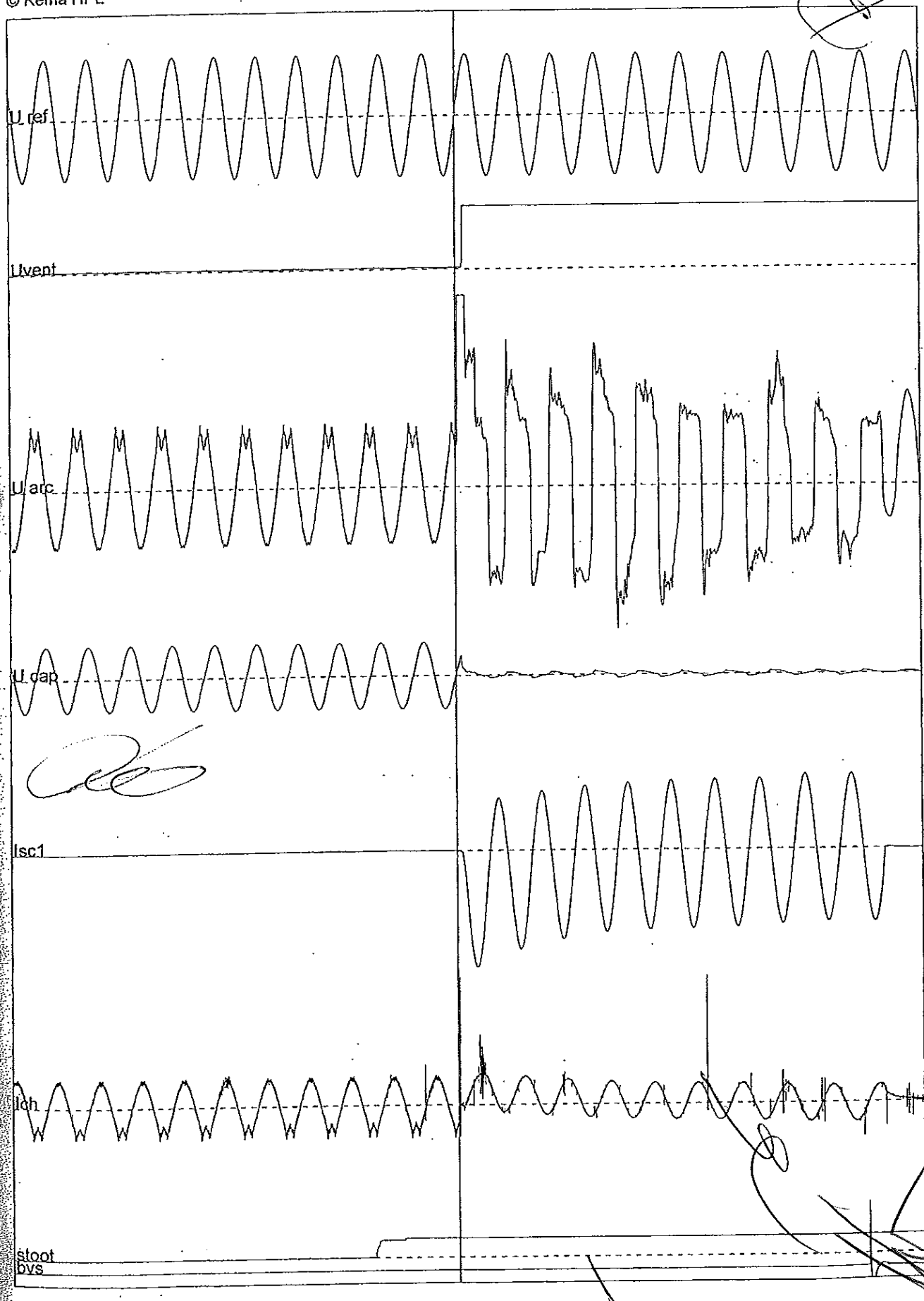
Project: 40175147 File: 14.dat

000155

ЗЯРНЫЙ С ОРИГИНАЛА

"КРАСИН" СМОЛЯН

Test: 011122-4010



Project: 40175147 File: 15.dat

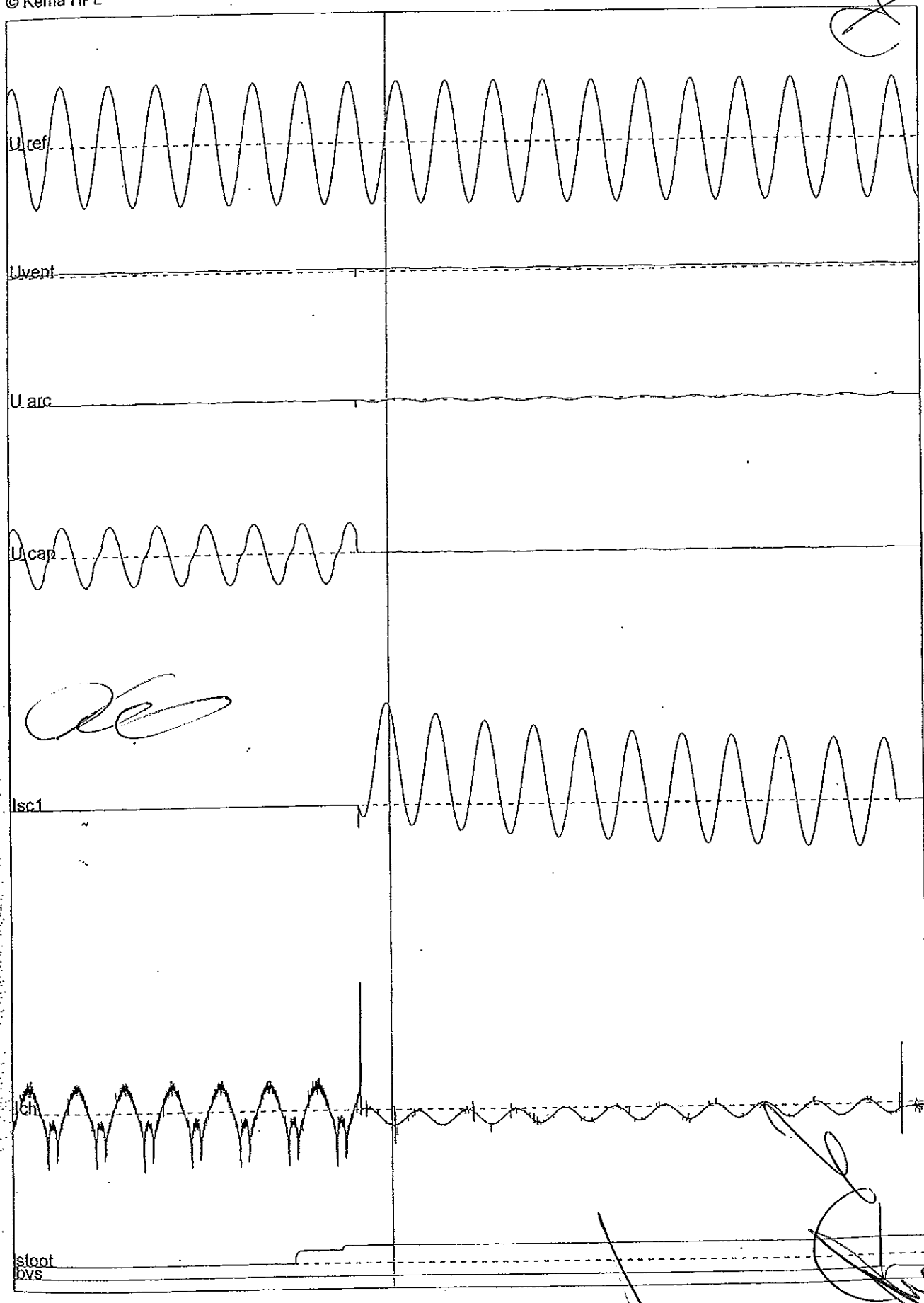
436 ms

000156

ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

Test: 011122-4013



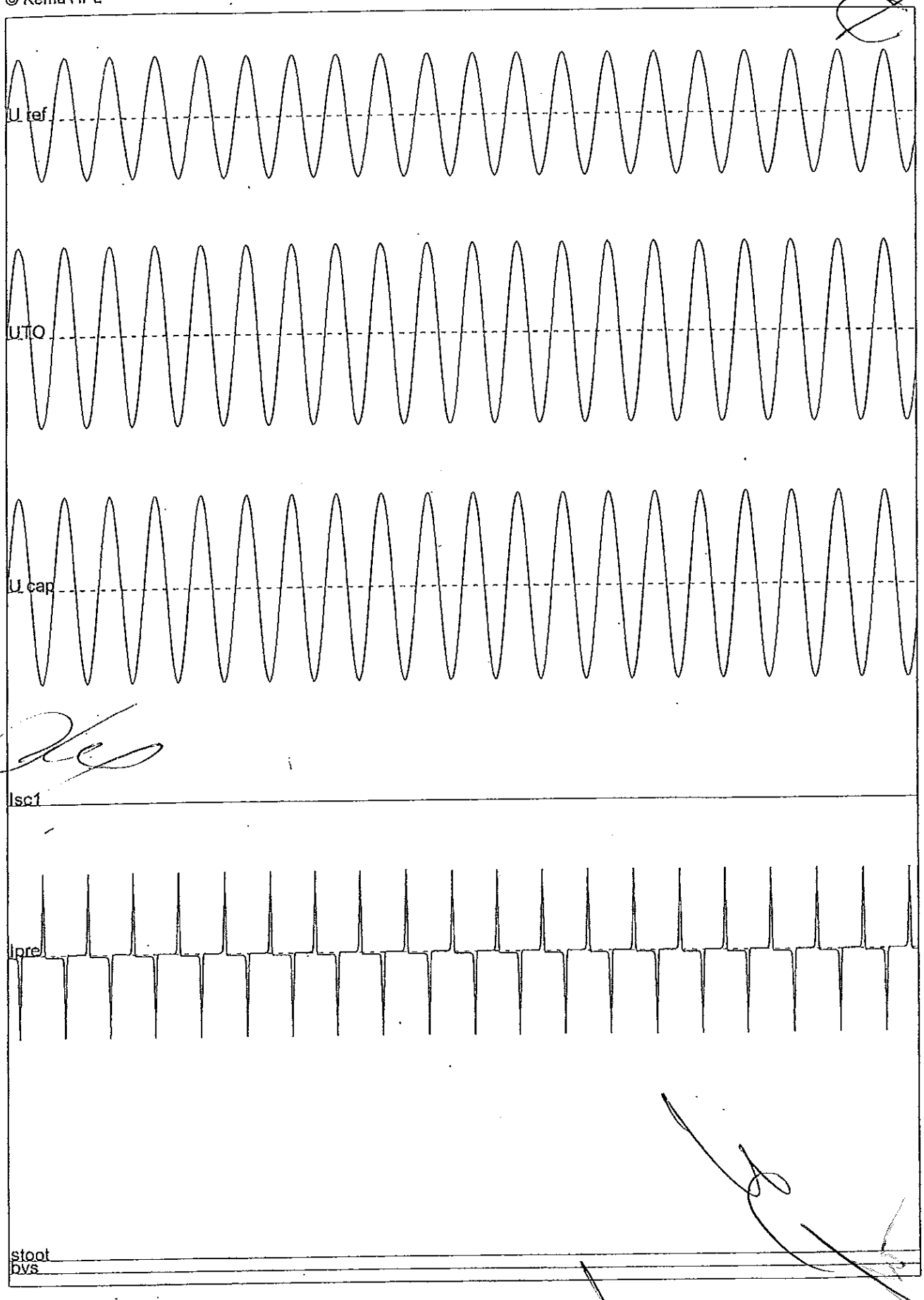
Project: 40175147 File: 18.dat

000157

ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

Test: 011122-4014



Project: 40175147 File: 19.dat

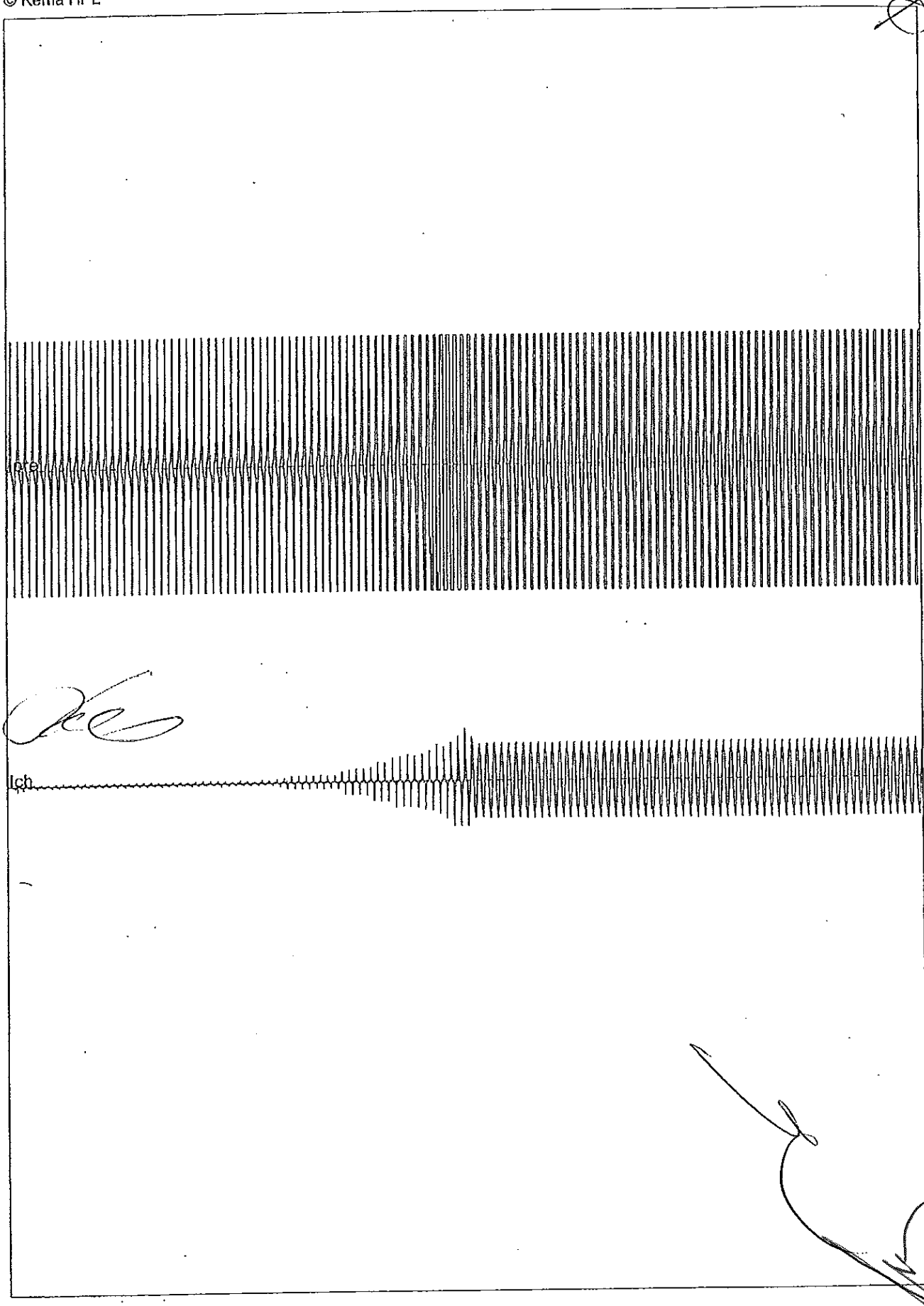
400 ms

000158

ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

Test: 011122-4015



Project: 40175147 File: 20.dat

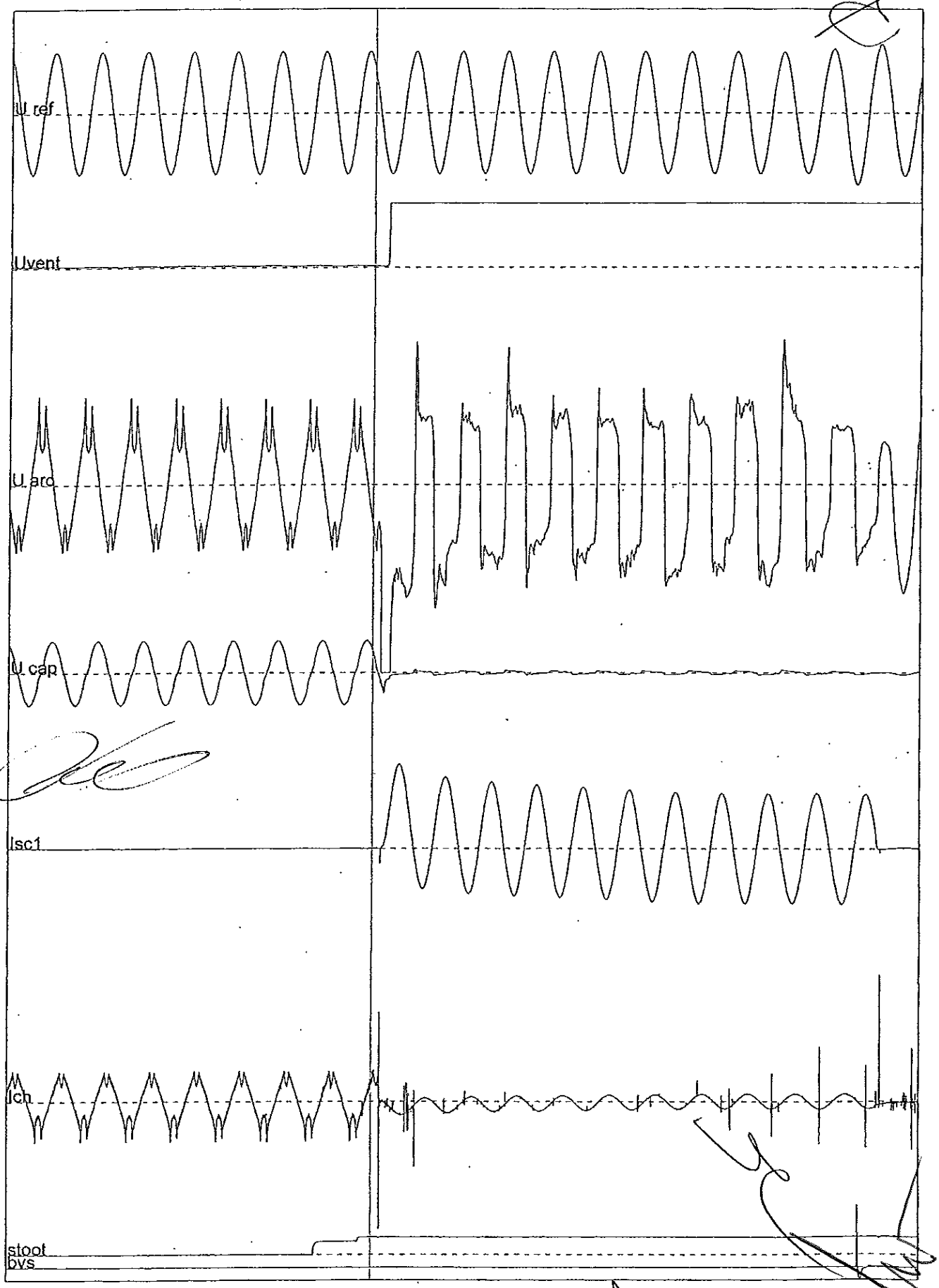
2.50 s

000159

ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

Test: 011122-4016



Project: 40175147 File: 21.dat

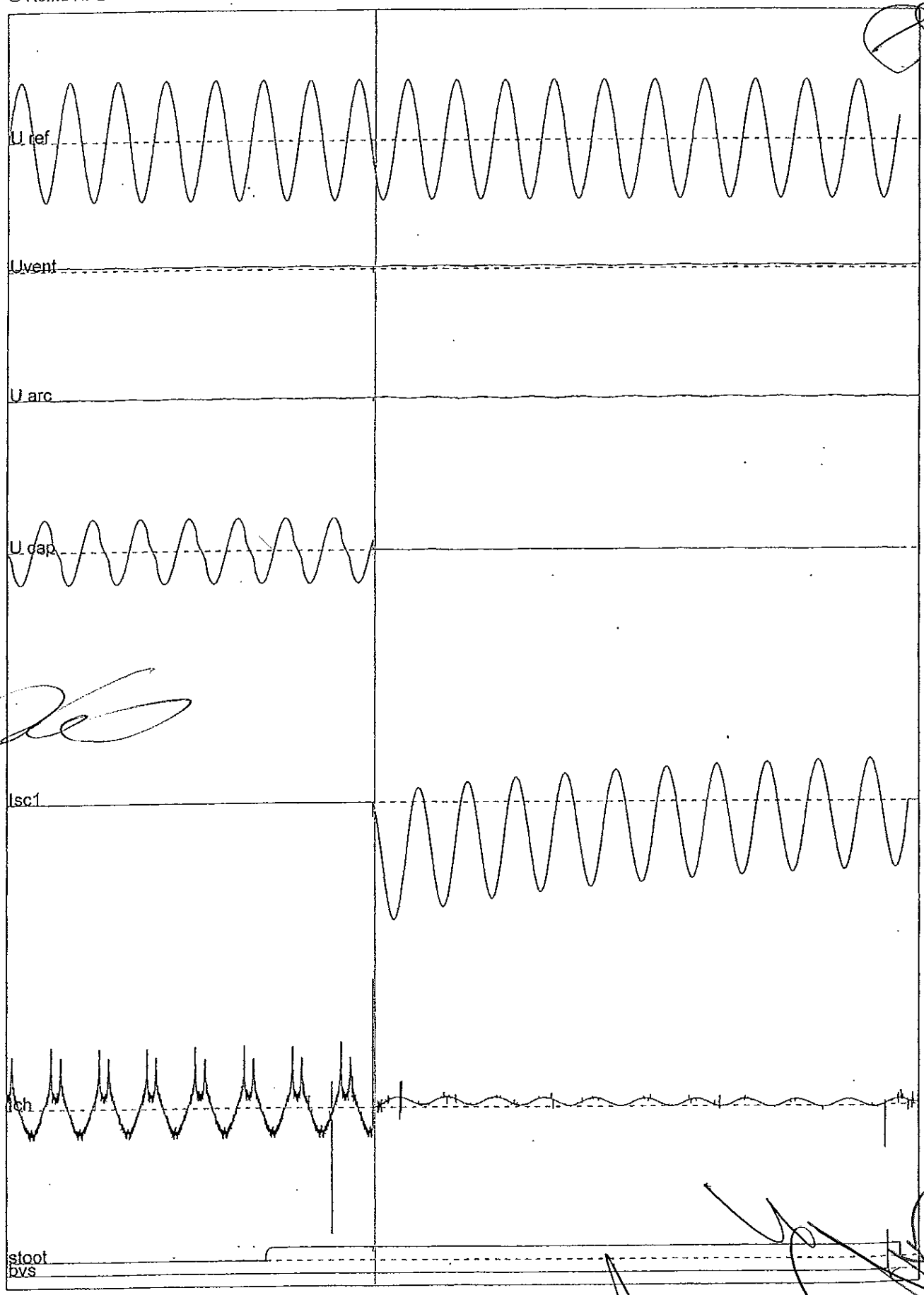
402 ms

000160

ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

Test: 011122-4019



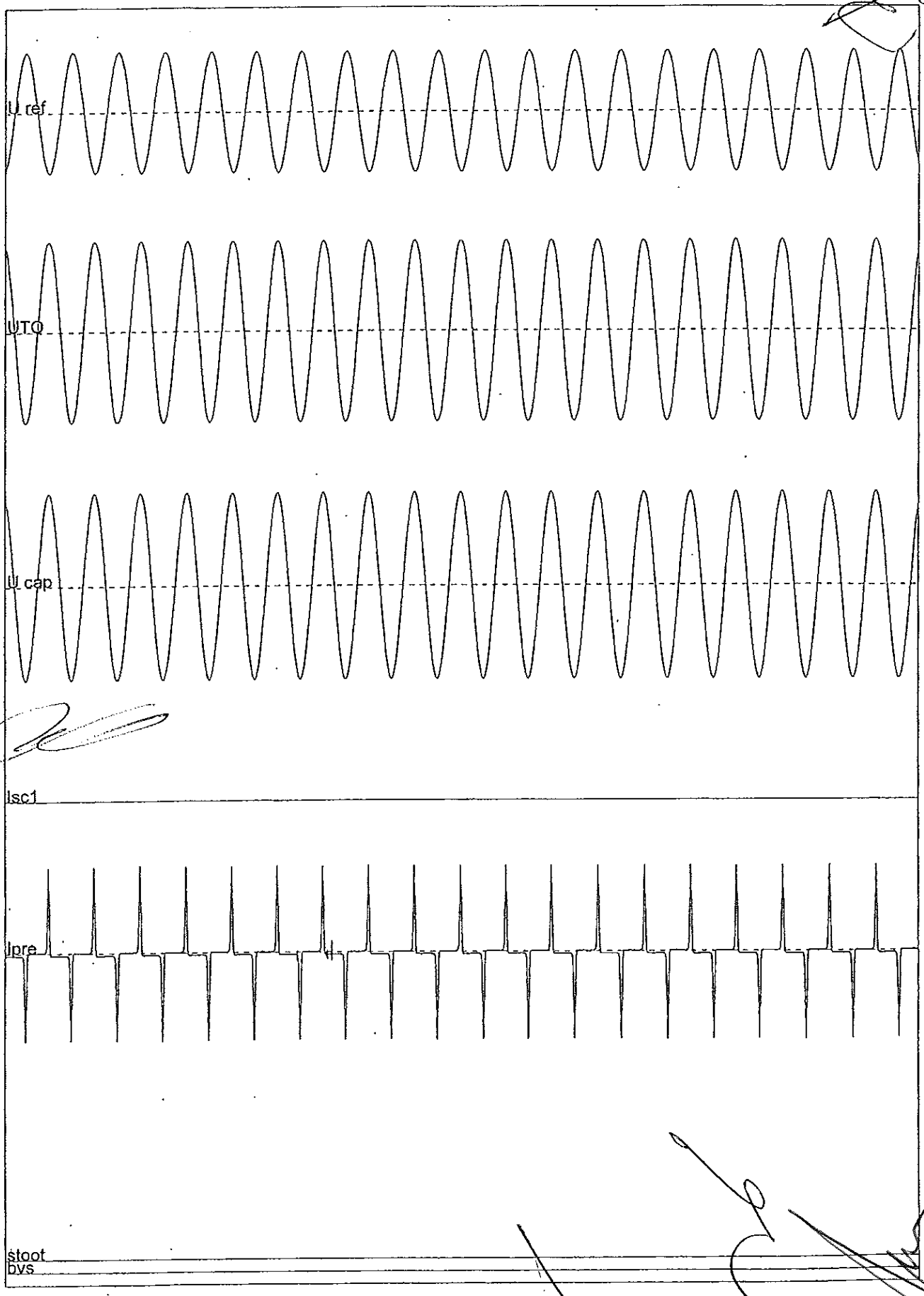
Project: 40175147 File: 30.dat

000161

ЗАРЕЗ С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

Test: 011122-4020



Project: 40175147 File: 32.dat

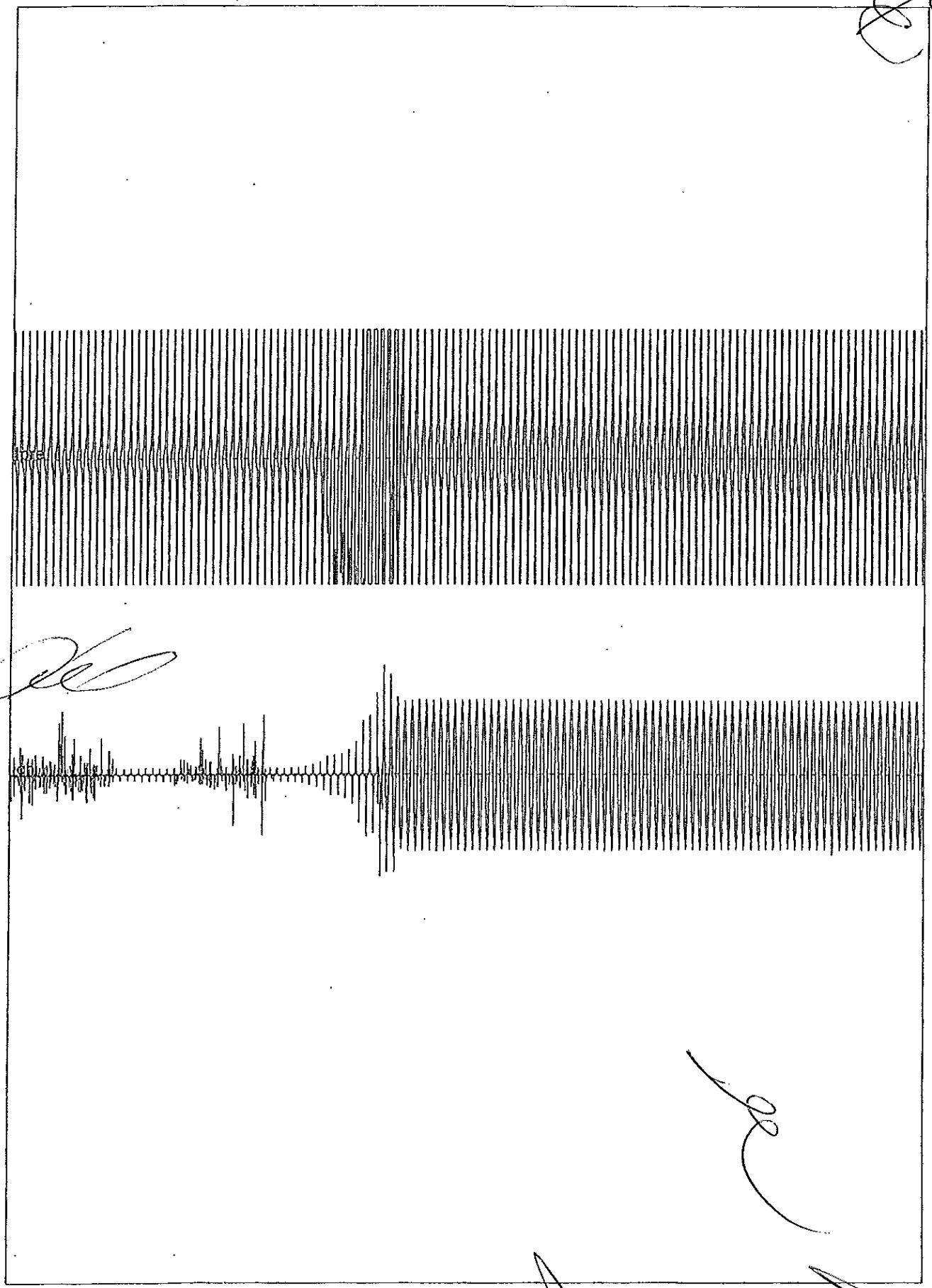
400 ms

000162

ВЕРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

Test: 011122-4021



Project: 40175147 File: 33.dat

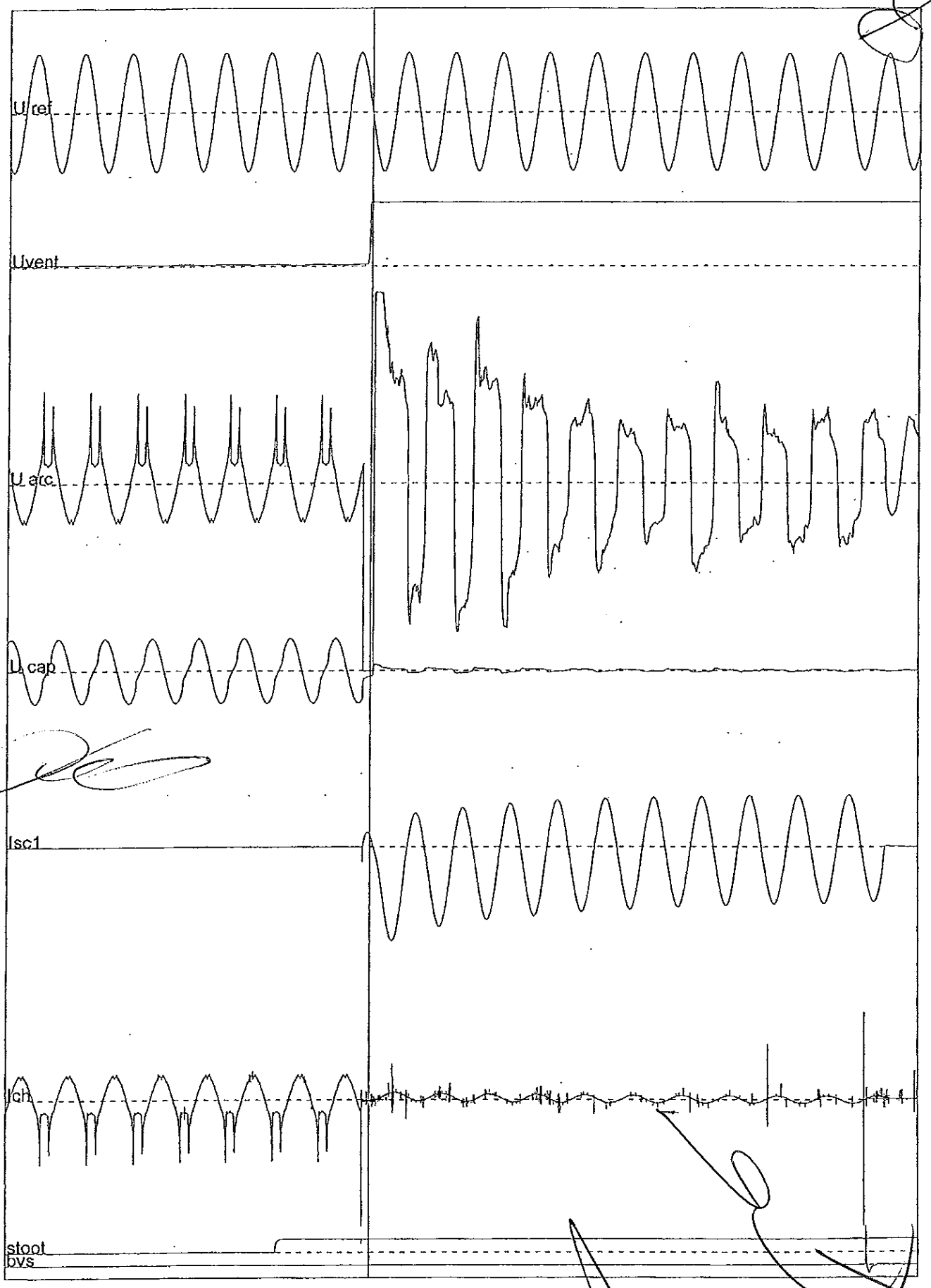
2.54.3

000163

ЗЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

Test: 011122-4022



Project: 40175147 File: 34.dat

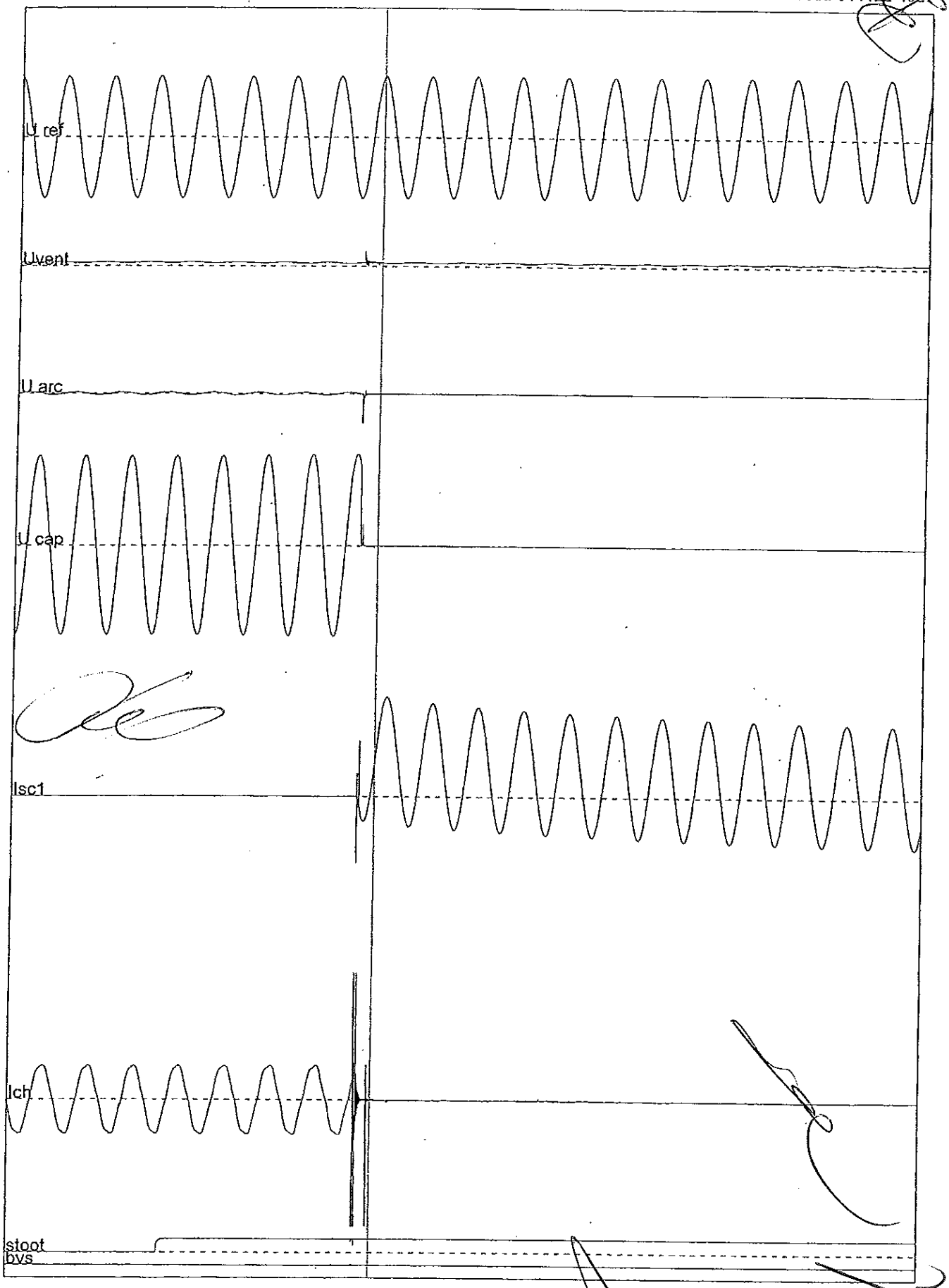
400 ms

000164

ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

Test: 011122-4025



Project: 40175147 File: 40.dat

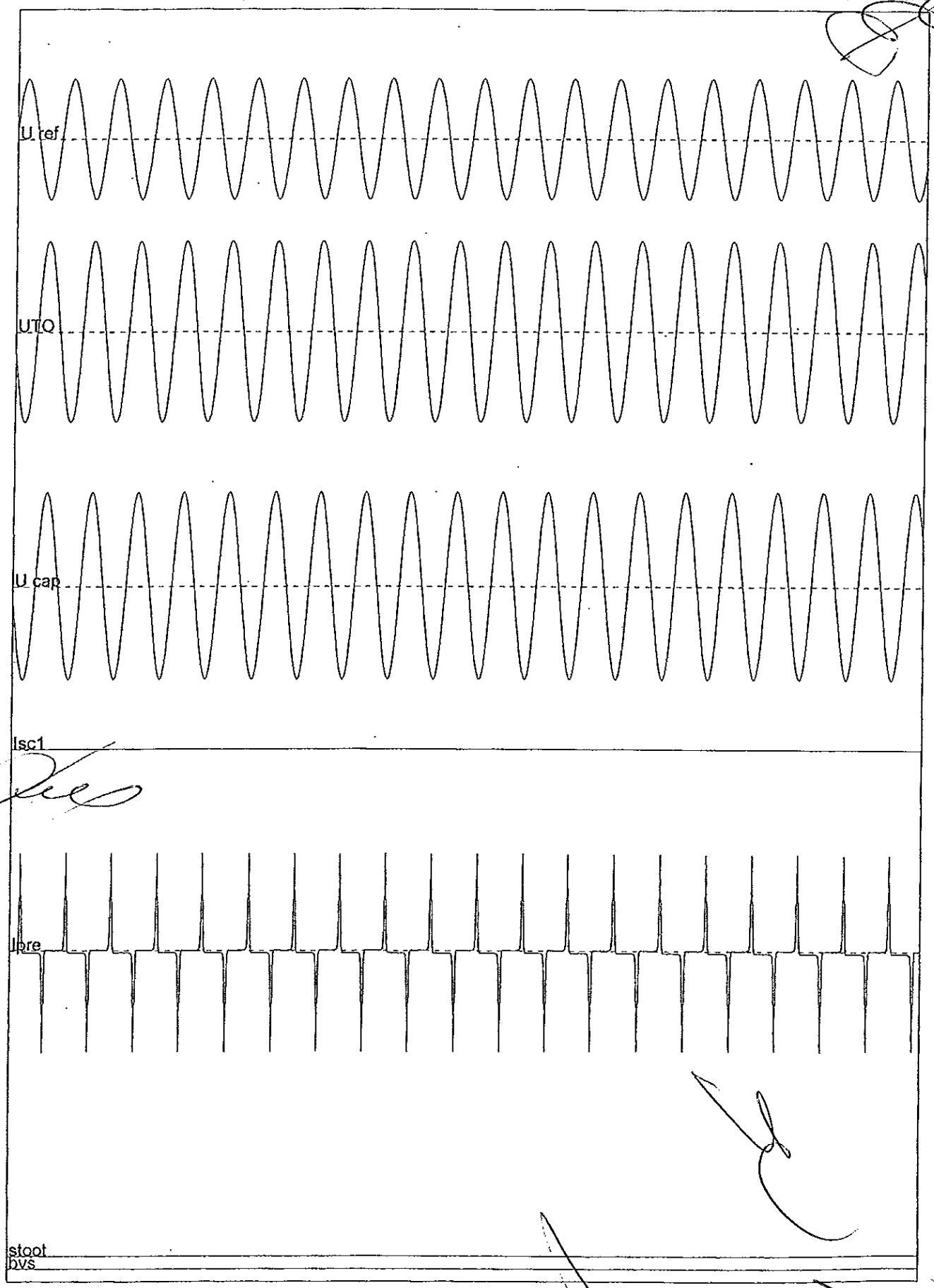
400 ms

000165

ЗАВЕРЕНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

Test: 011122-4028



Project: 40175147 File: 42.dat

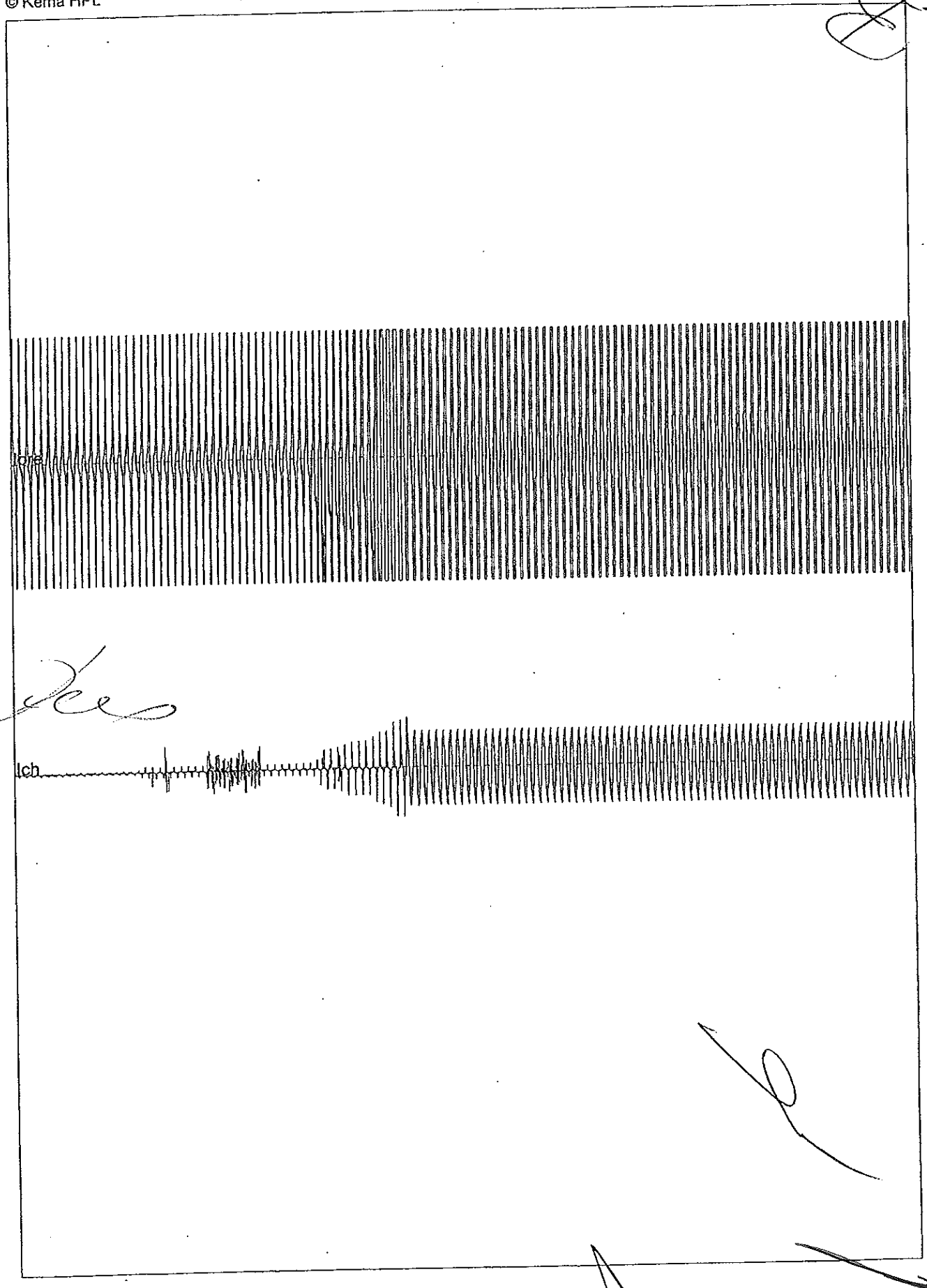
400 ms

000166

ВЕРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

Test: 011122-4029



2.51 s

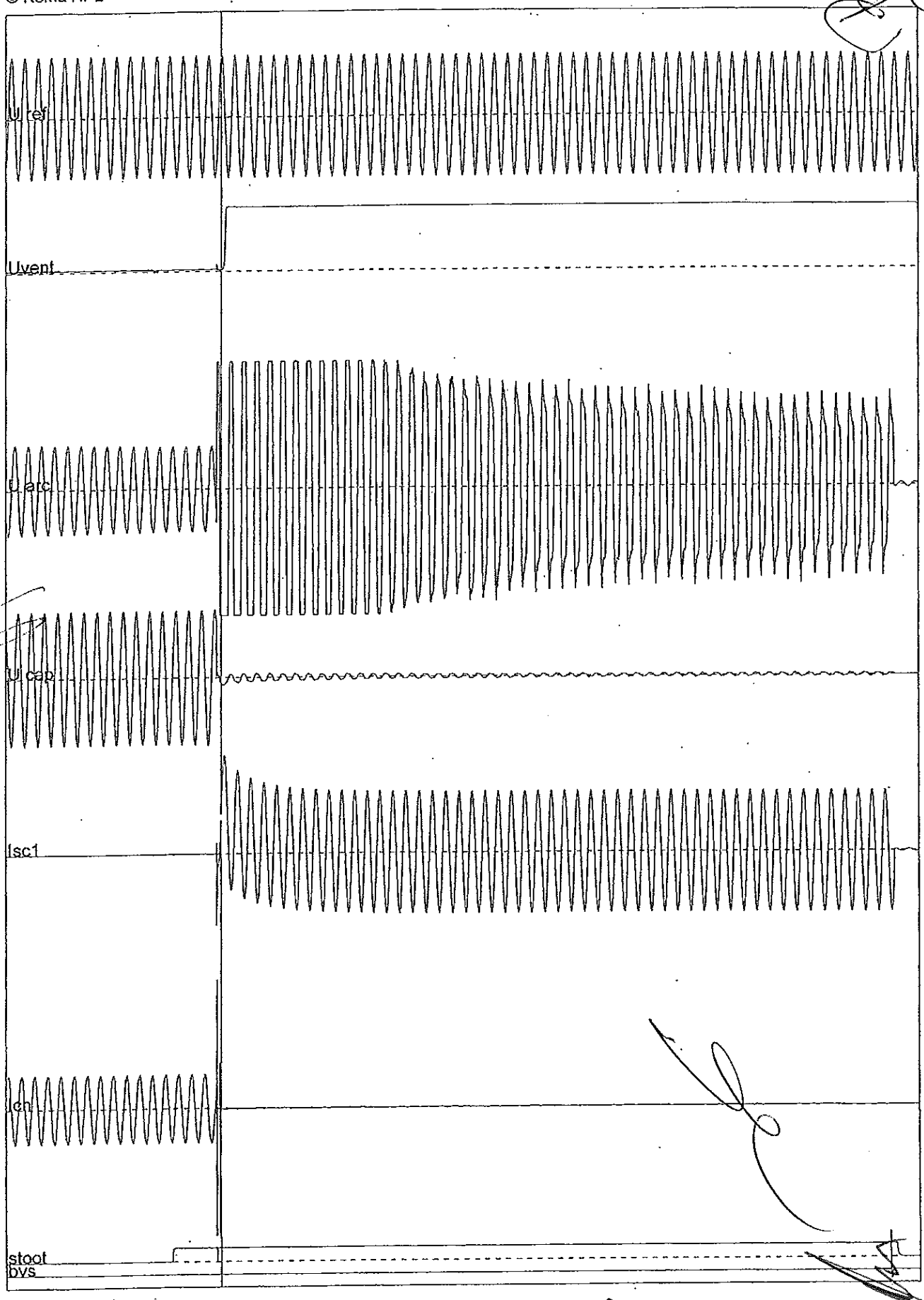
Project: 40175147 File: 43.dat

000167

ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

Test: 011122-4030



Project: 40175147 File: 45.dat

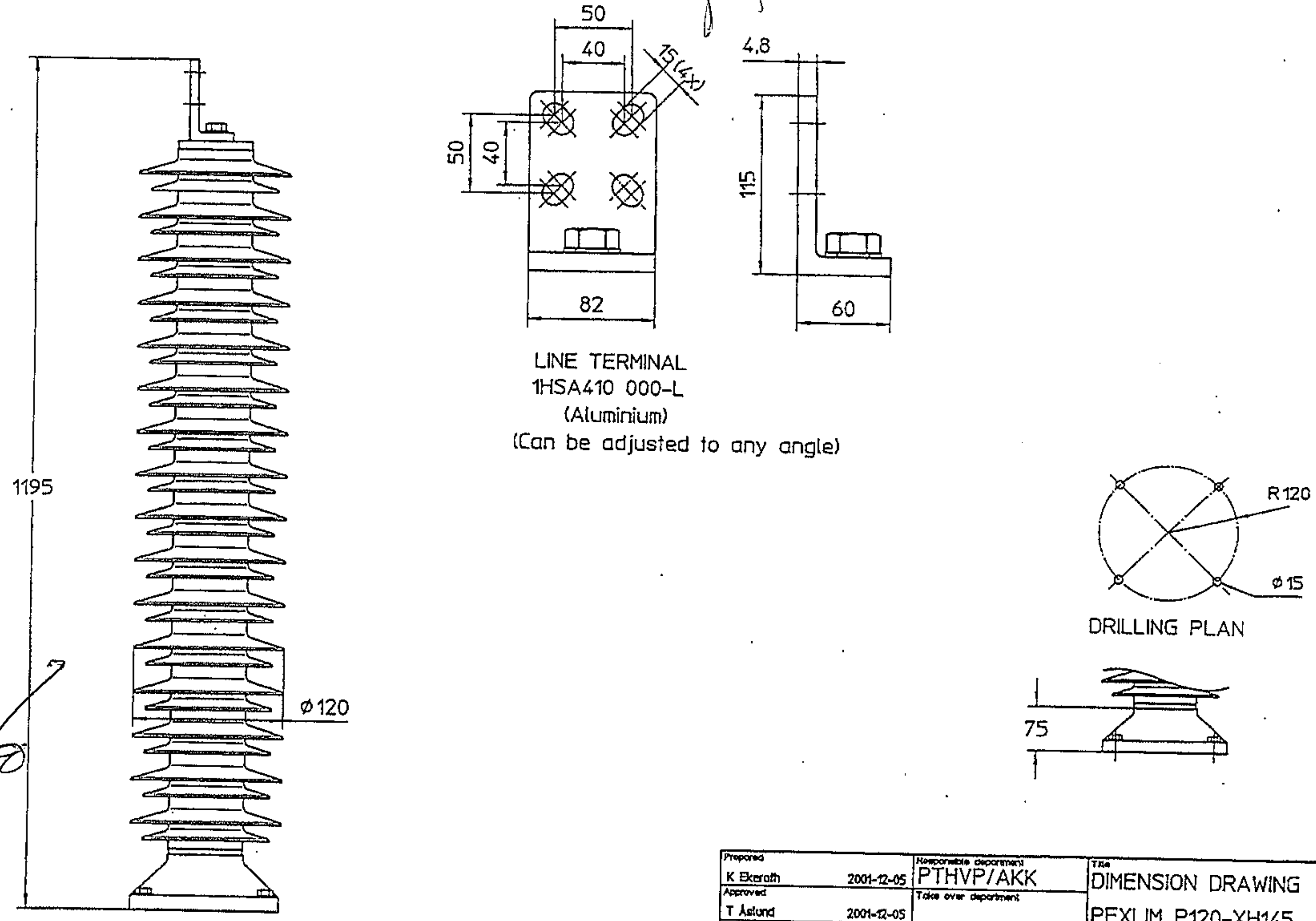
1.40 s

000168

ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

PEXLIM P120-XH145
Creepage distance: 3625 mm
Weight: 42 kg



Prepared: K Ekeroth 2001-12-05	Responsible department: PTHVP/AKK	Title: DIMENSION DRAWING PEXLIM P120-XH145	Language: en
Approved: T Åslund 2001-12-05	Take over department:		Sheet: 1
Revision: -			
ABB Power Technology Products		Document no. LAK 5869	Cont: -

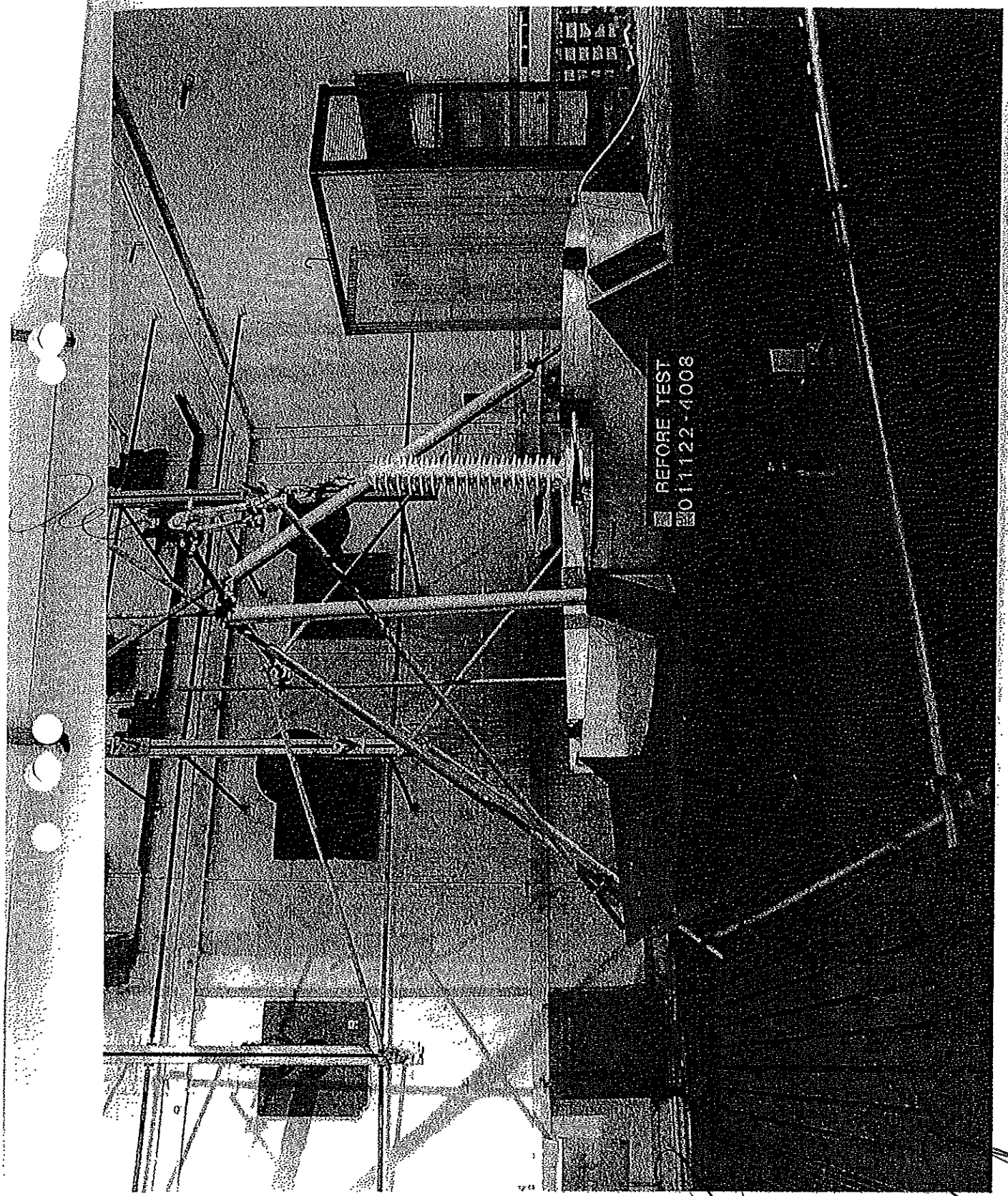
000169

ВЯРНО С ОРИГИНАЛА

„КАСИН“ ООД СМОЛЯН

KEMA

1415201



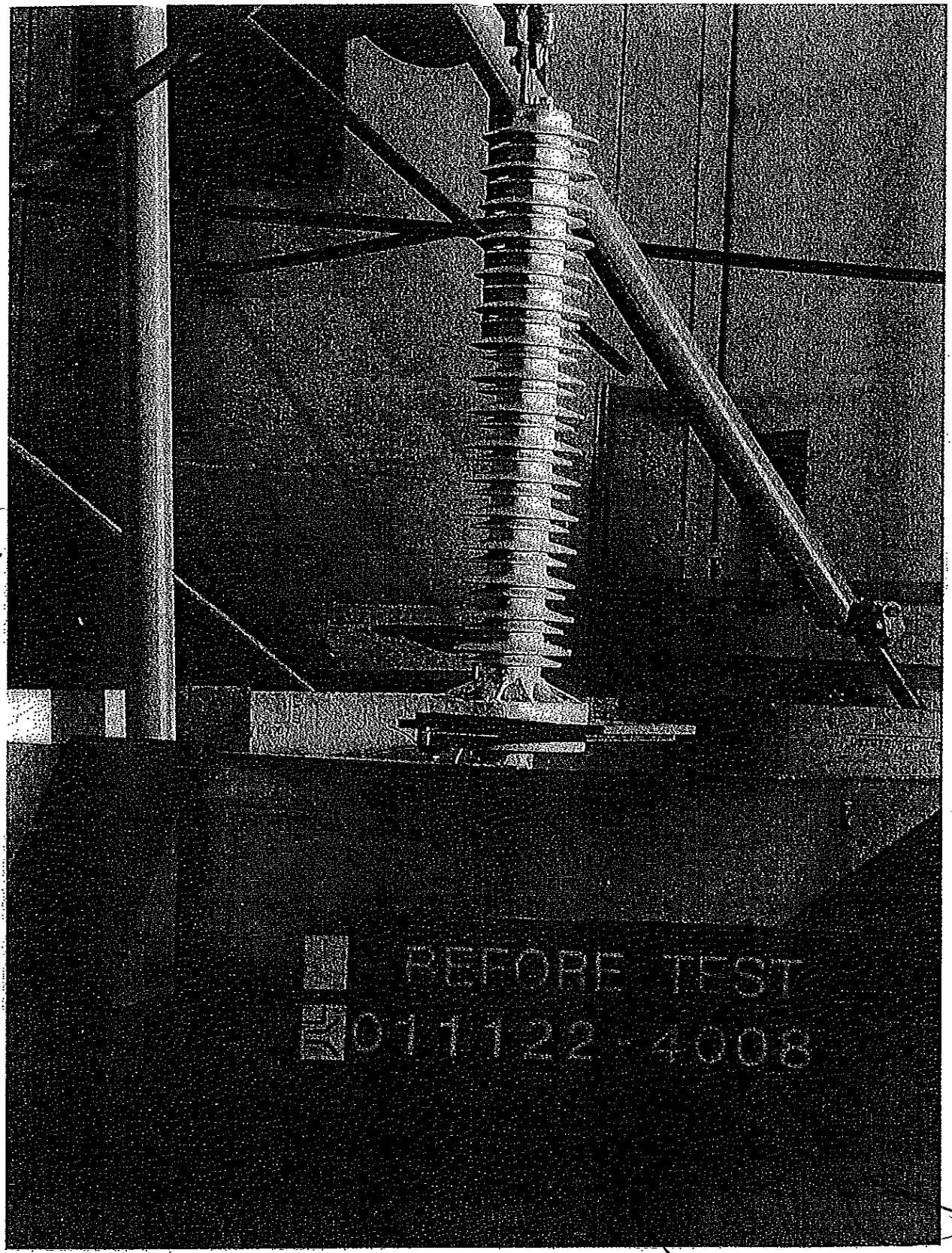
000170

ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

KEMA

1415202



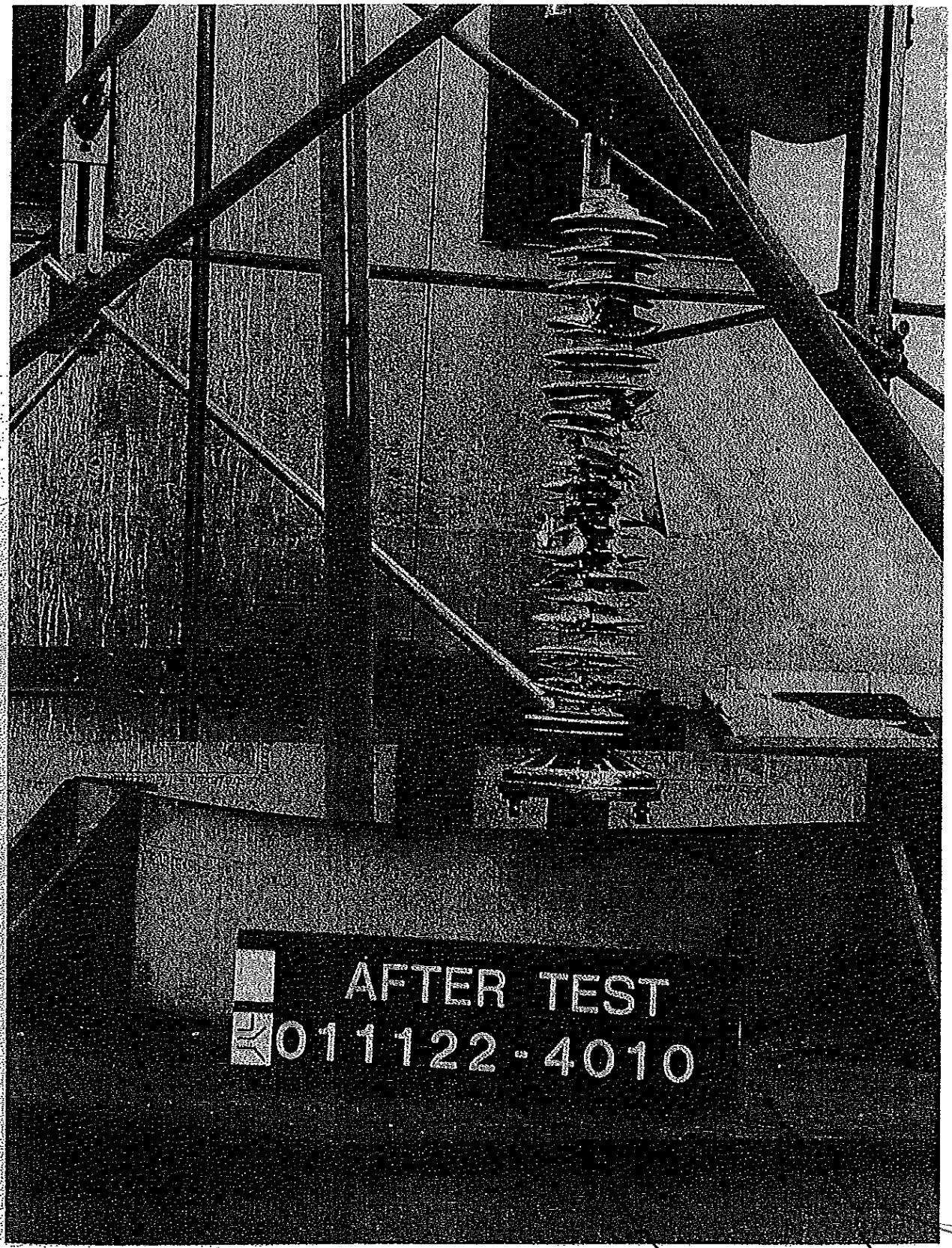
000171

ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН АД

KEMA

1415203



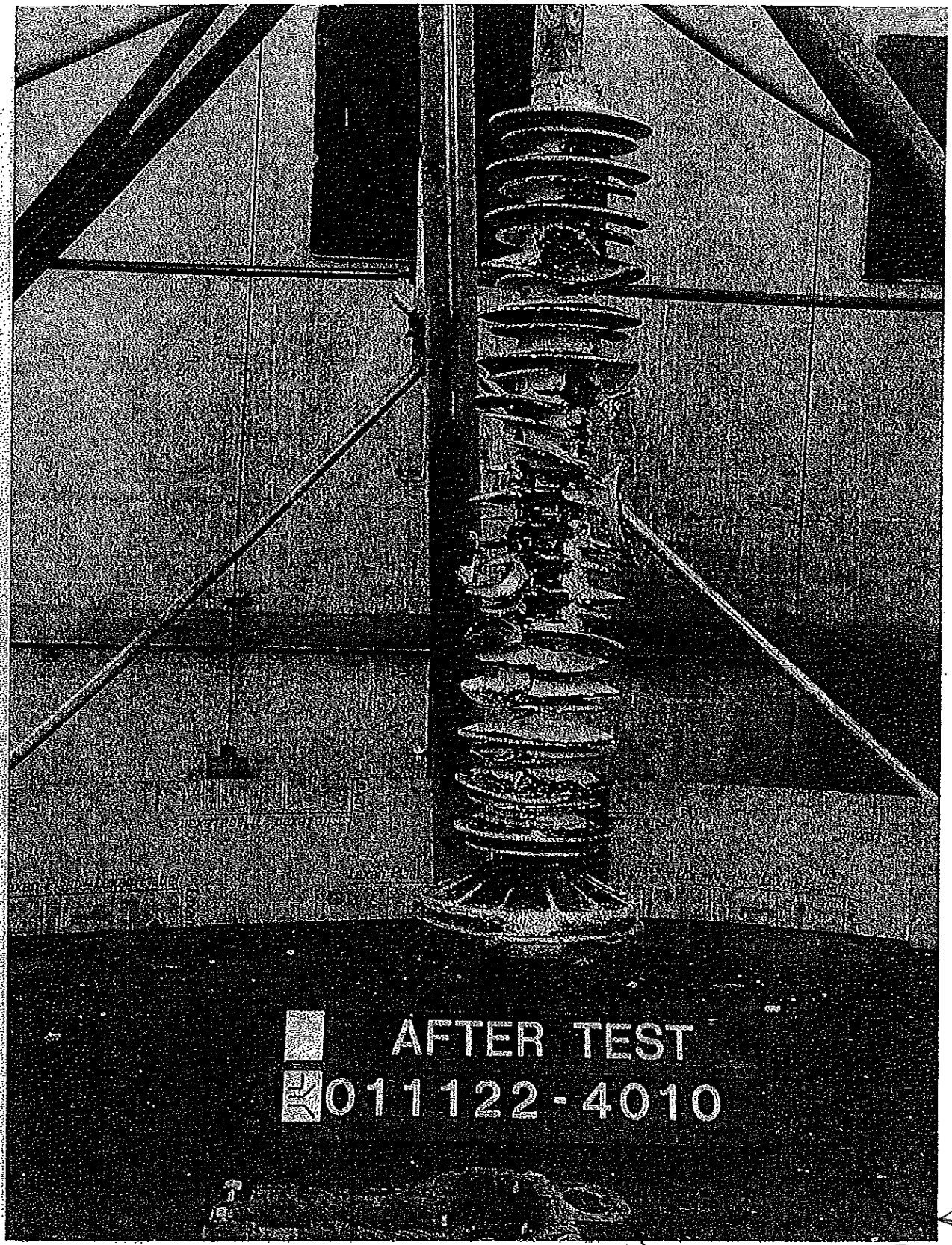
000172

ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

KEMA

1415204



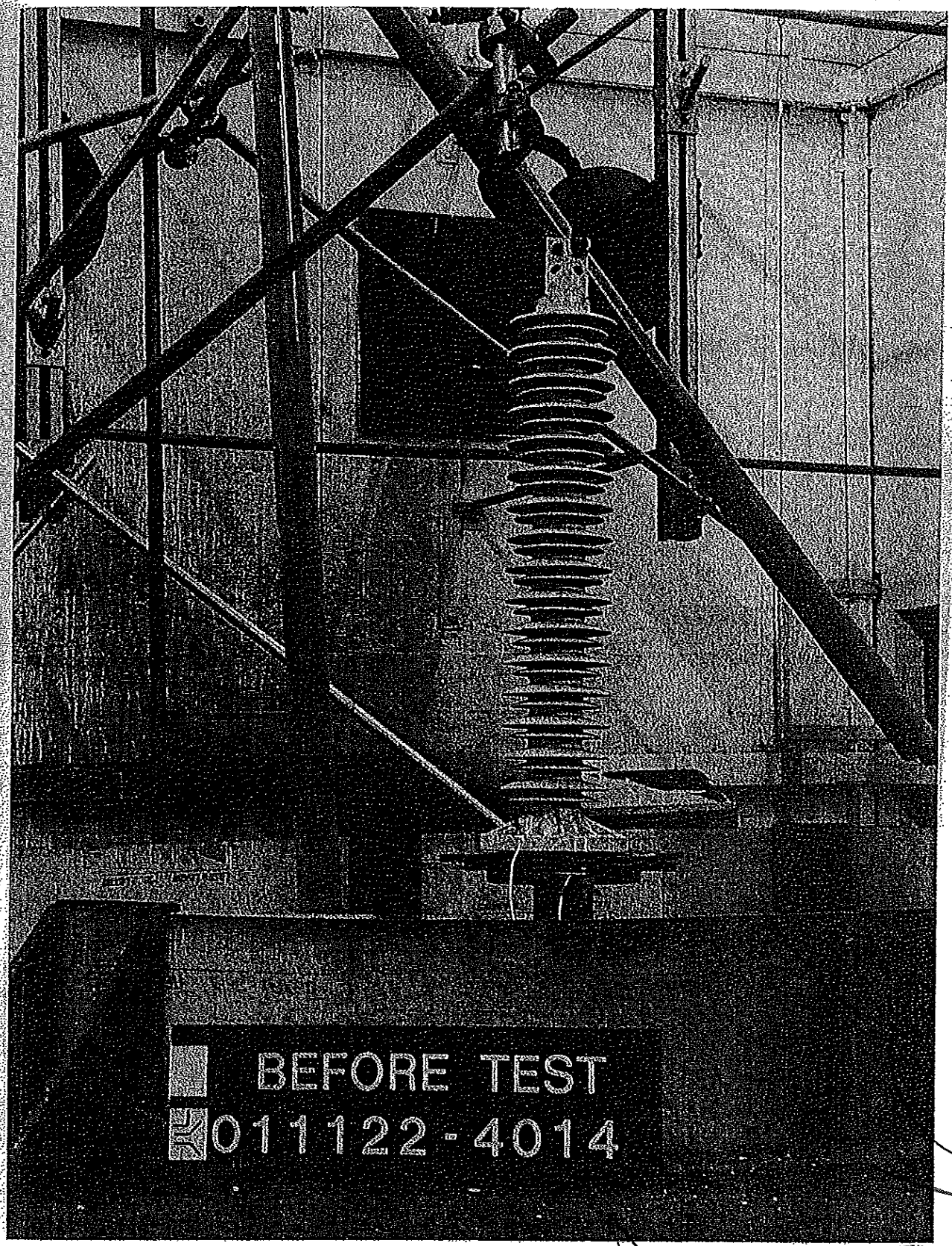
000173

ЗЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

KEMA

1415205



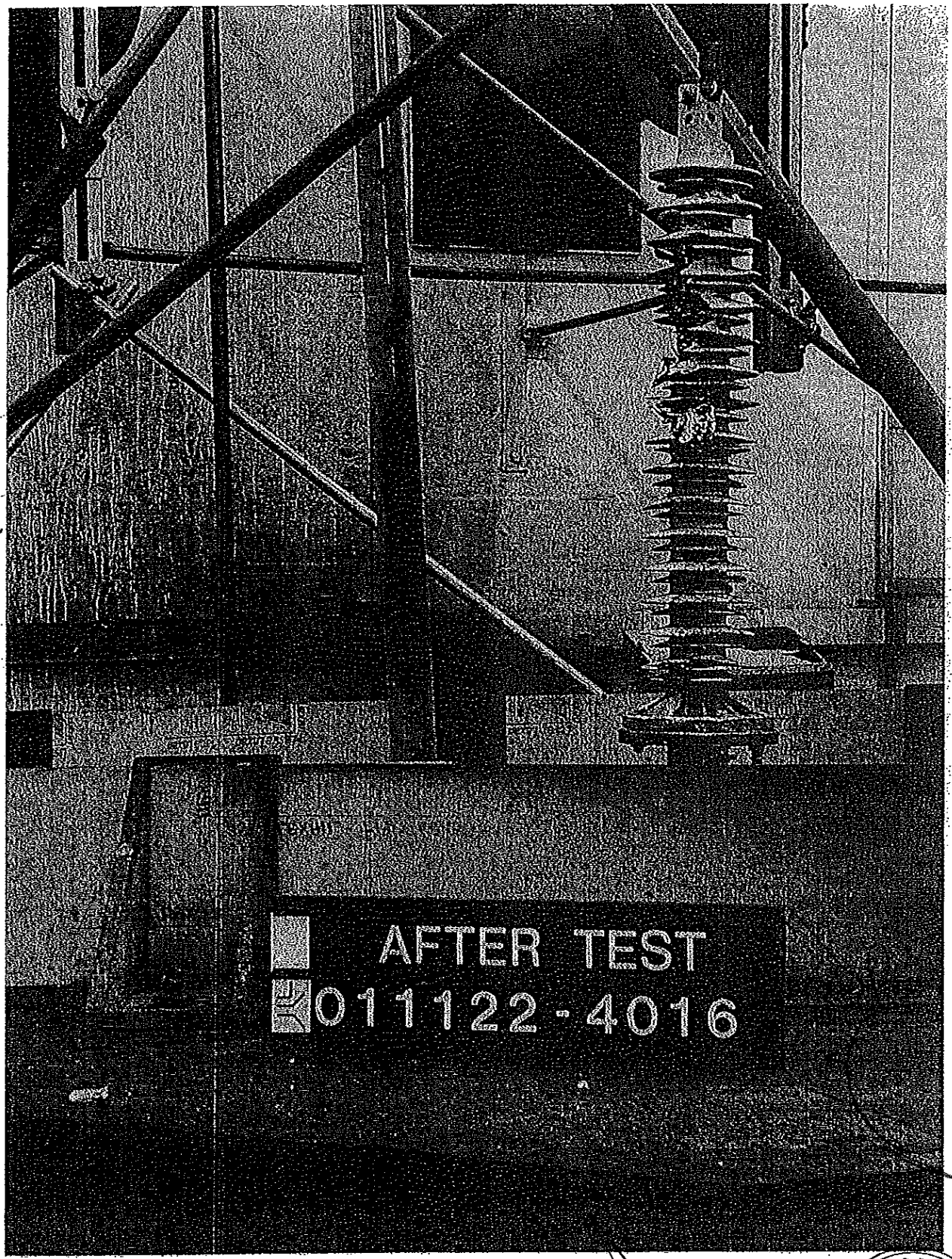
000174

ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

KEMA

1415206



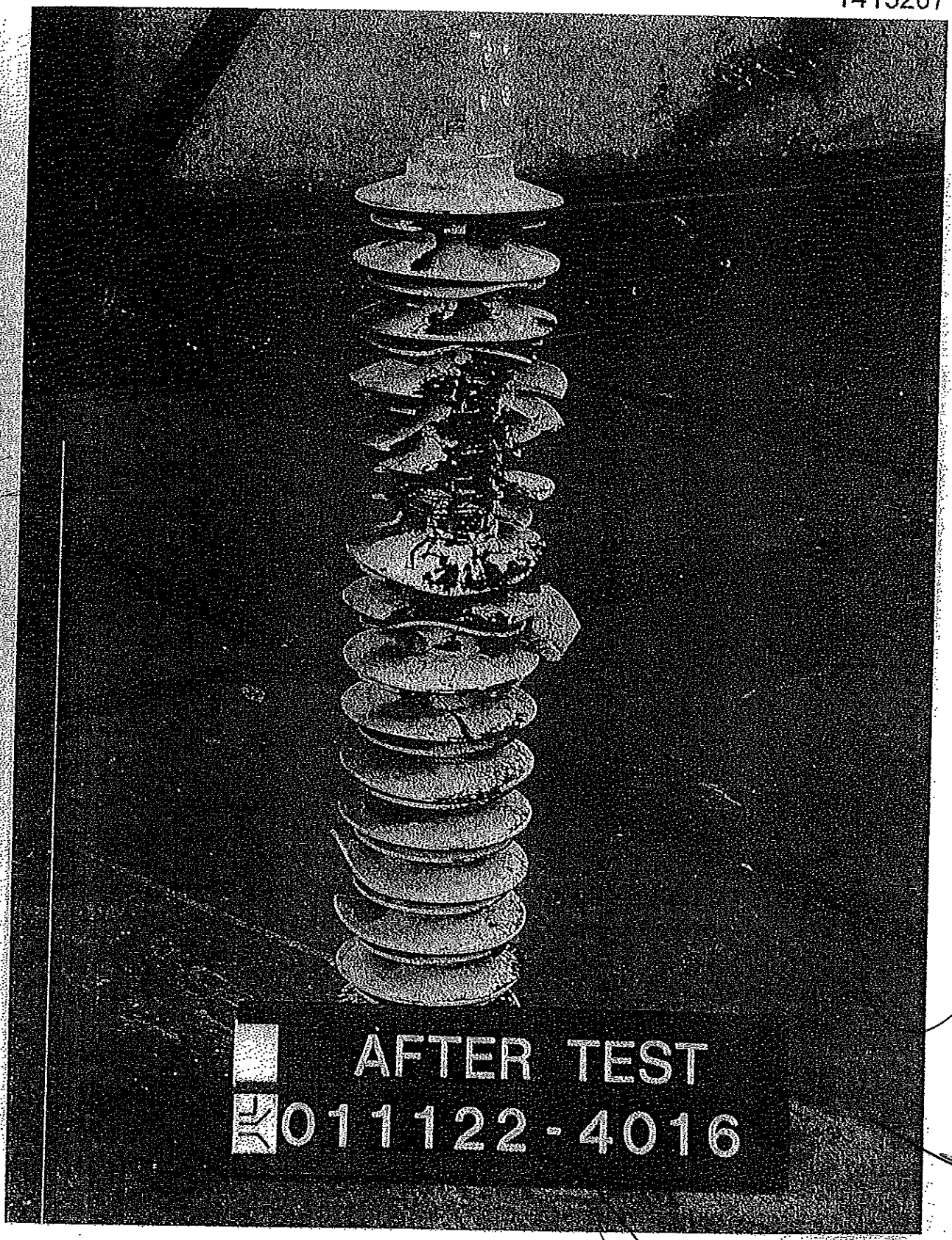
000175

ВЯРНО С ОРИГИНАЛА

"КРАСИН" смолян ООД

KEMA

1415207



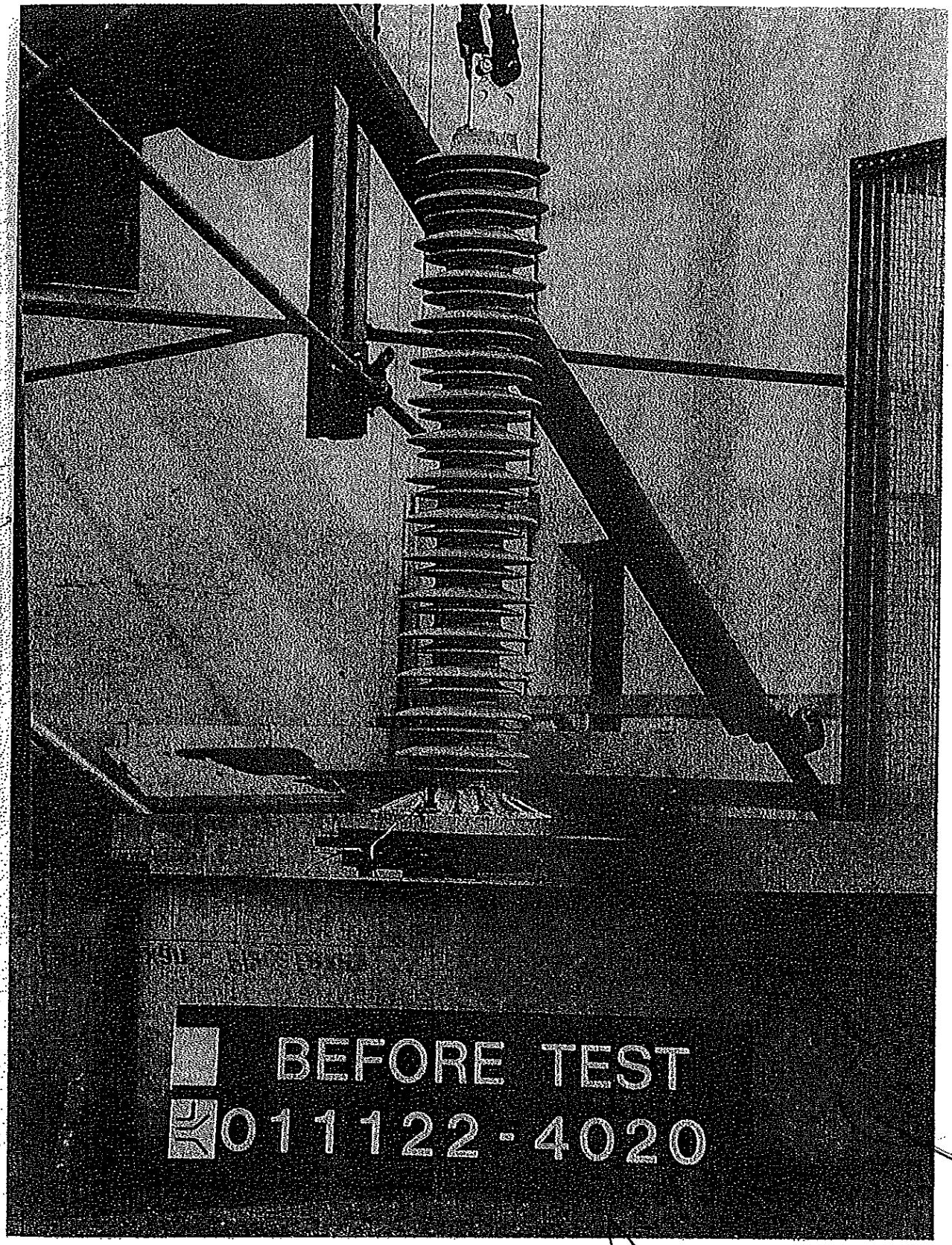
000176

ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

KEMA

1415210



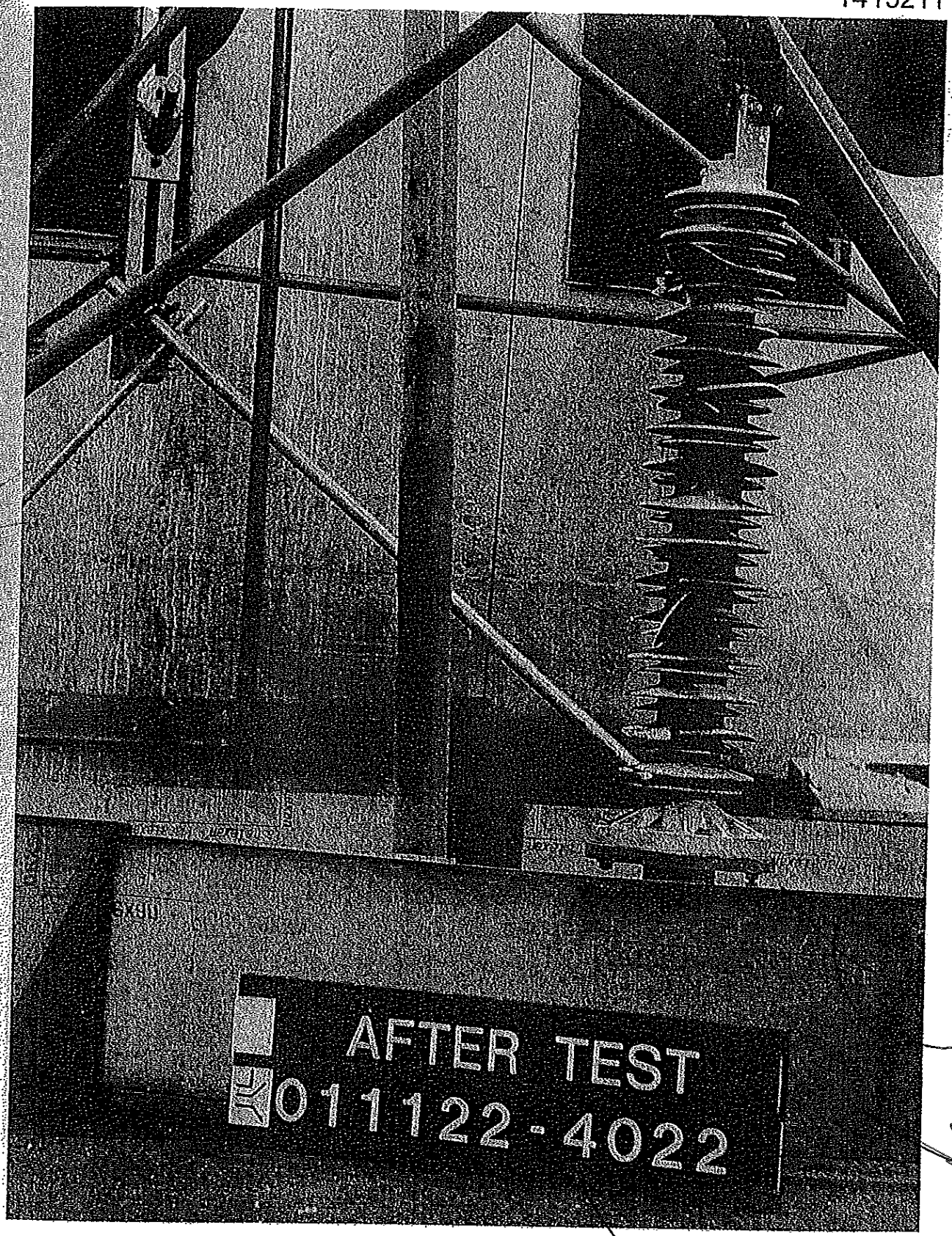
000177

ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

KEMA

1415211



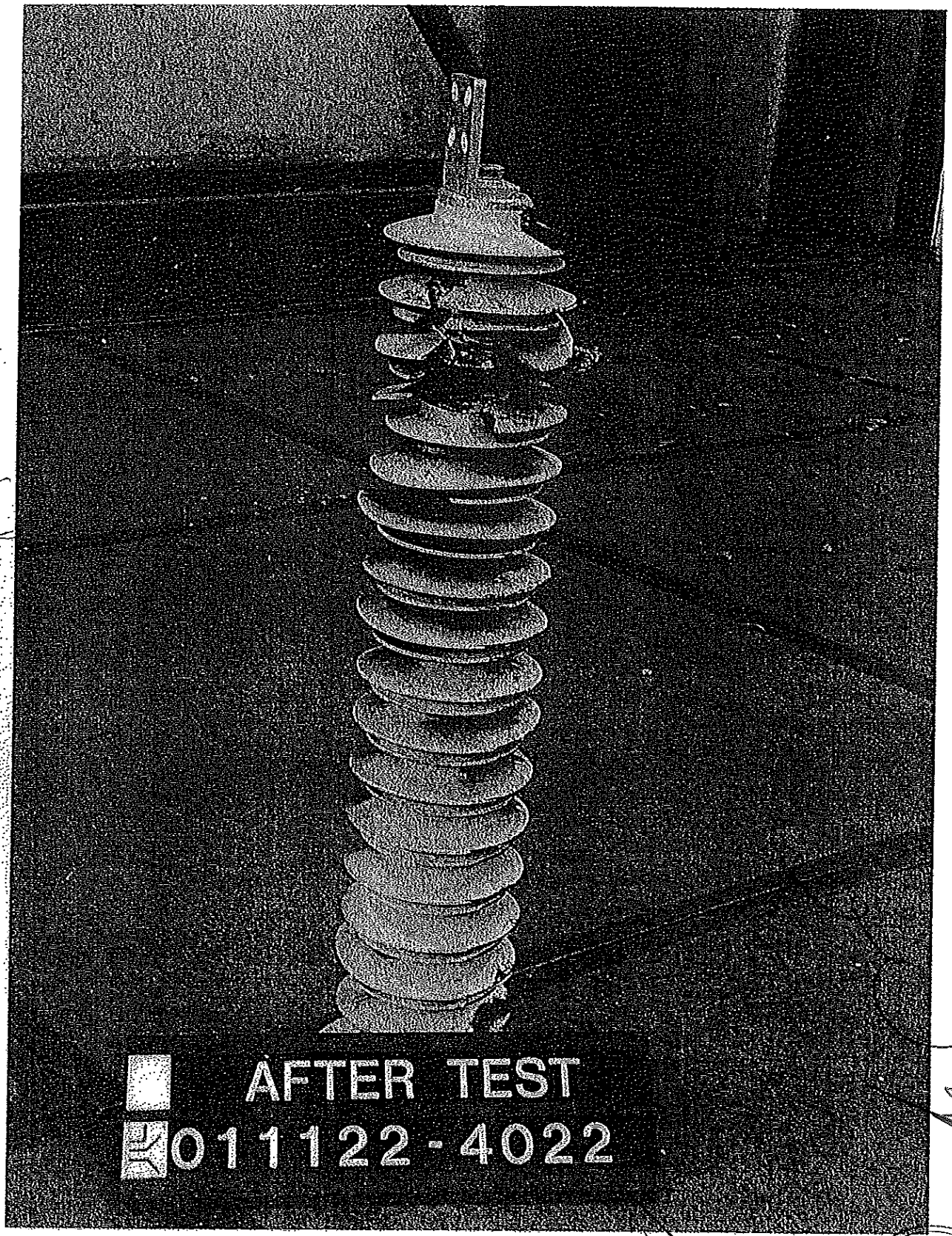
000178

ВЯРНО С ОРИГИНАЛА

КРАСИН
СМОЛЯН
ООД

KEMA

1415212



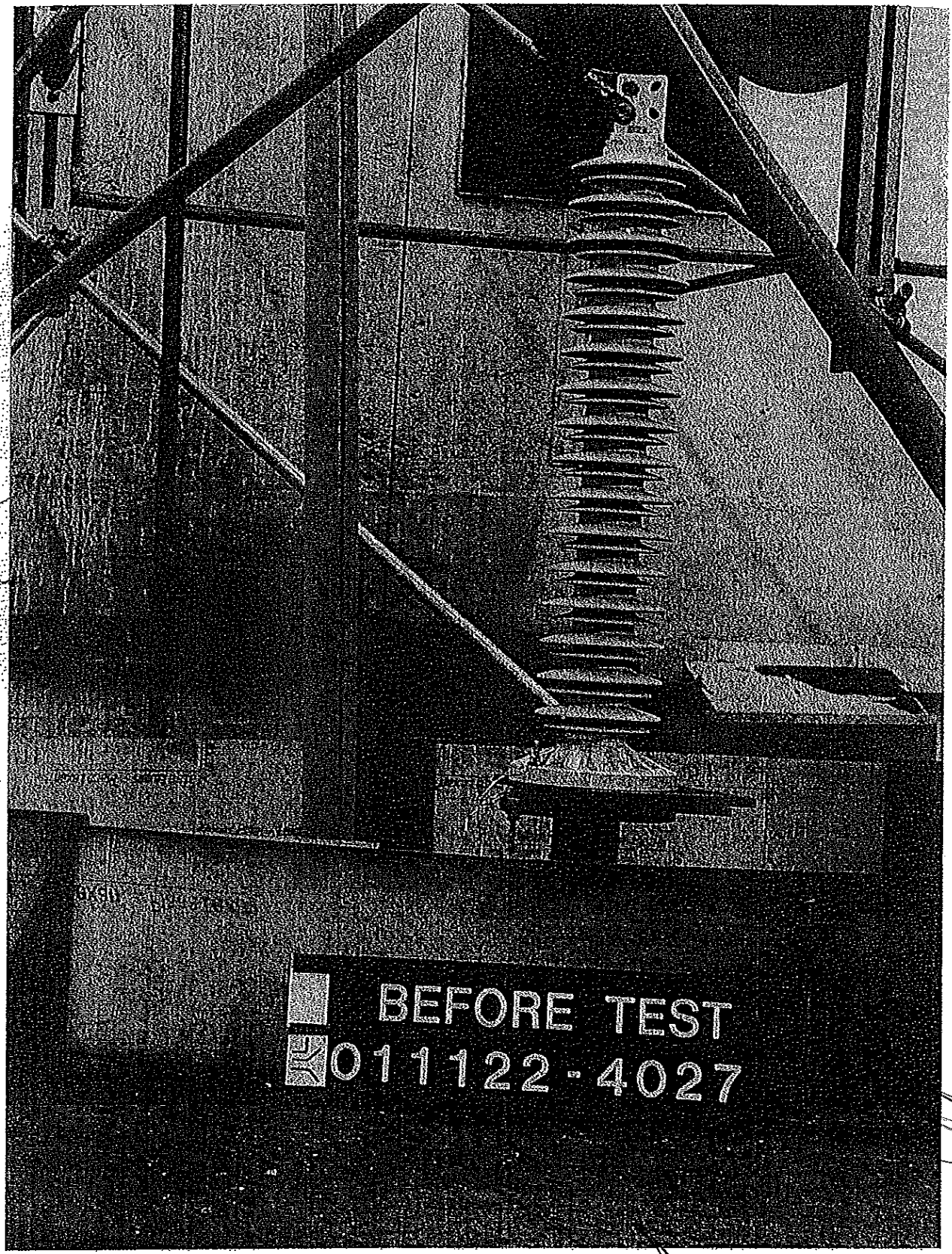
000179

ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

KEMA

1415214



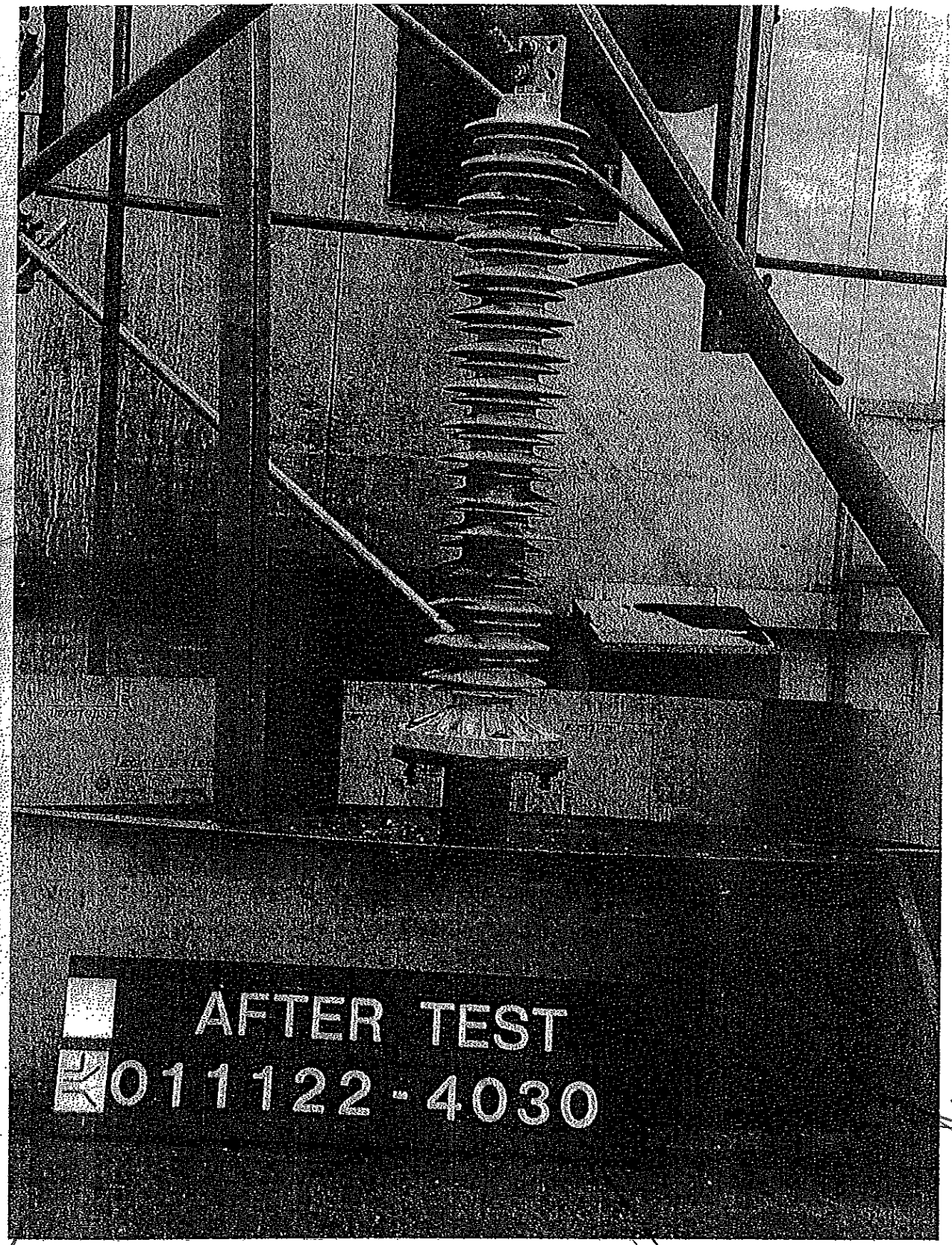
000180

ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

KEMA

1415215



000181

ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН

KEMA
HIGH–POWER LABORATORY
Utrechtseweg 310 – 6812 AR Arnhem – The Netherlands
Telephone +31 26 3562991 – Telefax +31 26 3511468 – E-mail hpl@kema.nl

1 *Certificate*

A Certificate contains a record of a series of type tests carried out strictly in accordance with a recognized standard. The equipment tested has fulfilled the requirements of this standard and the relevant ratings assigned by the manufacturer are endorsed by KEMA. The Certificate is applicable only to the equipment tested. KEMA is responsible for the validity and the contents of the Certificate.
The responsibility for conformity of any apparatus having the same designation as the one tested rests with the manufacturer. The Certificate contains the essential drawings and a description of the equipment tested.
Detailed rules are given in KEMA's Certification procedure.

2 *Report of Performance*

A Report of Performance contains a record of one or more tests which have been carried out according to the client's instructions. These tests are not necessarily in accordance with a recognized standard. The test results do not verify ratings of the test object.

KEMA issues three types of Reports of Performance:

2.1 *The tests have been carried out strictly in accordance with .... . The apparatus has complied with the relevant requirements.*

This sentence will appear on the front page of a Report of Performance if the tests have been performed in accordance with a recognized standard, but the series of tests does not completely fulfil the requirements for a Certificate of Compliance (for example, if the number of test duties is not a complete series of type tests).
The Report contains verified drawings and a description of the equipment tested. Detailed rules are given in KEMA's Certification procedure. The condition of the test object after the tests is assessed and recorded in the Report.

2.2 *The tests have been carried out in accordance with the client's instructions. Test procedure and test parameters were based on ....*

This sentence will appear on the front page of a Report of Performance if the number of tests, the test procedure and the test parameters are based on a recognized standard and related to the ratings assigned by the manufacturer. If the apparatus does not pass the tests such behaviour will be mentioned on the front sheet. Verification of the drawings (if submitted) and assessment of the condition after the tests is only done on the client's request.

2.3 *The tests have been carried out according to the client's instructions.*

This sentence will appear on the front page of a Report of Performance if the tests, test procedure and/or test parameters are not in accordance with a recognized standard.

3 *Standards*

When reference is made to a standard, and the date of issue is not stated, this applies to the latest issue, including amendments which have been officially published prior to the date of the tests.

4 *Official and uncontrolled test documents*

The official test documents of KEMA High–Power Laboratory are issued in bound form. Uncontrolled copies may be provided as loose sheets for convenience of reproduction by the client.
The copyright has to be respected at all times.

5 *Accuracy of measurement*

In the table of test results the measured quantities are given in three digits. This method of presentation does not indicate an accuracy. The guaranteed uncertainty in the figures mentioned, taking into account the total measuring system, is less than 5%, unless mentioned otherwise.

6 *Qualified by STERLAB*

KEMA High–Power Laboratory has been entered in the STERLAB register for laboratories under Nr. L 020 for the testing services as defined in the Field of Accreditation.
The accreditation is carried out in accordance with IESO/IEC 17025.

QUALIFIED BY STERLAB

000182

ВЕРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

Test Report: HVP/AK 02-03
rev 1

Type tests on PEXLIM P Surge Arresters

Test objects:	Surge arrester modules rated 36, 72 and 120 kV with the ZnO blocks replaced by insulating material
Standards:	IEC 60099-4, first edition 1991-11 IEC 60060-1, second edition 1989-11 ANSI/IEEE Std C62.11-1993 ANSI/IEEE Std 4-1978
Tests performed:	Insulation withstand tests
Test report:	Q 99-281
Validation:	The test objects initially represented arrester modules used for arrester type PEXLIM Q. However, the physical dimensions for the modules used for arrester type PEXLIM P-X are identical. The test results, therefore, also are valid for arresters of type PEXLIM P-X.
Tests completed:	1999-10-21
Tests performed at:	ABB Transformers AB/High Voltage Laboratory
Report consists of:	37 pages (Report Q 99-281, 36 pages)

We hereby certify that the objects specified above have successfully passed the test herein reported, thereby verifying guaranteed data.

Ludvika 2002-01-08

ABB Power Technology Products AB
High Voltage Products/Surge Arresters
Quality Department

ABB Power Technology Products AB QA QUALITY

Kurt Jansson

ABB Power Technology Products AB
000183

ABB TRANSFORMERS AB

на основание чл. 2 от ЗЗЛД

Report

R Q 99-281

Författare-Author
Mikael Gärdskog

Datum-Date Reg.
99-10-29

Reg.
5680

Sida-Page
1

Godkännare-Approved
Bengt Jö

на основание чл. 2 от ЗЗЛД

teoretisk
ökning-Analysis
ical investigation
ng, experim. under-
-Test, experi-
investigation
port-Interim Report

Uppdragsg
SWG/AK

Titel-Title
Dielectri
surge ar

Ordernummer-Ref.No.
6771.24407 UP6, project 970002

Debiteras ordernummer
#

Pkl/Akl

[X] Slutrapport-Final report

Antal textsidor-No. of pages
33

Antal bilagesidor-No. of supplem. pages
3

TYPE TESTS

Provning/undersökning avslutad
Test investigation finished
99-10-21

Sammanfattning-Summary

TEST OBJECT

Three empty surge arrester modules

1. PEXLIM Q36/R36, Document no. LAK 5476 Supplem. Page 1.
2. PEXLIM Q72/R72, Document no. LAK 5477 Supplem. Page 2.
3. PEXLIM Q120/R120, Document no. LAK 5478 Supplem. Page 3.

PERFORMED TESTS

- Full lightning impulse withstand voltage test, dry
- Switching impulse withstand voltage test, wet
- Power frequency withstand voltage test, dry and wet

APPLIED STANDARDS

IEC 99-4, first edition 1991-11, IEC 60-1, second edition 1989-11
ANSI/IEEE Std C62.11-1993, ANSI/IEEE Std 4-1978

RESULTS

The following withstand voltage levels were achieved (corrected for atmospheric conditions).

	PEXLIM Q36/R36 Withstand voltage level (kV)	PEXLIM Q72/R72 Withstand voltage level (kV)	PEXLIM Q120/R120 Withstand voltage level (kV)
1,2/50 µs, dry, ANSI / IEC	283	400	578
250/2500 µs, wet, IEC	242	330	462
50 Hz, wet, IEC	126	187	293
60 Hz, wet, ANSI	126	187	293
60 Hz, dry, ANSI	136	200	316

Distribution
SETFO/ T-arkiv SWG/AKB

Enbart sida 1-Page 1 only
SETFO/ Q-arkiv

Nyckelord /Ämnesord-Key words

Övriga nyckelord

Arkiveringstid Q
[ ] 1 år
[ ] 2 år
[X] mer än 3 år

Anm. Nyckelord/Ämnesord användes när rapporten skrivs på svenska.
"Keywords" används när rapporten skrivs på engelska
Övriga nyckelord användes endast i undantagsfall och avser t. ex. materialbeteckning, produktutveckling, leverantör, kund etc.
Se för övrigt ZQ-TA 990-101

000184

ОРИГИНАЛ

ABB
ASEA BROWN BOVERI

1
TEST OBJECT

Three empty surge arrester modules

1. PEXLIM Q36/R36, Document no. LAK 5476 Supplem. Page 1.
2. PEXLIM Q72/R72, Document no. LAK 5477 Supplem. Page 2.
3. PEXLIM Q120/R120, Document no. LAK 5478 Supplem. Page 3.

During the test the arrester housings were placed on a platform 1 m above the floor (ground level)

2
ATMOSPHERIC CONDITIONS

Date 99-09-14	Date 99-09-29	Date 99-08-26
t= 19 °C	t= 20 °C	t= 23 °C
h= 38 %	h= 50 %	h= 33 %
b= 752 mmHg	b= 728 mmHg	b= 749 mmHg

Date 99-09-15	Date 99-10-20	Date 99-10-21
t= 23 °C	t= 21 °C	t= 21 °C
h= 39 %	h= 27 %	h= 27 %
b= 749 mmHg	b= 756 mmHg	b= 755 mmHg

3
TESTS

3.1
Full lightning impulse withstand voltage test, 1,2/50 µs, dry According to IEC Standard

The test was carried out by the up and down method for determination of the $U_{50\%}$ disruptive discharge voltage, positive polarity.

Number of applied impulses, 30. dU= 3%.

The withstand voltage was determined by application of 15 impulses of both positive and negative polarity at a voltage 3% lower than the achieved U50% voltage level.

The table below shows the obtained results (corrected for atmospheric conditions).

K= 1.00, applied at the test.

	Date 99-09-14	Date 99-09-29	Date 99-08-26
1,2/50 µs, dry, ANSI / IEC	PEXLIM Q36/R36 U50% disruptive discharge	PEXLIM Q72/R72 U50% disruptive discharge	PEXLIM Q120/R120 U50% disruptive discharge
Corrected (kV)	Kt=0.969 **291.5**	Kt=0.940 **412**	Kt=0.940 **595**
	Withstand voltage level	Withstand voltage level	Withstand voltage level
Corrected (kV)	Kt=0.969 **283**	Kt=0.940 **400**	Kt=0.940 **578**

ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

3.2

Switching impulse withstand voltage test, wet, 250/2500 µs According to IEC Standard

The test was carried out by the up and down method for determination of the $U_{50\%}$ disruptive discharge voltage, positive polarity.

Number of applied impulses, 30, dU= 3%.

The withstand voltage was determined by application of 15 impulses of both positive and negative polarity at a voltage 3-6% lower than the achieved $U_{50\%}$ voltage level.

The table below shows the obtained results (corrected for atmospheric conditions).

K= 1.00, applied at the test.

	Test date 99-09-15	Test date 99-10-20	Test date 99-10-20
250/2500 µs, wet, IEC	**PEXLIM Q36/R36** U50% disruptive discharge	**PEXLIM Q72/R72** U50% disruptive discharge	**PEXLIM Q120/R120** U50% disruptive discharge
Corrected (kV)	K1=0.976 **249**	K1=0.991 **341**	K1=0.991 **491**
	Withstand voltage level	Withstand voltage level	Withstand voltage level
Corrected (kV)	K1=0.976 **242**	K1=0.940 **330**	K1=0.991 **462**
Precipitation rate: (horisontal/vertical)	1,8/1,6 mm/min,	1,0/1,6 mm/min,	1,3/1,3 mm/min,
Resistivity of water:	100 Ωm	95 Ωm	95 Ωm

3.3

Power frequency withstand voltage test, 50 Hz, 60s, wet. According to IEC Standards
Power frequency withstand voltage test, 60 Hz, 10s, wet. According to ANSI/EEE Standards
Power frequency withstand voltage test, 60 Hz, 60s, dry. According to ANSI/EEE Standards
The table below shows the obtained results (corrected for atmospheric conditions).
K= 1.00, applied at the test.

	Test date 99-10-20	Test date 99-10-20	Test date 99-10-20
50 Hz, wet, IEC	**PEXLIM Q36/R36** Withstand voltage level	**PEXLIM Q72/R72** Withstand voltage level	**PEXLIM Q120/R120** Withstand voltage level
Corrected (kV)	K1=0.991 **126**	K1=0.992 **187**	K1=0.991 **293**
Precipitation rate: (horisontal/vertical)	1,2/1,4 mm/min,	1,3/1,3 mm/min,	1,3/1,3 mm/min,
Resistivity of water:	95 Ωm	95 Ωm	95 Ωm

	Test date 99-10-21	Test date 99-10-21	Test date 99-10-21
60 Hz, wet, ANSI/IEEE Std 4-1978, 1.3.3.2, table 1.2, Practice in USA	**PEXLIM Q36/R36** Withstand voltage level	**PEXLIM Q72/R72** Withstand voltage level	**PEXLIM Q120/R120** Withstand voltage level
Corrected (kV)	K1=0.990 **126**	K1=0.991 **187**	K1=0.990 **293**
Precipitation rate:	5.0 mm/min,	4.7 mm/min,	4.5 mm/min,
Resistivity of water:	180 Ωm	180 Ωm	180 Ωm

	Test date 99-10-21	Test date 99-10-21	Test date 99-10-21
60 Hz, dry, ANSI/IEEE	**PEXLIM Q36/R36** Withstand voltage level	**PEXLIM Q72/R72** Withstand voltage level	**PEXLIM Q120/R120** Withstand voltage level
Corrected (kV)	Kt=0.919 **136**	Kt=0.923 **200**	Kt=0.919 **316**

ABB TRANSFORMERS AB

Test Record

Test date 15 Sep 1999

Serial nbr. R27

IMPULSE VOLTAGE TEST

MEASUREMENTS

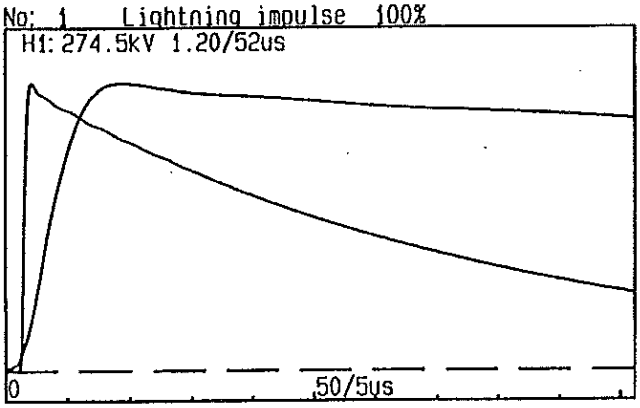
LIGHTNING IMPULSE VOLTAGE TEST on terminal H1
Nominal test voltage 300kV.

Amplitude %	kV	Impulse shape µs	Oscillogram number
100	275	1.20/52	1
100	274	1.20/52	2
100	274	1.20/12	3
100	274	1.21/52	4
100	274	1.20/52	5
100	274	1.20/52	6
100	274	1.20/52	7
100	273	1.21/52	8
100	274	1.20/52	9
100	274	1.20/52	10
100	274	1.19/52	11
100	273	1.19/52	12
100	275	1.21/52	13
100	274	1.21/52	14
100	274	1.20/52	15

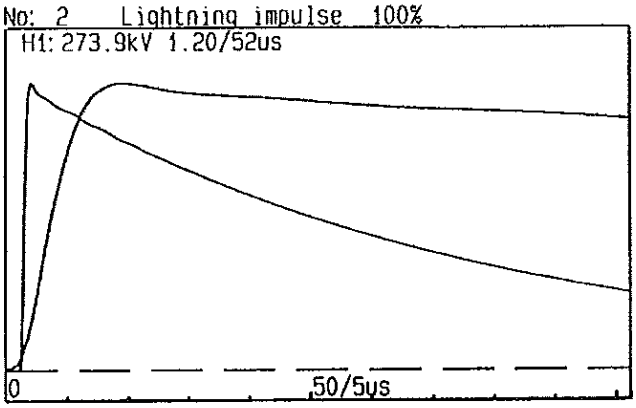
LIGHTNING IMPULSE VOLTAGE TEST on terminal H1
Nominal test voltage -300kV.

Amplitude %	kV	Impulse shape µs	Oscillogram number
100	-274	1.21/52	16
100	-274	1.21/52	17
100	-274	1.21/52	18
100	-274	1.21/52	19
100	-274	1.20/52	20
100	-274	1.21/52	21
100	-274	1.20/52	22
100	-274	1.20/52	23
100	-274	1.21/52	24
100	-274	1.20/52	25
100	-274	1.20/52	26
100	-274	1.20/52	27
100	-274	1.20/52	28
100	-274	1.21/52	29
100	-274	1.21/52	30

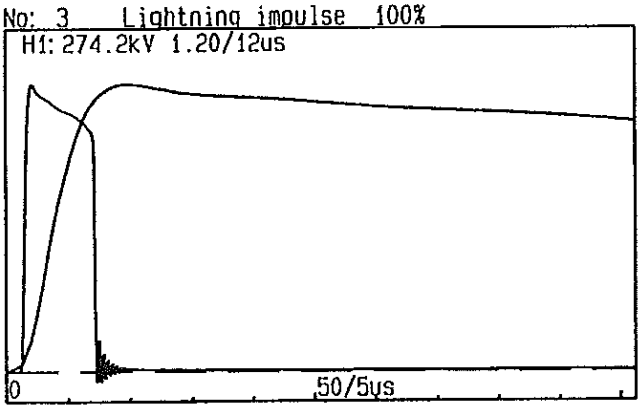
No: 1 Lightning impulse 100%
H1: 274.5kV 1.20/52us



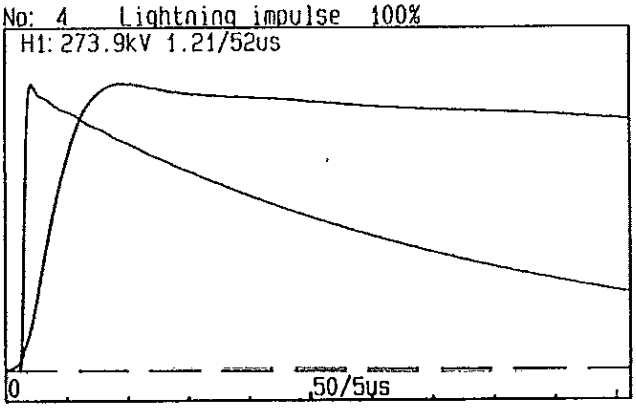
No: 2 Lightning impulse 100%
H1: 273.9kV 1.20/52us



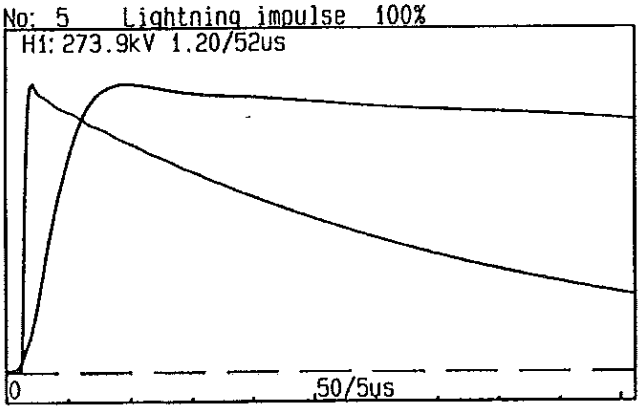
No: 3 Lightning impulse 100%
H1: 274.2kV 1.20/12us



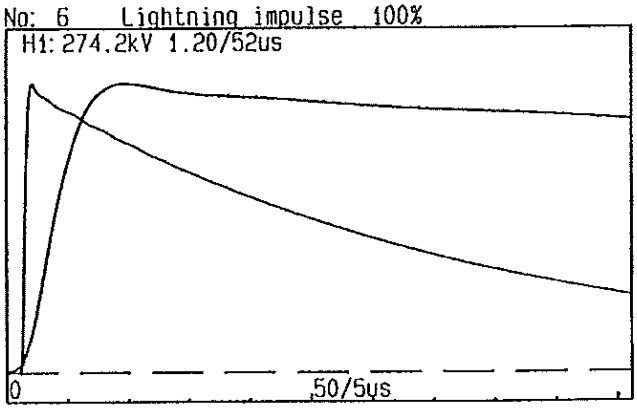
No: 4 Lightning impulse 100%
H1: 273.9kV 1.21/52us



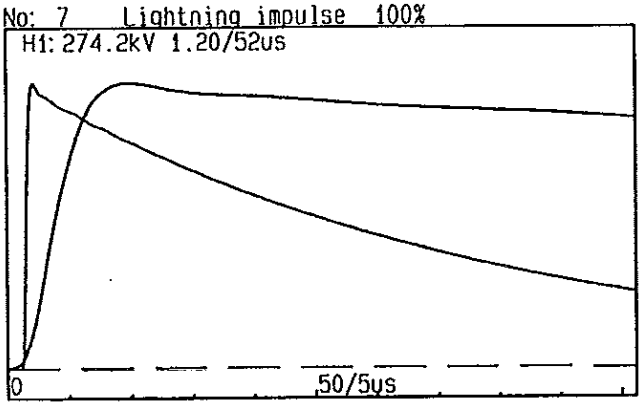
No: 5 Lightning impulse 100%
H1: 273.9kV 1.20/52us



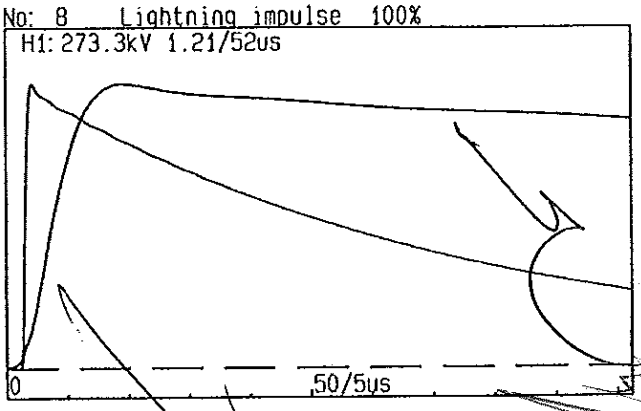
No: 6 Lightning impulse 100%
H1: 274.2kV 1.20/52us



No: 7 Lightning impulse 100%
H1: 274.2kV 1.20/52us



No: 8 Lightning impulse 100%
H1: 273.3kV 1.21/52us



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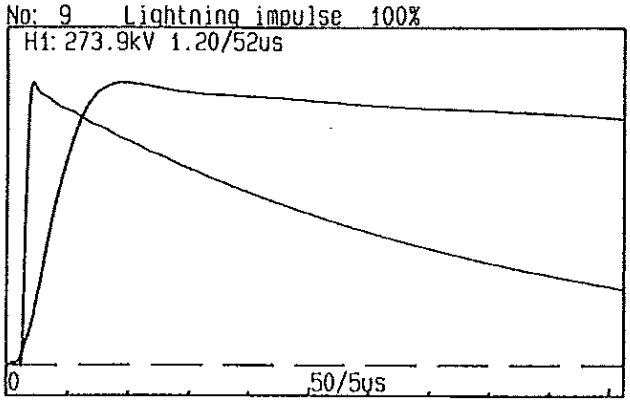
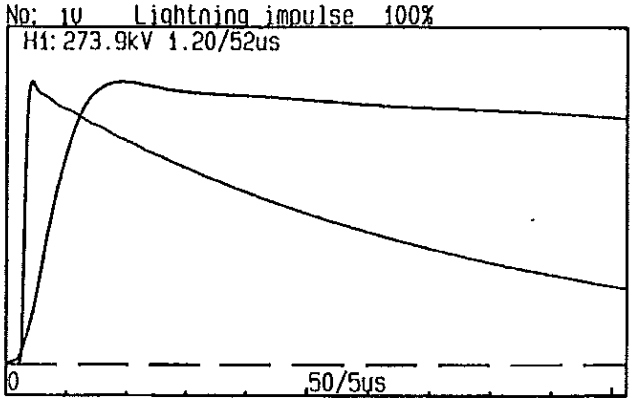
ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯЯН ООД

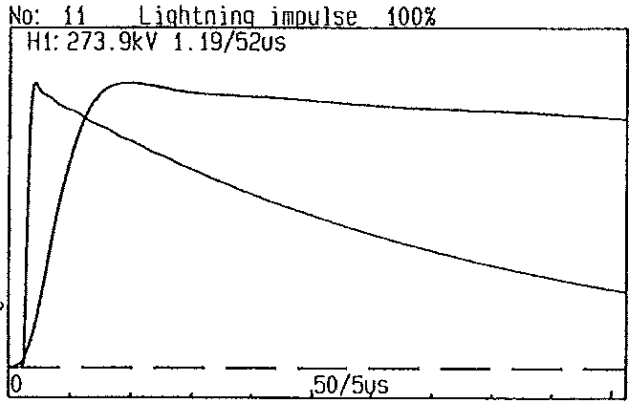
No: 9 Lightning impulse 100%
H1: 273.9kV 1.20/52us



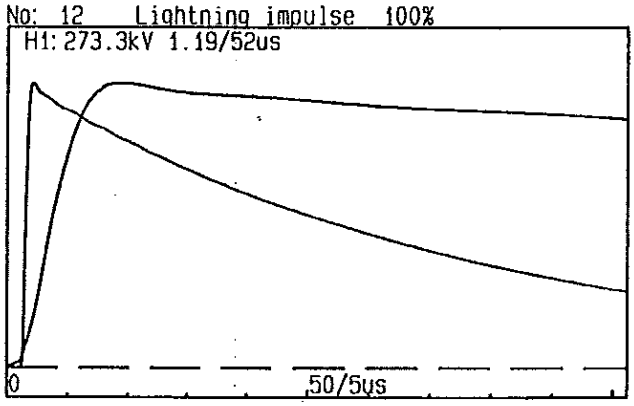
No: 10 Lightning impulse 100%
H1: 273.9kV 1.20/52us



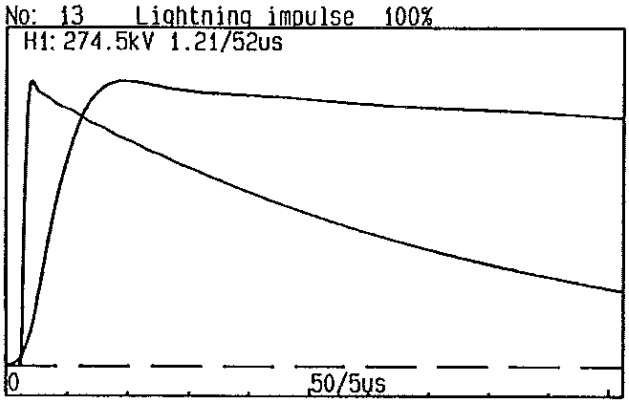
No: 11 Lightning impulse 100%
H1: 273.9kV 1.19/52us



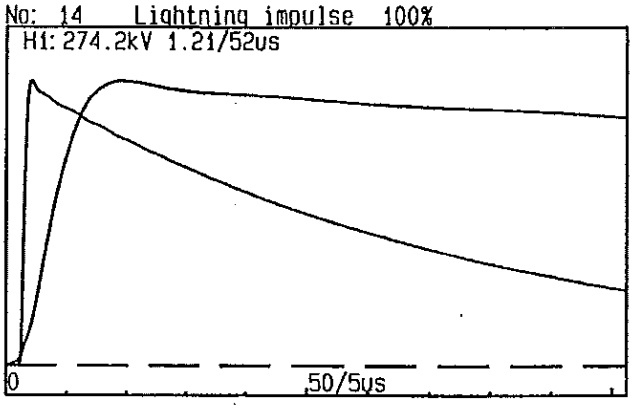
No: 12 Lightning impulse 100%
H1: 273.3kV 1.19/52us



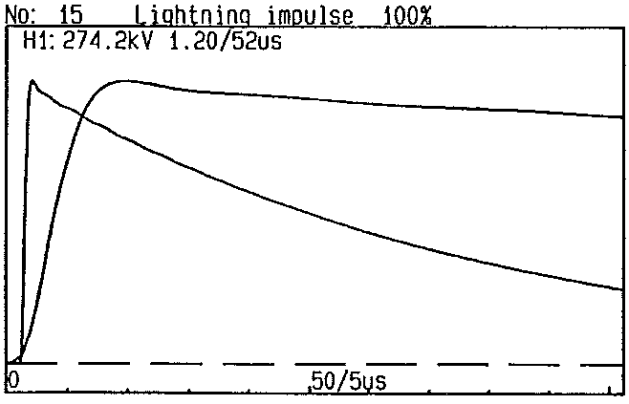
No: 13 Lightning impulse 100%
H1: 274.5kV 1.21/52us



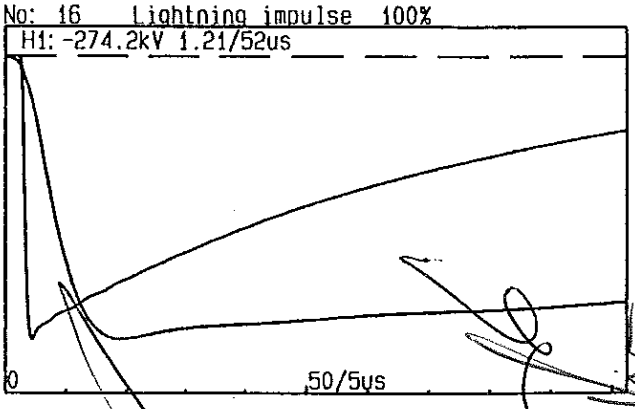
No: 14 Lightning impulse 100%
H1: 274.2kV 1.21/52us



No: 15 Lightning impulse 100%
H1: 274.2kV 1.20/52us



No: 16 Lightning impulse 100%
H1: -274.2kV 1.21/52us



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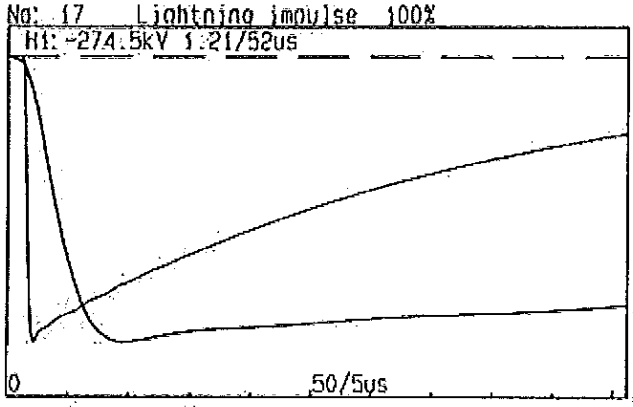
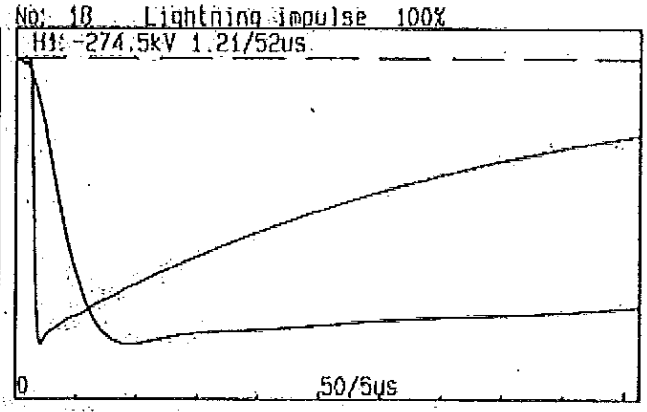
ВЗЯТО С ОРИГИНАЛА

«КРАСНЫЙ» СМОЛЯНИН ООО

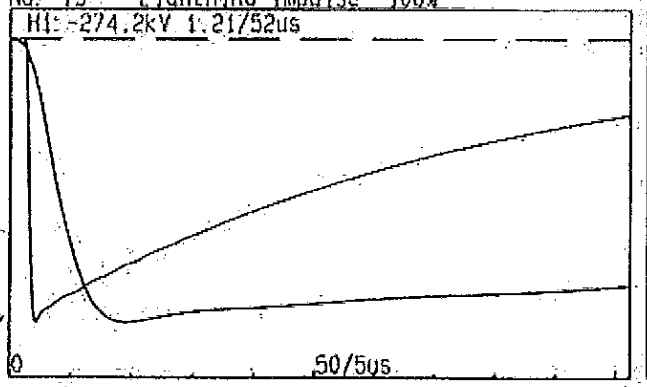
No: 17 Lightning impulse 100%
H1: -274.5kV 1.21/52us
0 50/5us



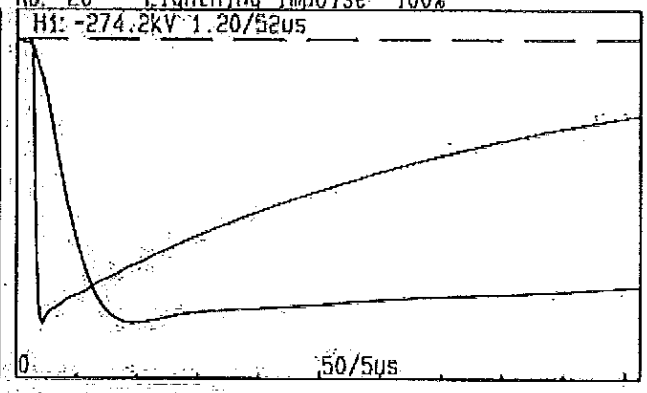
No: 18 Lightning impulse 100%
H1: -274.5kV 1.21/52us
0 50/5us



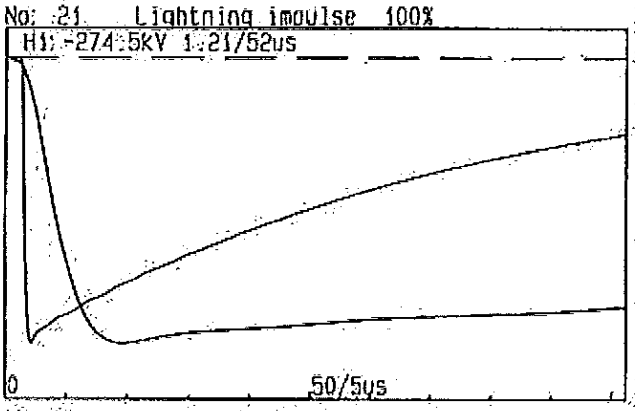
No: 19 Lightning impulse 100%
H1: -274.2kV 1.21/52us
0 50/5us



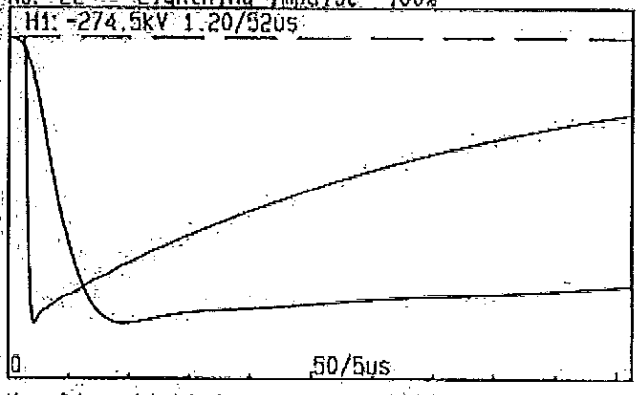
No: 20 Lightning impulse 100%
H1: -274.2kV 1.20/52us
0 50/5us



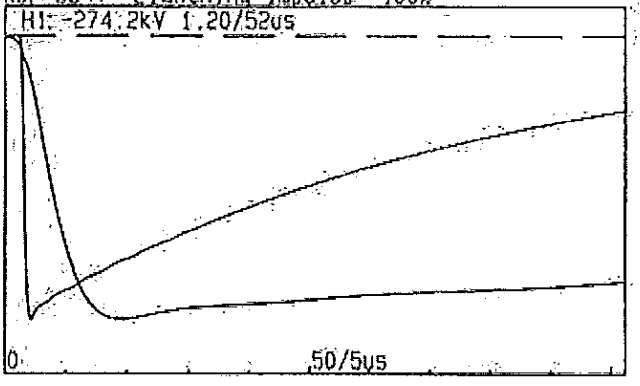
No: 21 Lightning impulse 100%
H1: -274.5kV 1.21/52us
0 50/5us



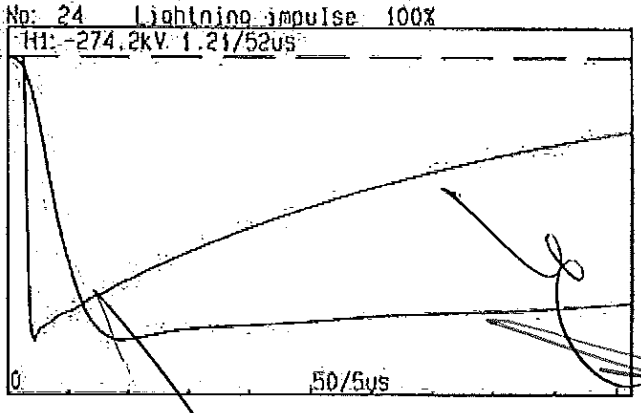
No: 22 Lightning impulse 100%
H1: -274.5kV 1.20/52us
0 50/5us



No: 23 Lightning impulse 100%
H1: -274.2kV 1.20/52us
0 50/5us



No: 24 Lightning impulse 100%
H1: -274.2kV 1.21/52us
0 50/5us



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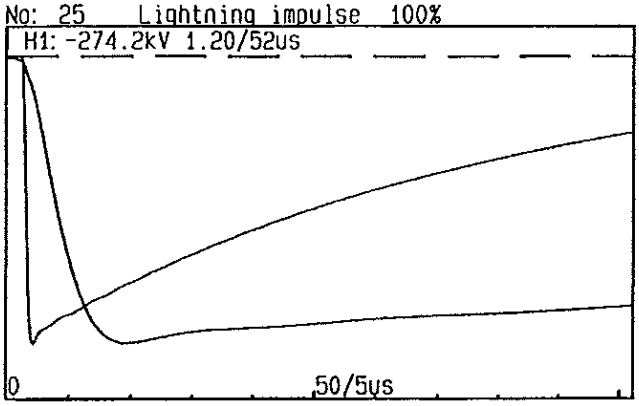
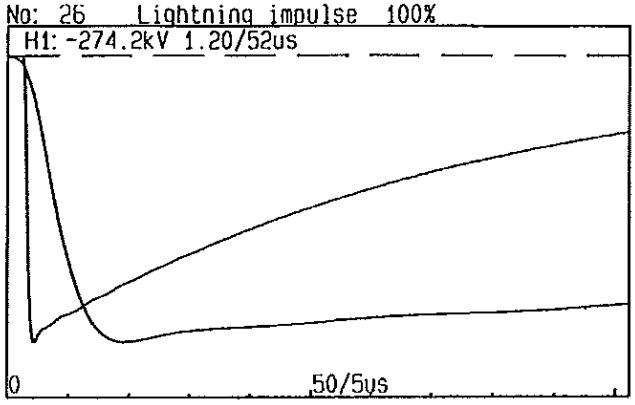
ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

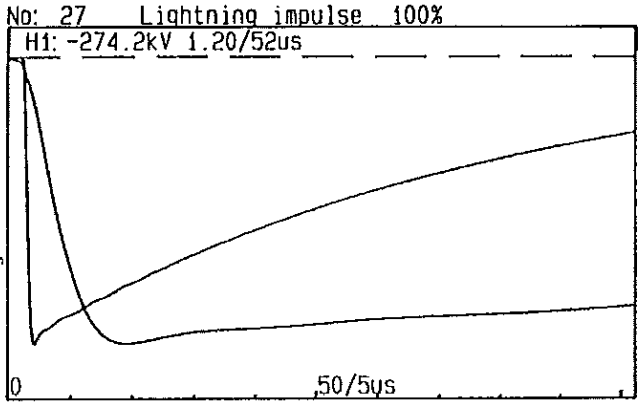
No: 25 Lightning impulse 100%
H1: -274.2kV 1.20/52us



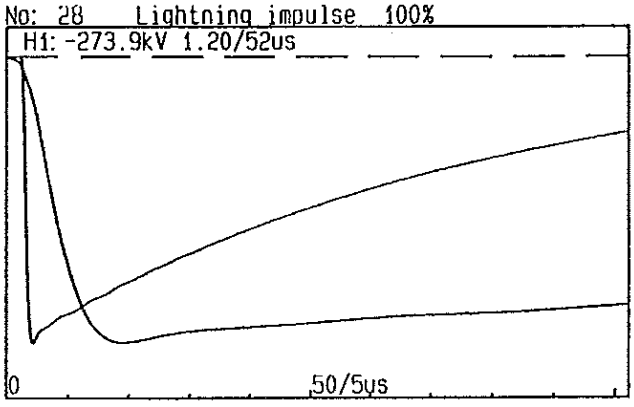
No: 26 Lightning impulse 100%
H1: -274.2kV 1.20/52us



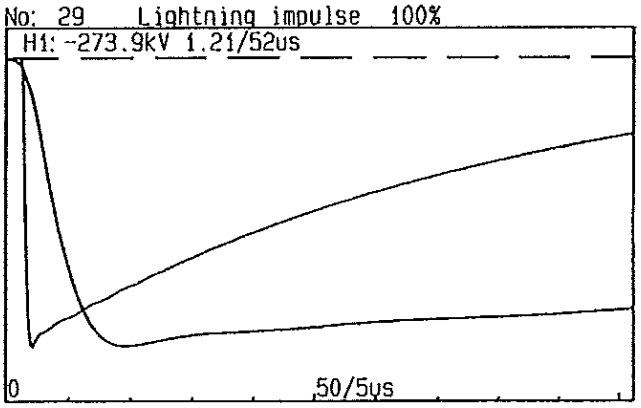
No: 27 Lightning impulse 100%
H1: -274.2kV 1.20/52us



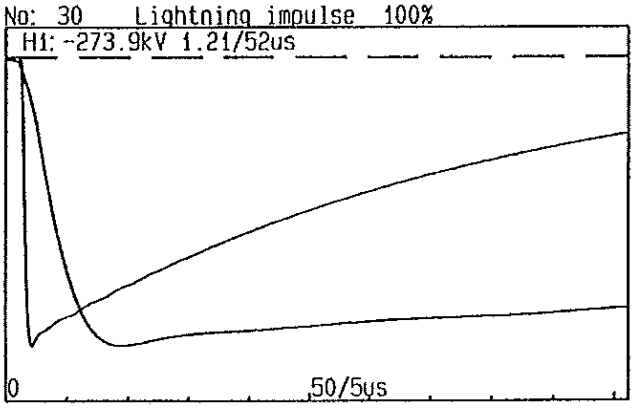
No: 28 Lightning impulse 100%
H1: -273.9kV 1.20/52us



No: 29 Lightning impulse 100%
H1: -273.9kV 1.21/52us



No: 30 Lightning impulse 100%
H1: -273.9kV 1.21/52us



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ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

ABB TRANSFORMERS AB

Test Record

Test date : 15 Sep 1999

Serial nbr. : R27

IMPULSE VOLTAGE TEST

MEASUREMENTS

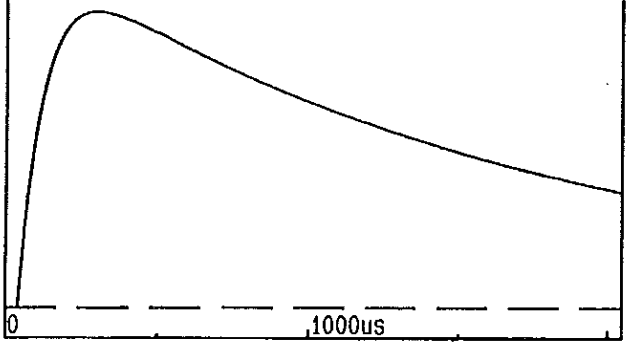
SWITCHING IMPULSE VOLTAGE TEST on terminal H1
Nominal test voltage 250kV.

Amplitude %	kV	Impulse shape µs	Oscillogram number
100	238	248/1544	31
100	237	247/1551	32
100	237	256/1548	33
100	237	252/1548	34
100	237	259/1549	35
100	237	259/1549	36
100	236	245/1549	37
100	236	247/1549	38
100	236	250/1548	39
100	236	250/1549	40
100	236	253/299	41
100	236	259/1550	42
100	236	251/1552	43
100	236	252/384	44
100	236	248/1549	45

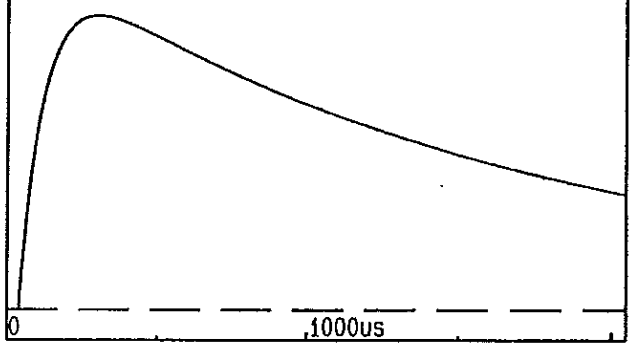
SWITCHING IMPULSE VOLTAGE TEST on terminal H1.
Nominal test voltage -250kV.

Amplitude %	kV	Impulse shape µs	Oscillogram number
100	-236	261/1546	46
100	-235	243/1548	47
100	-236	250/1546	48
100	-236	248/1547	49
100	-236	252/1546	50
100	-236	251/1548	51
100	-236	249/1546	52
100	-236	255/1546	53
100	-236	239/1549	54
100	-236	256/1546	55
100	-236	244/1548	56
100	-236	257/1545	57
100	-236	244/1545	58
100	-236	243/1543	59
100	-236	259/1547	60

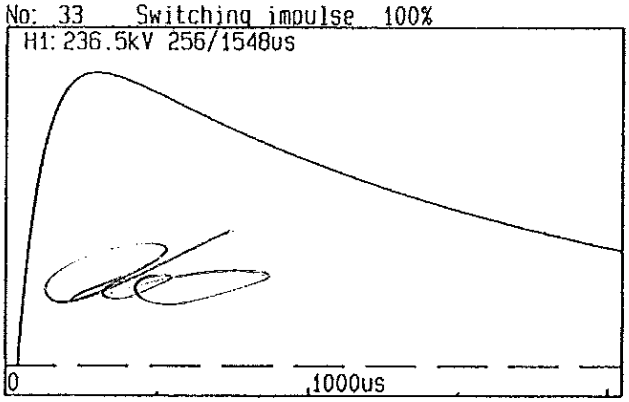
No: 31 Switching impulse 100%
H1: 237.8kV 248/1544us



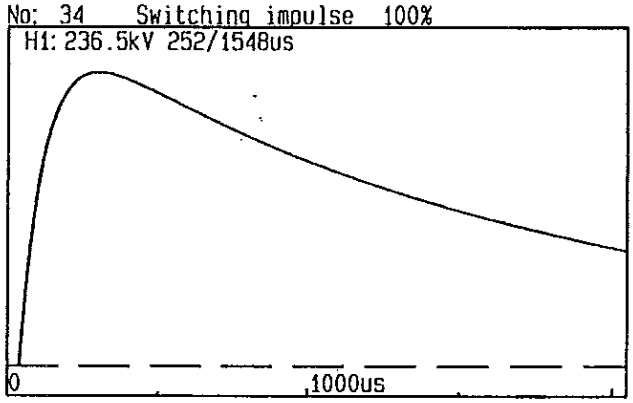
No: 32 Switching impulse 100%
H1: 236.5kV 247/1551us



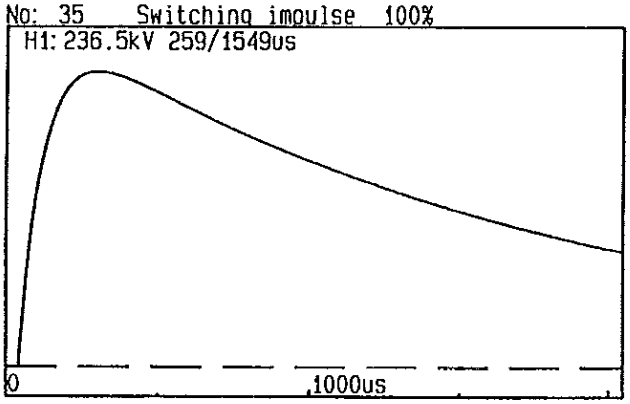
No: 33 Switching impulse 100%
H1: 236.5kV 256/1548us



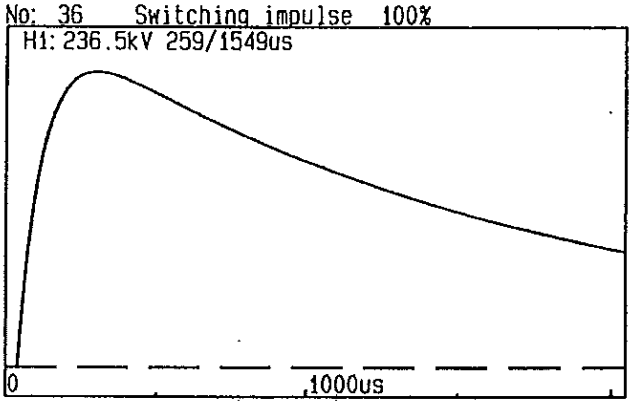
No: 34 Switching impulse 100%
H1: 236.5kV 252/1548us



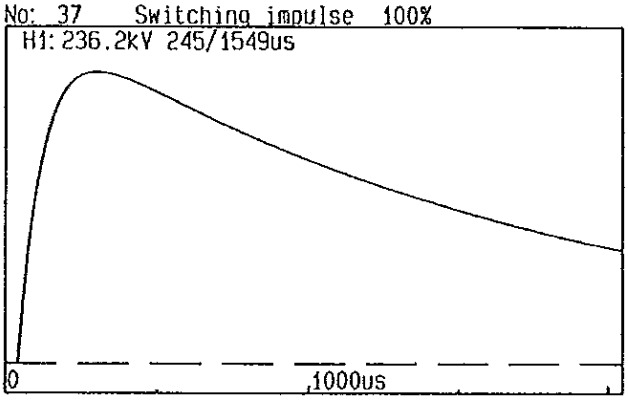
No: 35 Switching impulse 100%
H1: 236.5kV 259/1549us



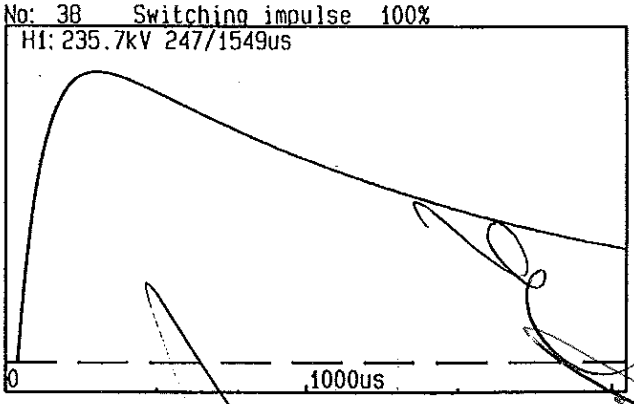
No: 36 Switching impulse 100%
H1: 236.5kV 259/1549us



No: 37 Switching impulse 100%
H1: 236.2kV 245/1549us



No: 38 Switching impulse 100%
H1: 235.7kV 247/1549us



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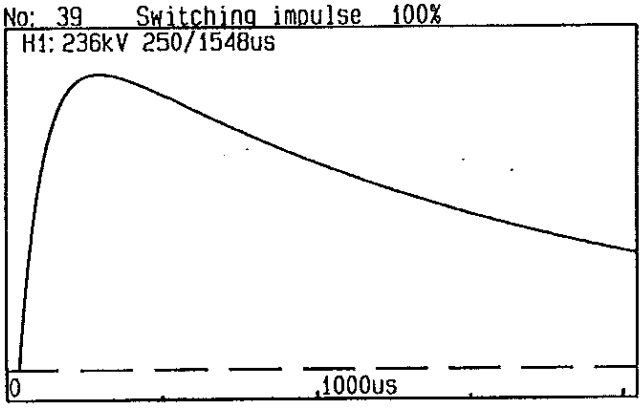
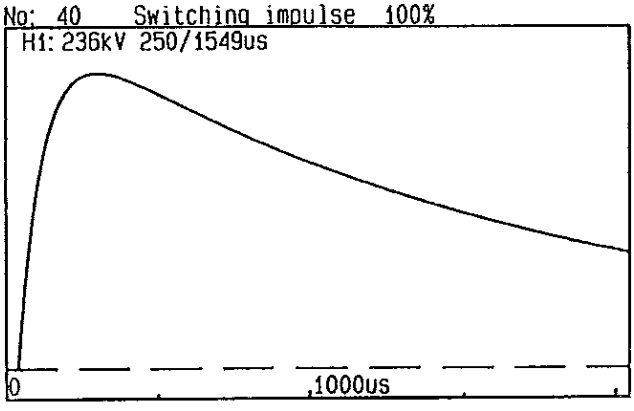
ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН

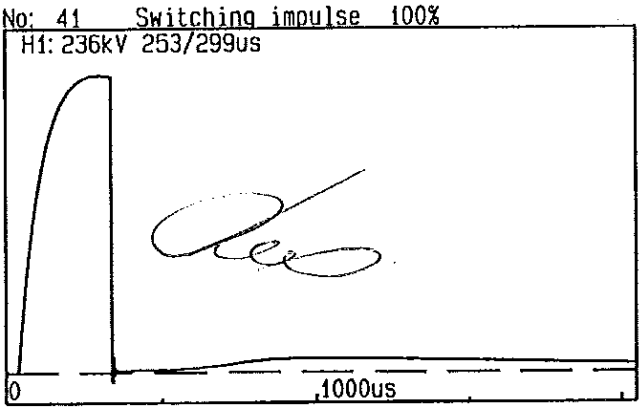
No: 39 Switching impulse 100%
H1: 236kV 250/1548us



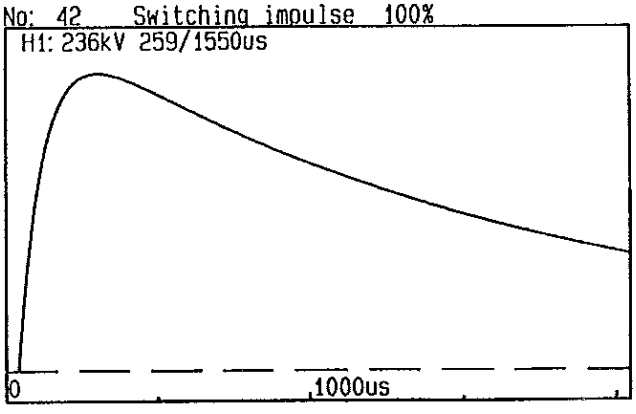
No: 40 Switching impulse 100%
H1: 236kV 250/1549us



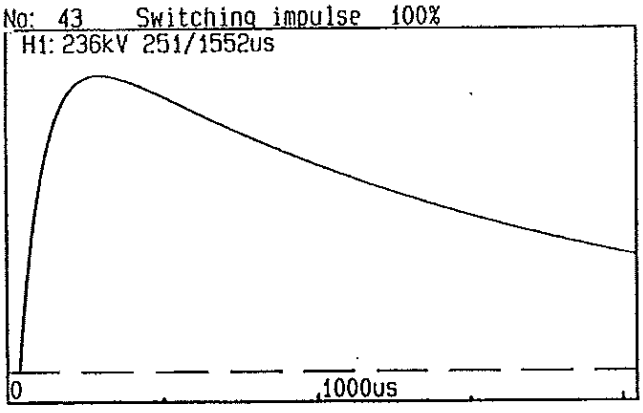
No: 41 Switching impulse 100%
H1: 236kV 253/299us



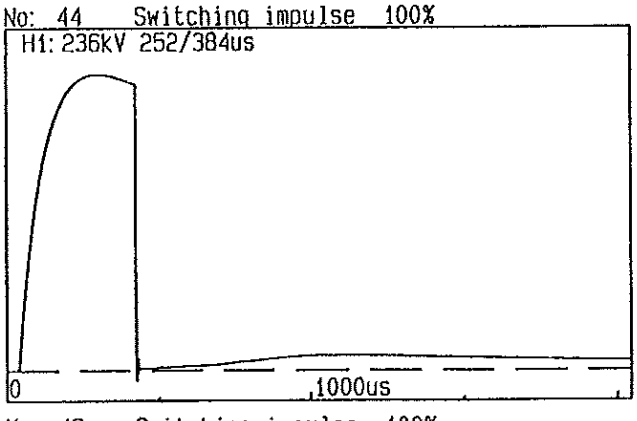
No: 42 Switching impulse 100%
H1: 236kV 259/1550us



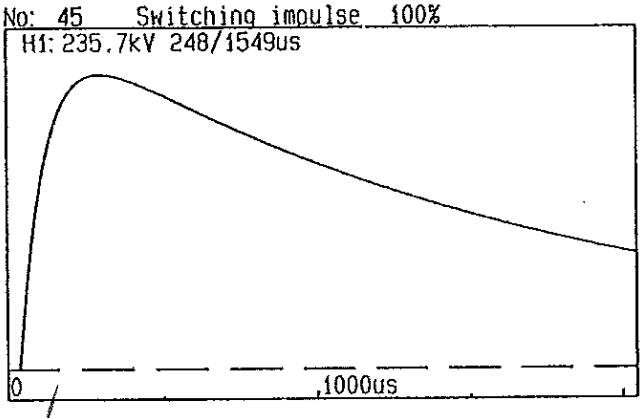
No: 43 Switching impulse 100%
H1: 236kV 251/1552us



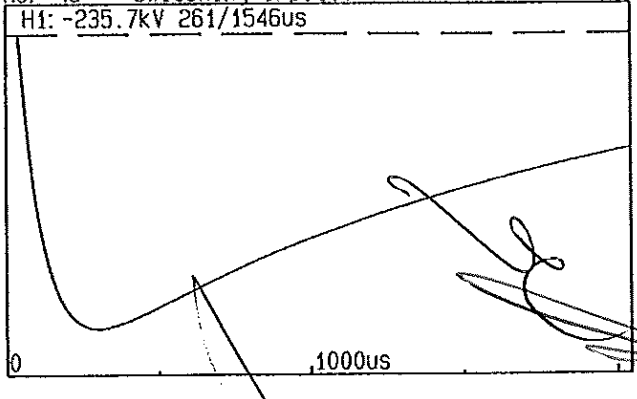
No: 44 Switching impulse 100%
H1: 236kV 252/384us



No: 45 Switching impulse 100%
H1: 235.7kV 248/1549us



No: 46 Switching impulse 100%
H1: -235.7kV 261/1546us

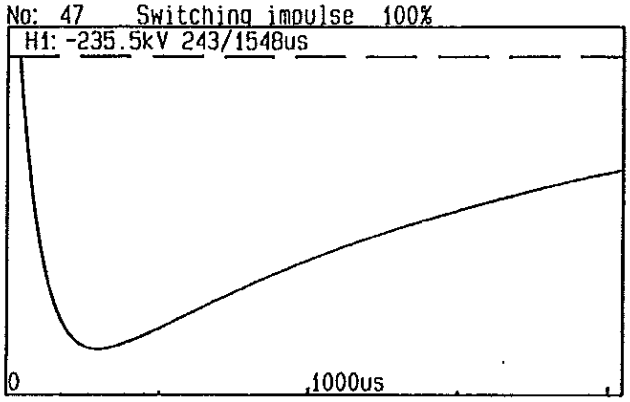


000194

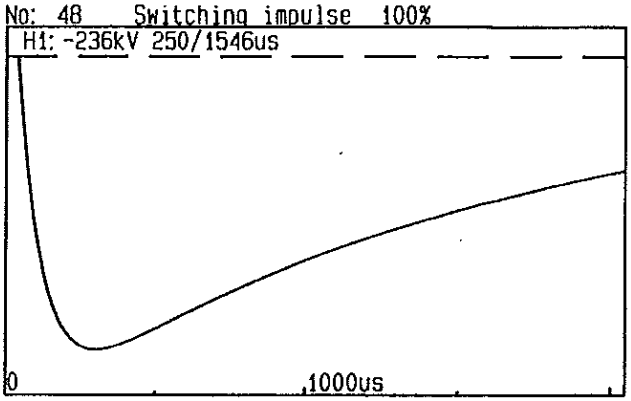
ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

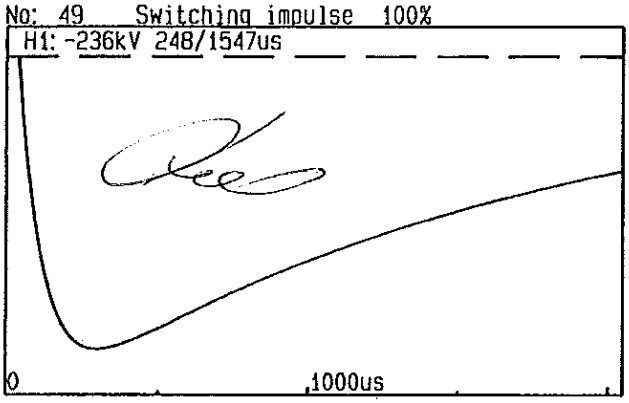
No: 47 Switching impulse 100%
H1: -235.5kV 243/1548us



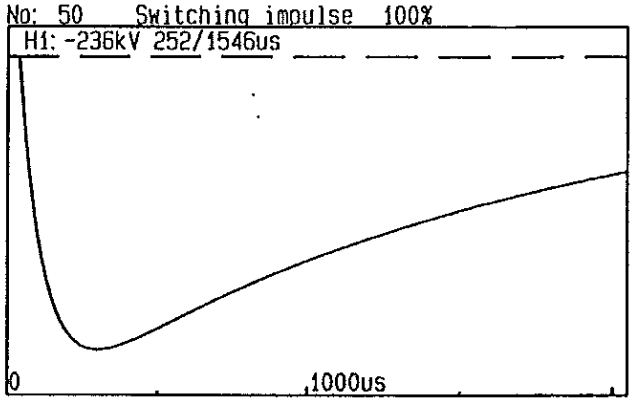
No: 48 Switching impulse 100%
H1: -236kV 250/1546us



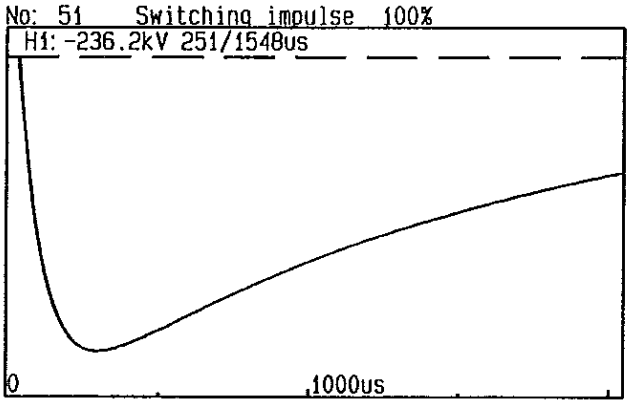
No: 49 Switching impulse 100%
H1: -236kV 248/1547us



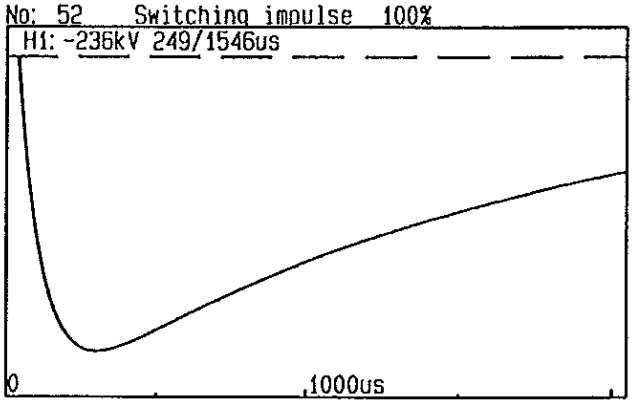
No: 50 Switching impulse 100%
H1: -236kV 252/1546us



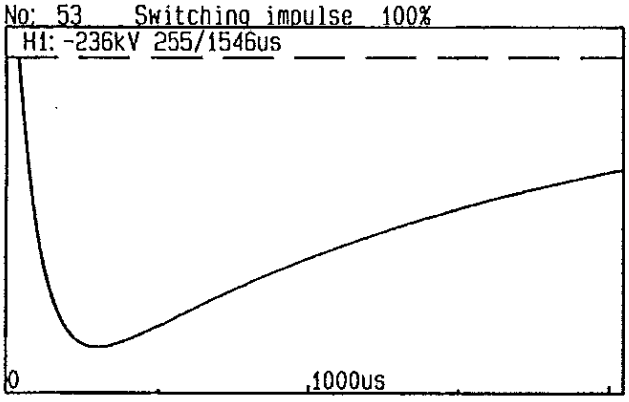
No: 51 Switching impulse 100%
H1: -236.2kV 251/1548us



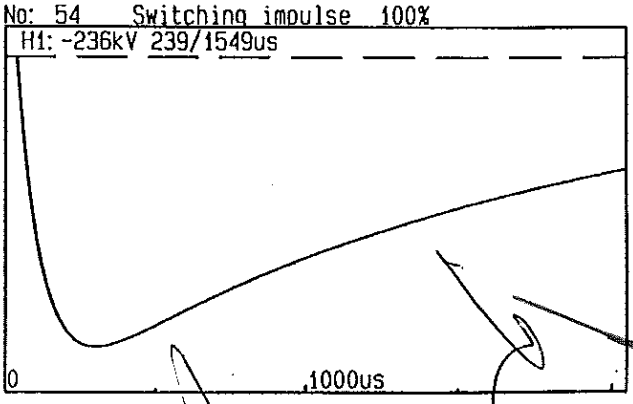
No: 52 Switching impulse 100%
H1: -236kV 249/1546us



No: 53 Switching impulse 100%
H1: -236kV 255/1546us



No: 54 Switching impulse 100%
H1: -236kV 239/1549us

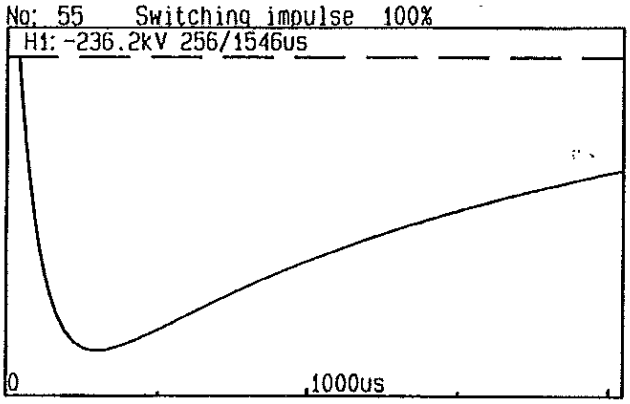


000195

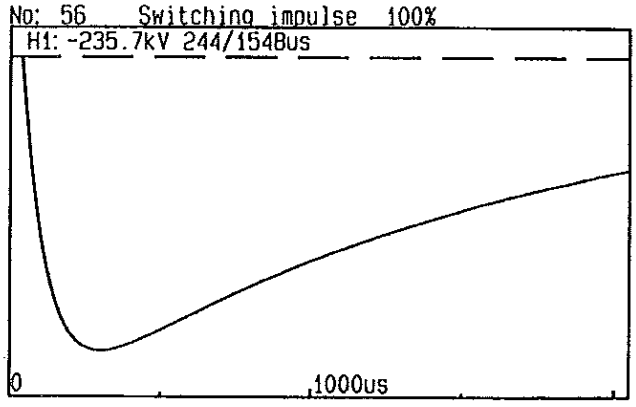
ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

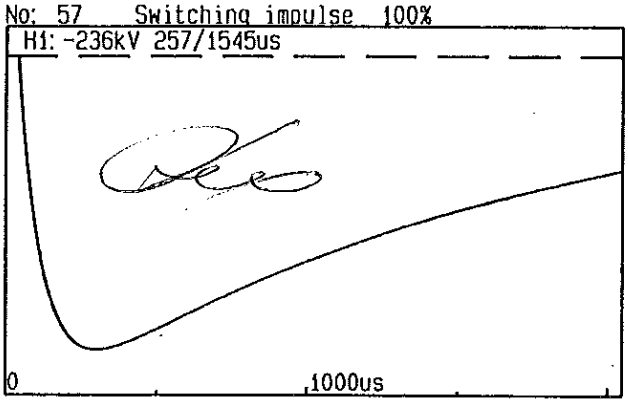
No: 55 Switching impulse 100%
H1: -236.2kV 256/1546us



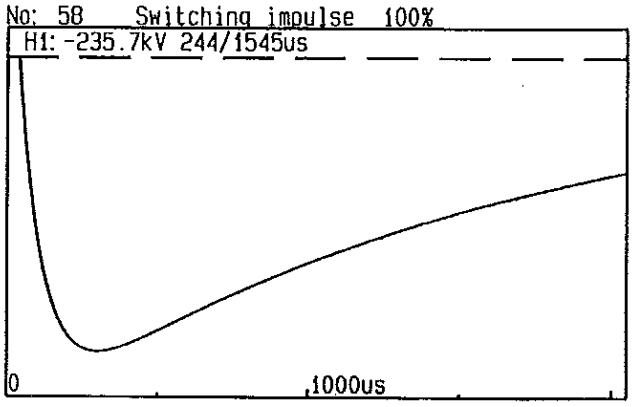
No: 56 Switching impulse 100%
H1: -235.7kV 244/1548us



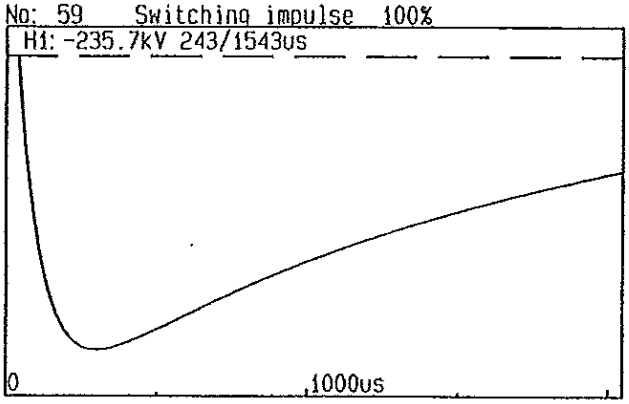
No: 57 Switching impulse 100%
H1: -236kV 257/1545us



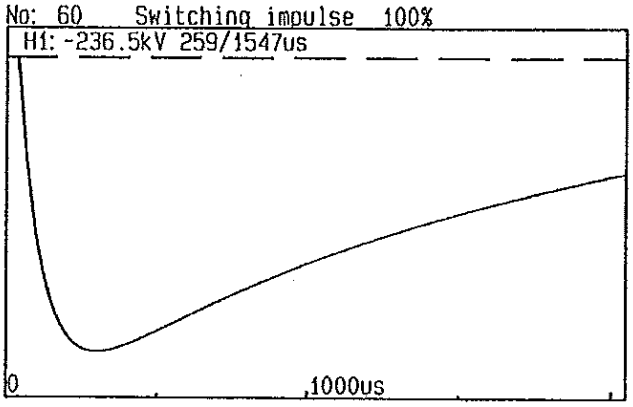
No: 58 Switching impulse 100%
H1: -235.7kV 244/1545us



No: 59 Switching impulse 100%
H1: -235.7kV 243/1543us



No: 60 Switching impulse 100%
H1: -236.5kV 259/1547us



000196

ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

ABB TRANSFORMERS AB

Test Record

Test date : 29 Sep 1999

Serial nbr. : Q72

IMPULSE VOLTAGE TEST

MEASUREMENTS

LIGHTNING IMPULSE VOLTAGE TEST on terminal H1.
Nominal test voltage 376kV.

Amplitude %	kV	Impulse shape µs	Oscillogram number
100	375	1.30/53	1
100	375	1.30/53	2
100	375	1.31/54	3
100	376	1.30/54	4
100	376	1.31/53	5
100	376	1.31/53	6
100	376	1.31/53	7
100	376	1.31/53	8
100	376	1.31/53	9
100	375	1.30/54	10
100	375	1.30/54	11
100	376	1.31/54	12
100	375	1.30/53	13
100	375	1.31/54	14
100	375	1.30/54	15

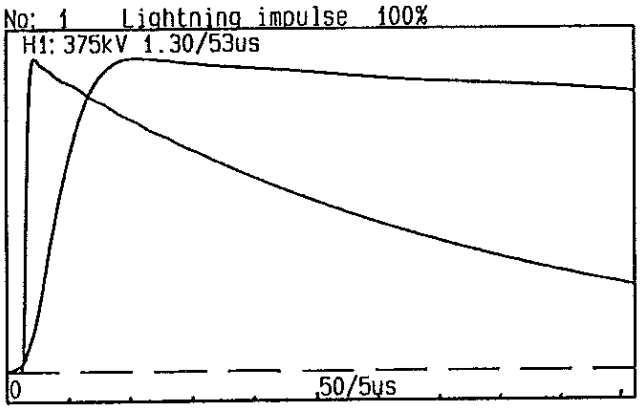
LIGHTNING IMPULSE VOLTAGE TEST on terminal H1.
Nominal test voltage -376kV.

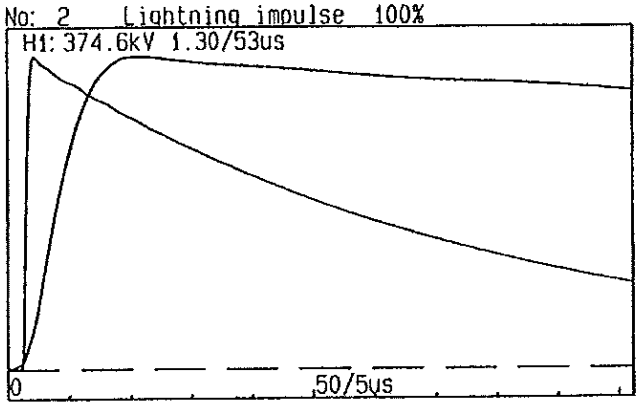
Amplitude %	kV	Impulse shape µs	Oscillogram number
100	-375	1.30/53	16
100	-375	1.29/53	17
100	-376	1.30/53	18
100	-376	1.29/53	19
100	-376	1.29/53	20
100	-376	1.29/53	21
100	-375	1.29/53	22
100	-375	1.29/53	23
100	-376	1.30/53	24
100	-375	1.29/53	25
100	-375	1.29/53	26
100	-375	1.29/53	27
100	-375	1.29/53	28
100	-375	1.29/53	29
100	-375	1.30/53	30

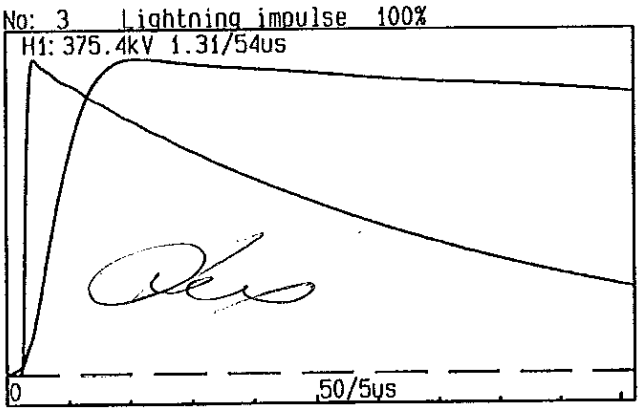
000197

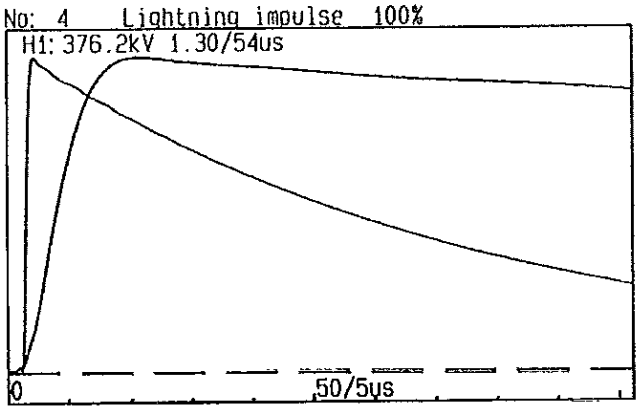
ВЯРНО С ОРИГИНАЛА

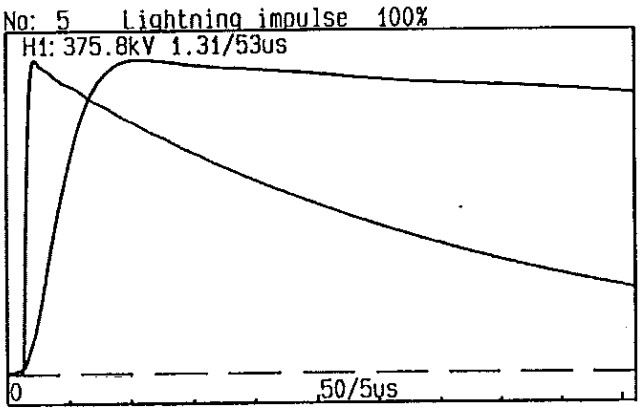
"КРАСИН" СМОЛЯН ООД

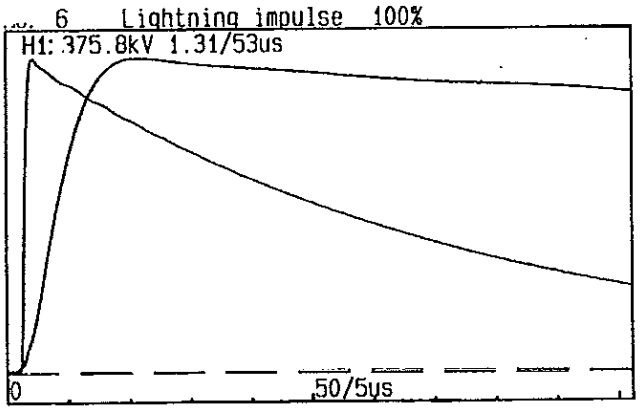


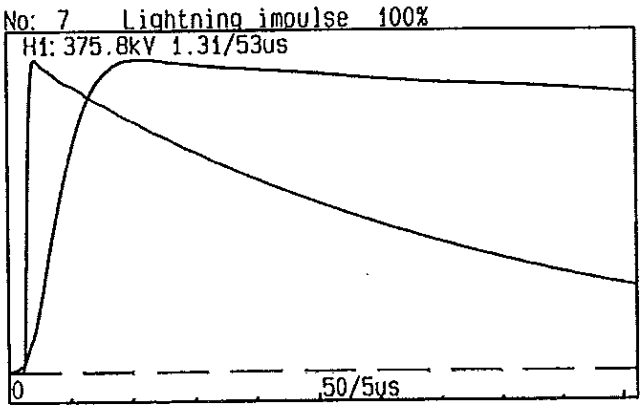


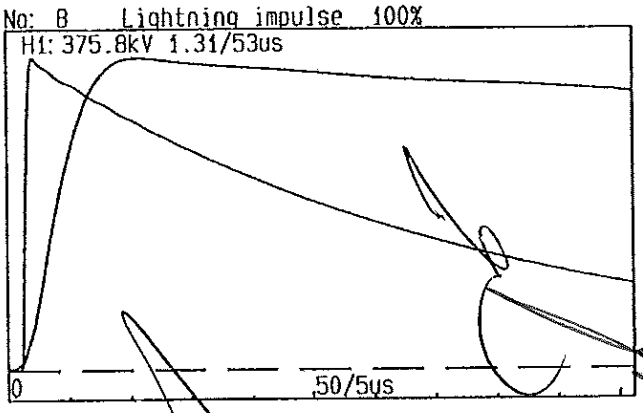










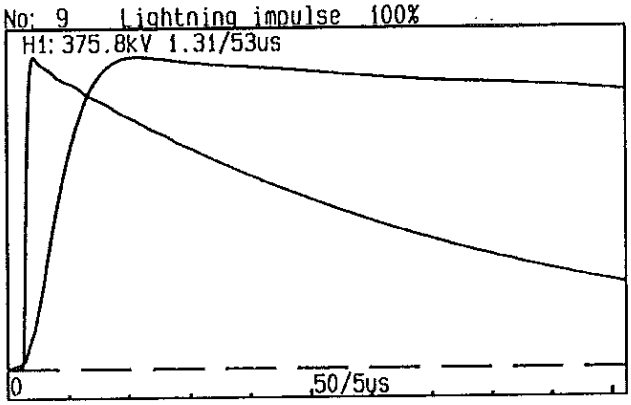


000198

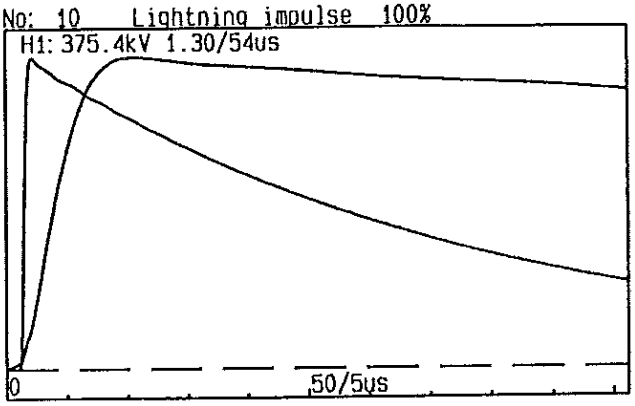
ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

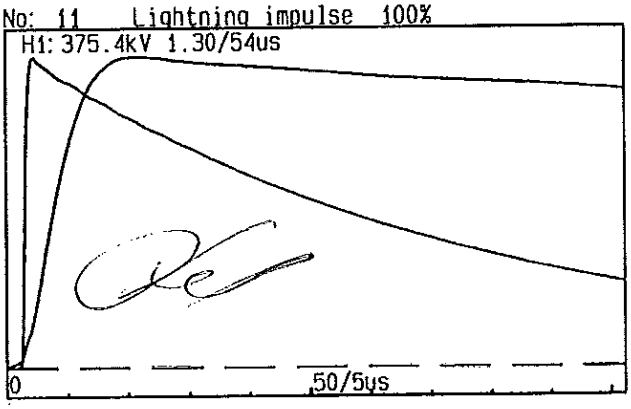
No: 9 Lightning impulse 100%



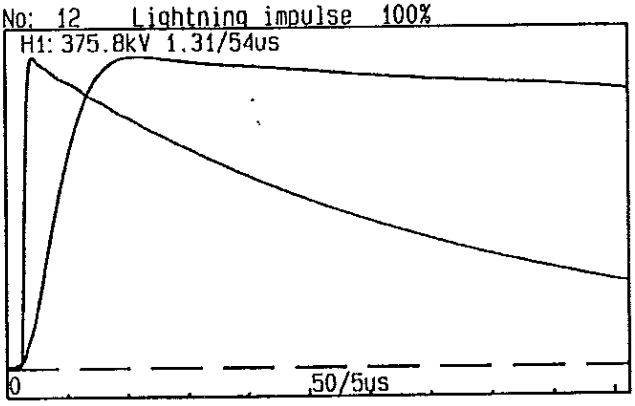
No: 10 Lightning impulse 100%



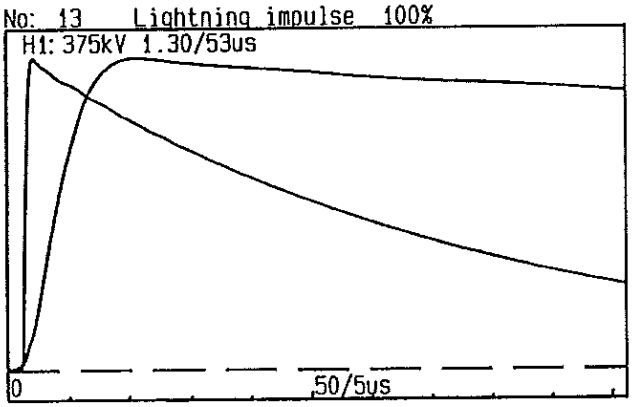
No: 11 Lightning impulse 100%



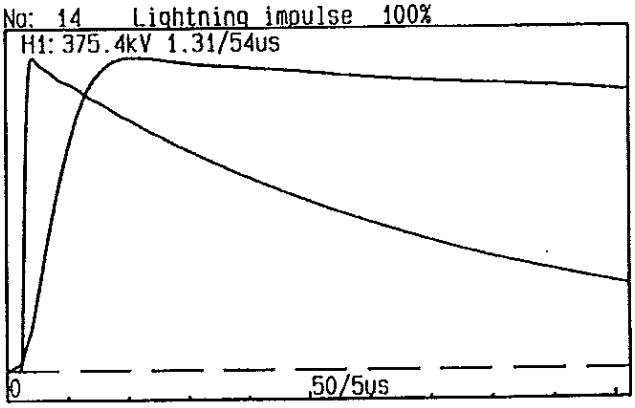
No: 12 Lightning impulse 100%



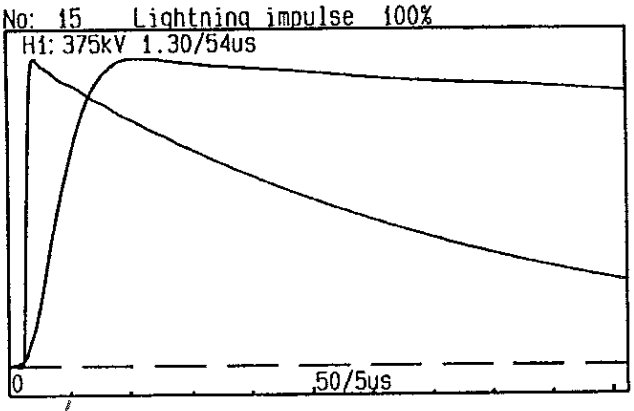
No: 13 Lightning impulse 100%



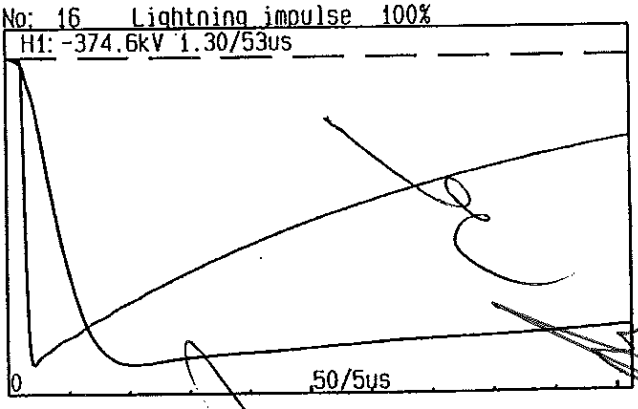
No: 14 Lightning impulse 100%



No: 15 Lightning impulse 100%



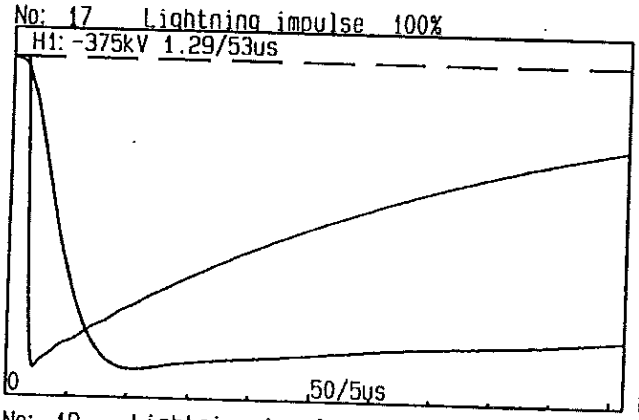
No: 16 Lightning impulse 100%

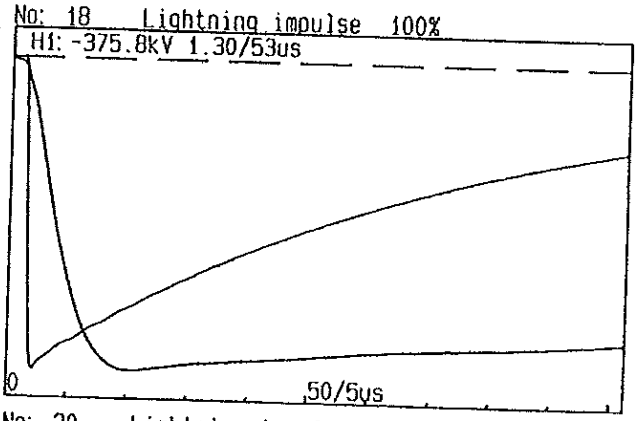


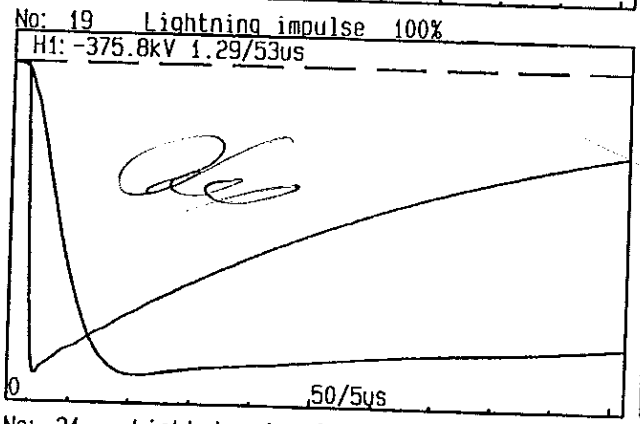
000199

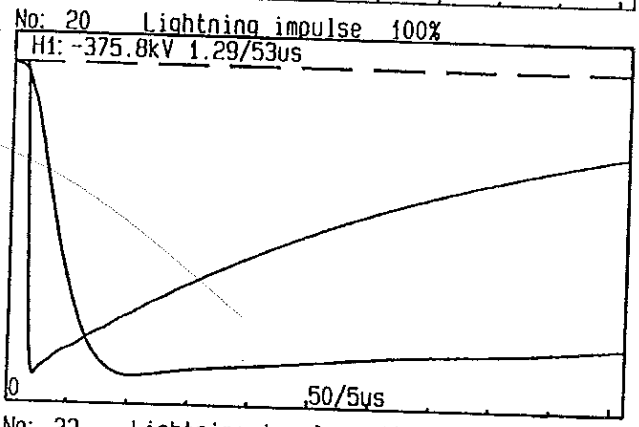
ВЯРНО С ОРИГИНАЛА

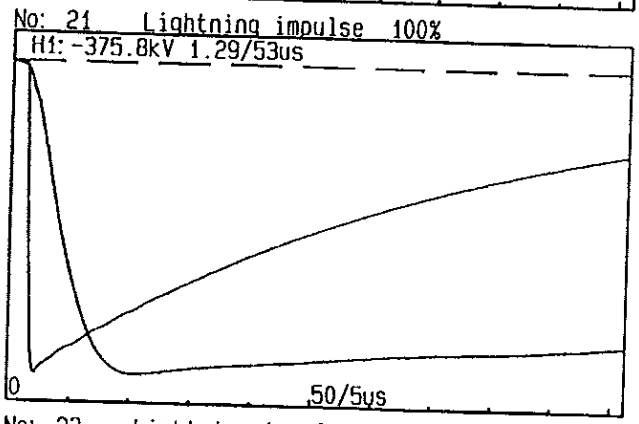
"КРАСИН" СМОЛЯН ООД

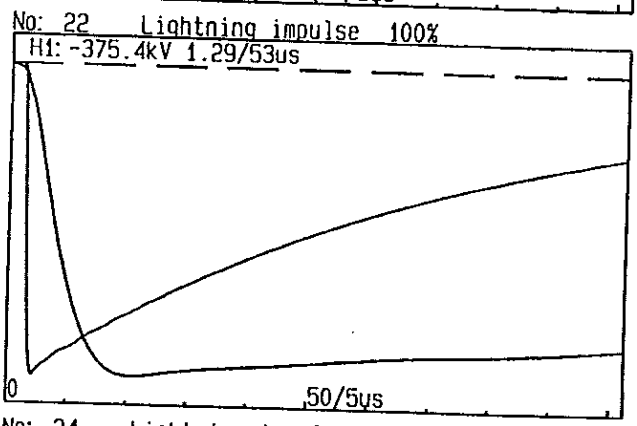


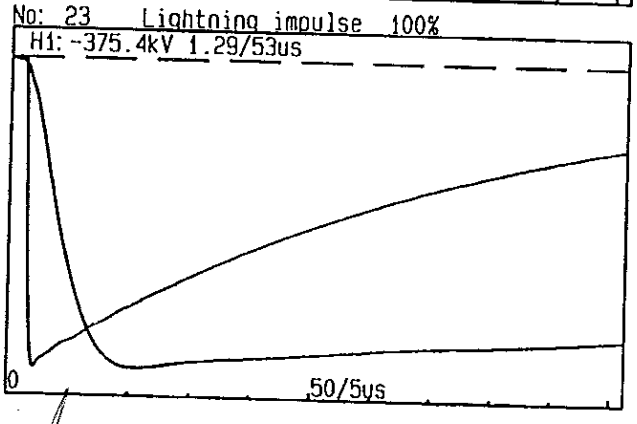


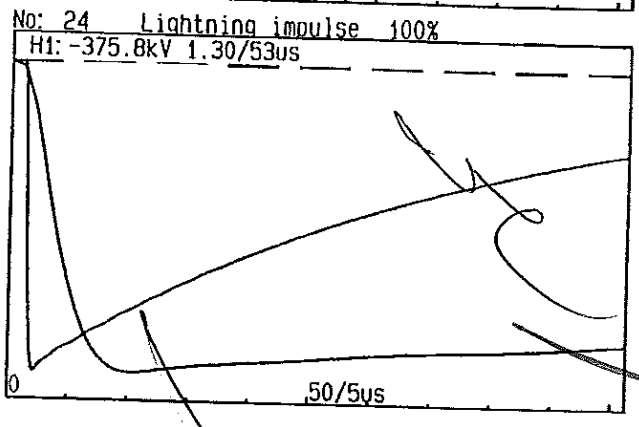










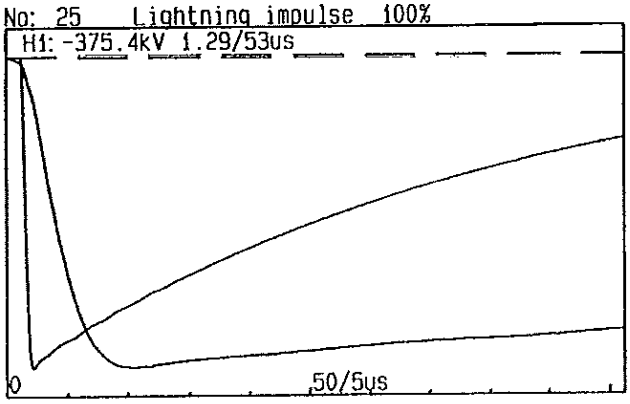


000200

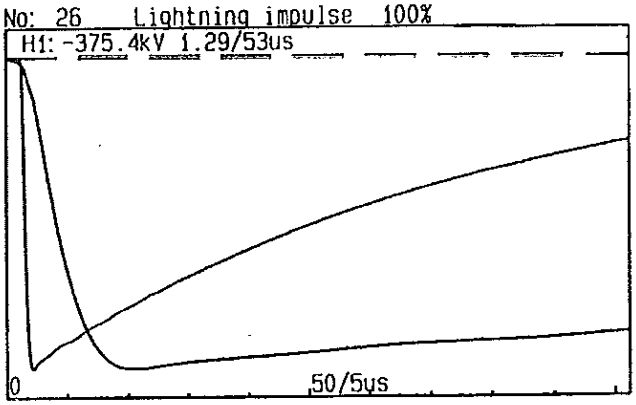
ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

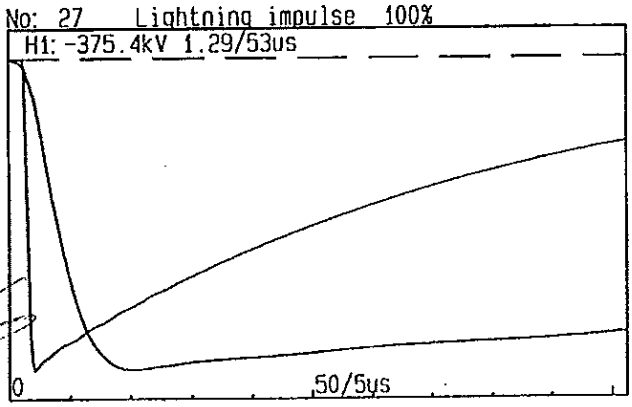
No: 25 Lightning impulse 100%



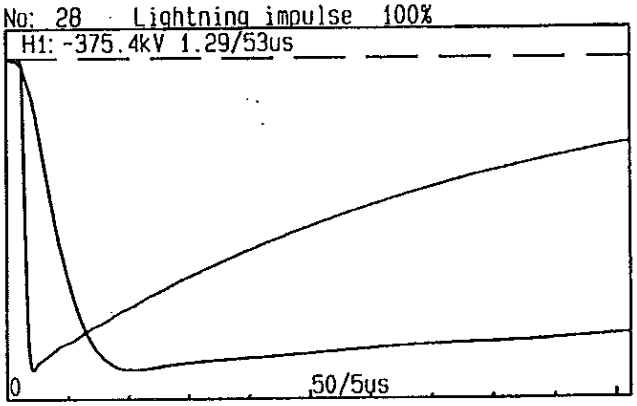
No: 26 Lightning impulse 100%



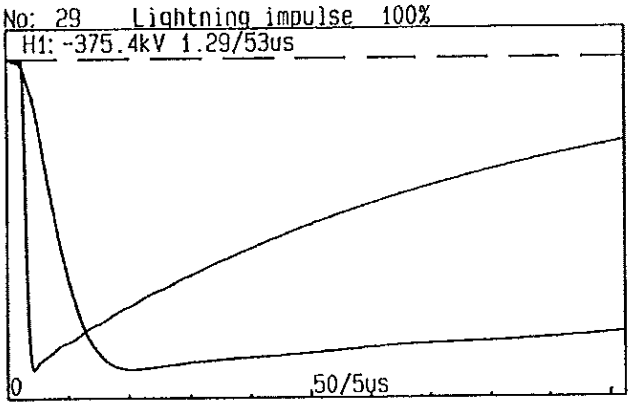
No: 27 Lightning impulse 100%



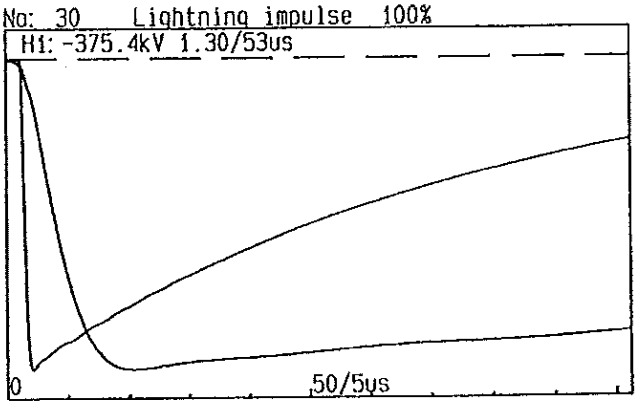
No: 28 Lightning impulse 100%



No: 29 Lightning impulse 100%



No: 30 Lightning impulse 100%



000201

ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

ABB TRANSFORMERS AB

Test Record

Test date 20 Oct 1999

Serial nbr. Q72

IMPULSE VOLTAGE TEST

MEASUREMENTS

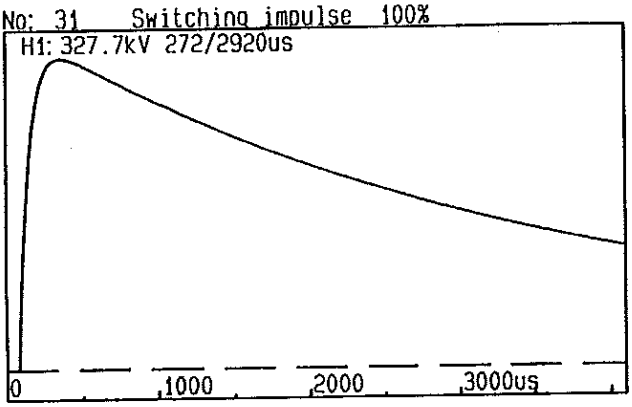
SWITCHING IMPULSE VOLTAGE TEST on terminal H1
Nominal test voltage 328kV.

Amplitude %	kV	Impulse shape µs	Oscillogram number
100	328	272/2920	31
100	327	280/2930	32
100	327	274/2921	33
100	326	260/2925	34
100	327	264/2924	35
100	328	268/2924	36
100	327	265/2912	37
100	327	281/2927	38
100	327	263/2920	39
100	328	265/2919	40
100	327	269/789	41
100	327	259/585	42
100	327	265/2928	43
100	327	261/2930	44
100	327	266/2918	45

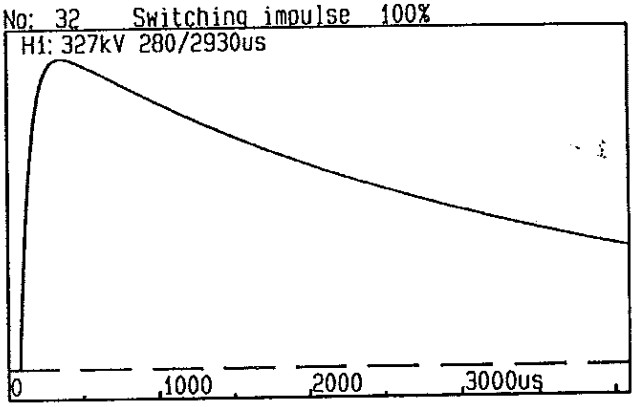
SWITCHING IMPULSE VOLTAGE TEST on terminal H1
Nominal test voltage -328kV.

Amplitude %	kV	Impulse shape µs	Oscillogram number
100	-325	277/2914	46
100	-328	260/2915	47
100	-327	274/2918	48
100	-328	258/2935	49
100	-325	260/2918	50
100	-329	268/2919	51
100	-329	272/2918	52
100	-328	261/2932	53
100	-329	267/2905	54
100	-329	270/2922	55
100	-328	260/2914	56
100	-328	261/2916	57
100	-329	262/2904	58
100	-328	263/2908	59
100	-329	264/2920	60

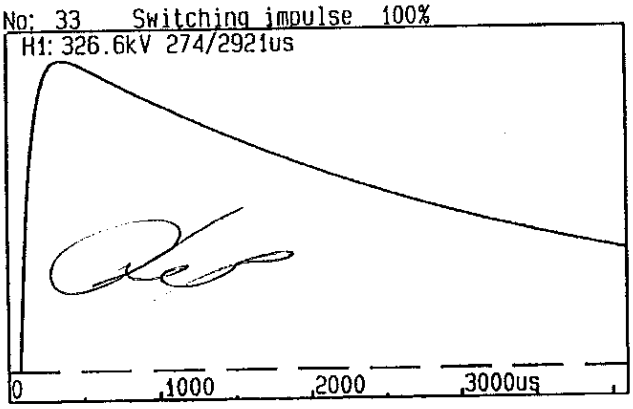
No: 31 Switching impulse 100%
H1: 327.7kV 272/2920us



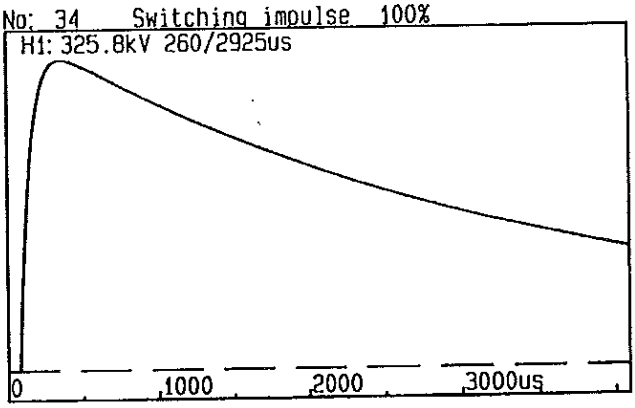
No: 32 Switching impulse 100%
H1: 327kV 280/2930us



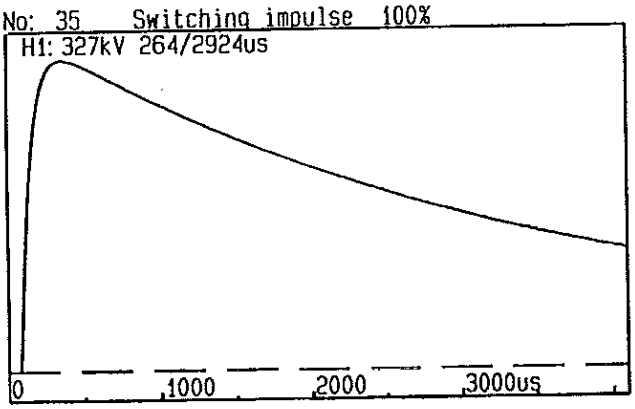
No: 33 Switching impulse 100%
H1: 326.6kV 274/2921us



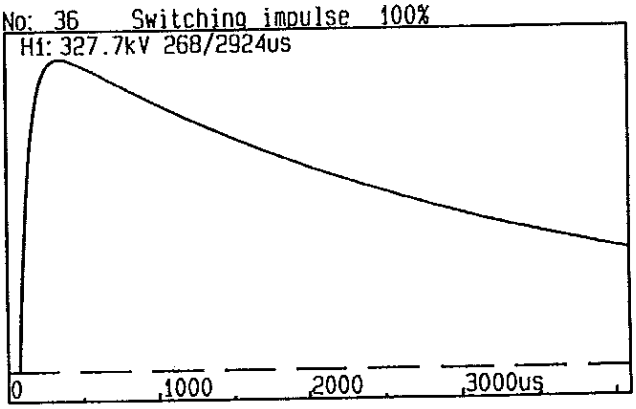
No: 34 Switching impulse 100%
H1: 325.8kV 260/2925us



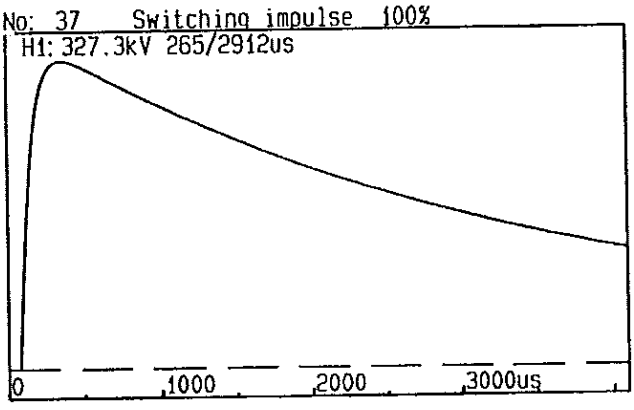
No: 35 Switching impulse 100%
H1: 327kV 264/2924us



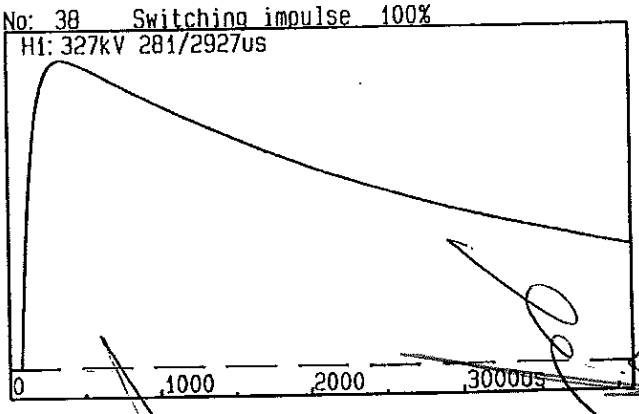
No: 36 Switching impulse 100%
H1: 327.7kV 268/2924us



No: 37 Switching impulse 100%
H1: 327.3kV 265/2912us



No: 38 Switching impulse 100%
H1: 327kV 281/2927us

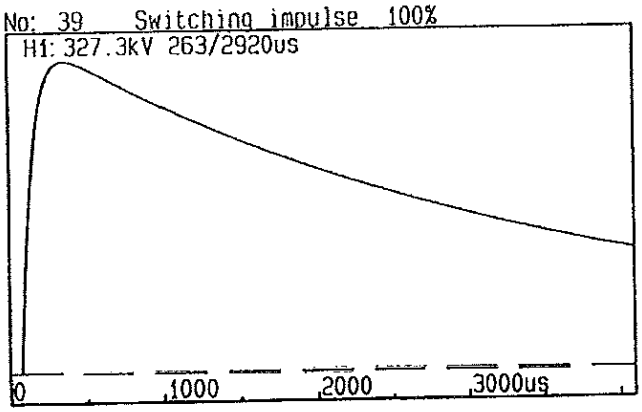


000203

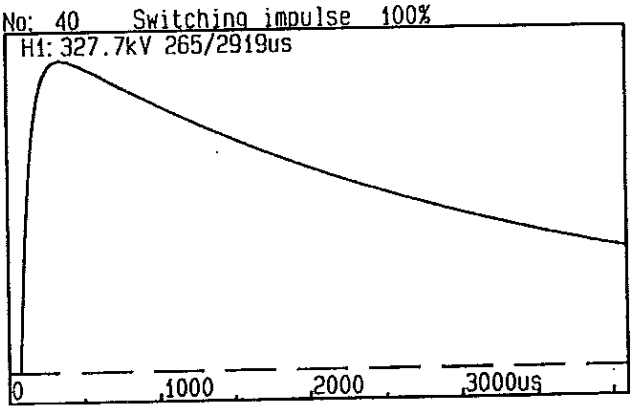
ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

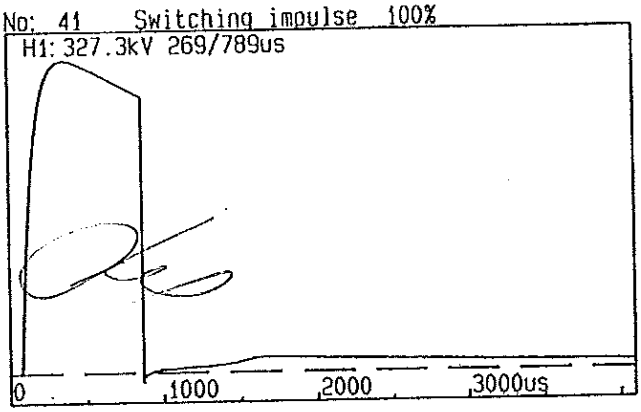
No: 39 Switching impulse 100%
H1: 327.3kV 263/2920us



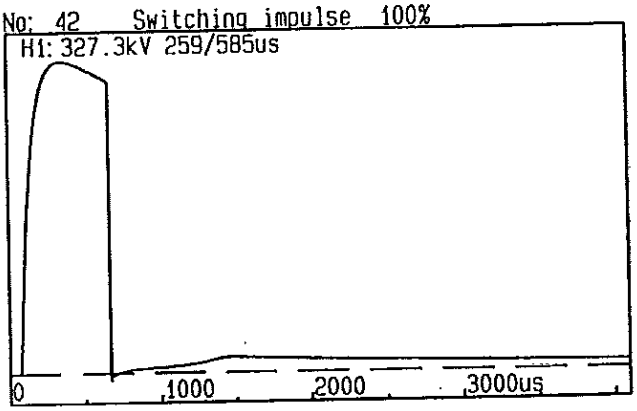
No: 40 Switching impulse 100%
H1: 327.7kV 265/2919us



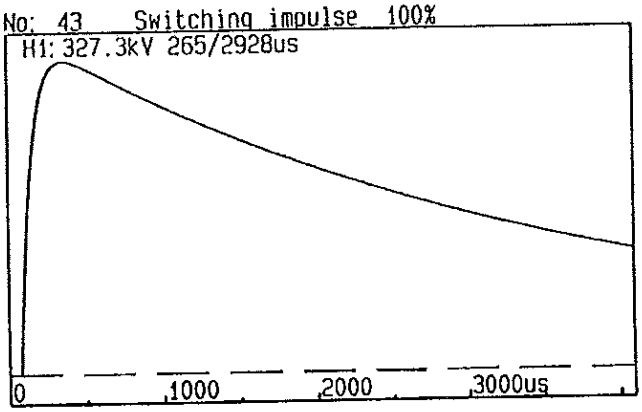
No: 41 Switching impulse 100%
H1: 327.3kV 269/789us



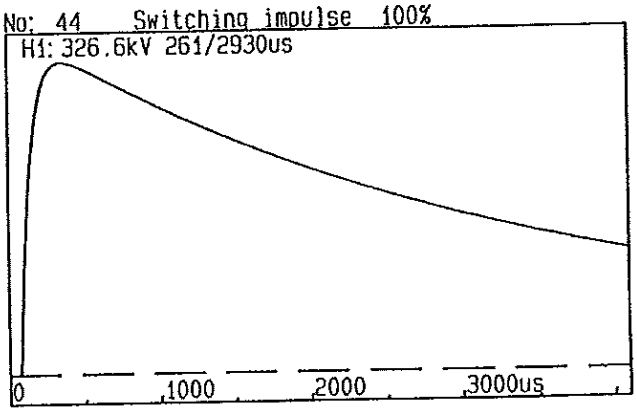
No: 42 Switching impulse 100%
H1: 327.3kV 259/585us



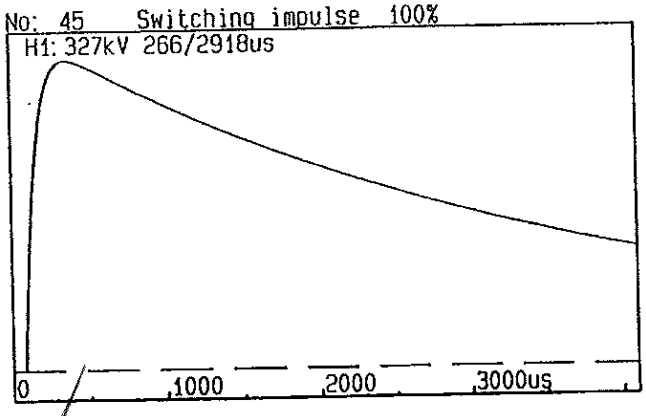
No: 43 Switching impulse 100%
H1: 327.3kV 265/2928us



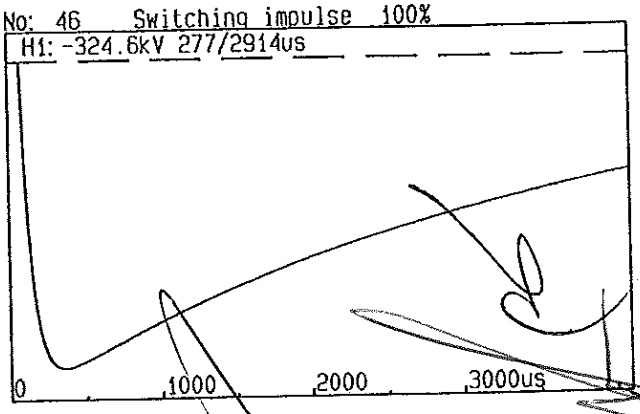
No: 44 Switching impulse 100%
H1: 326.6kV 261/2930us



No: 45 Switching impulse 100%
H1: 327kV 266/2918us



No: 46 Switching impulse 100%
H1: -324.6kV 277/2914us

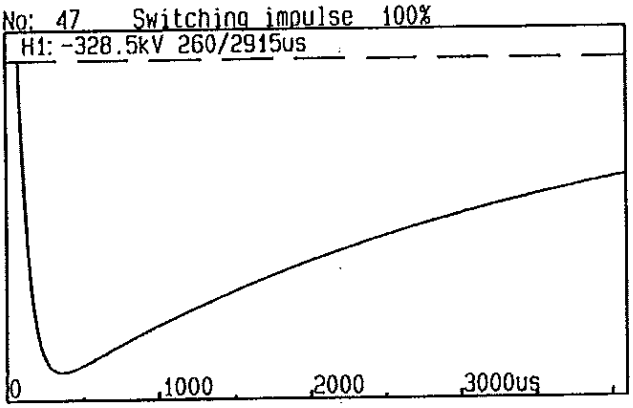


000204

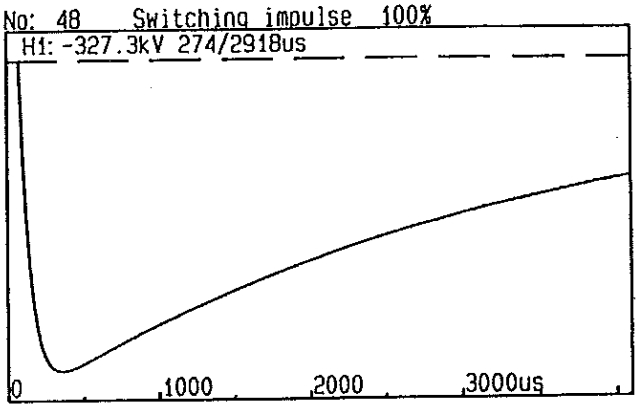
ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

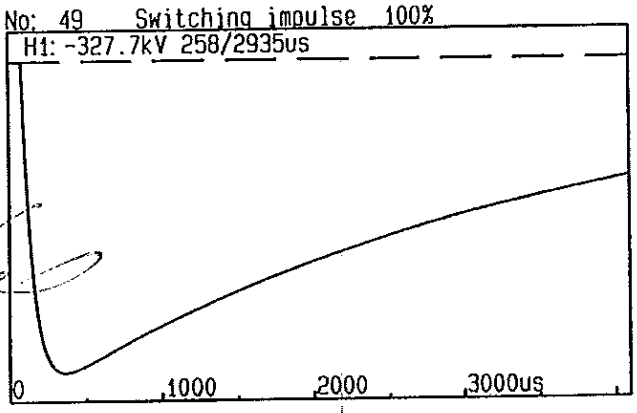
No: 47 Switching impulse 100%
H1: -328.5kV 260/2915us



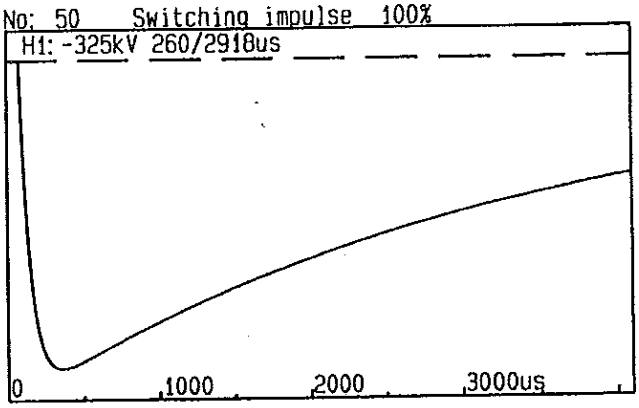
No: 48 Switching impulse 100%
H1: -327.3kV 274/2918us



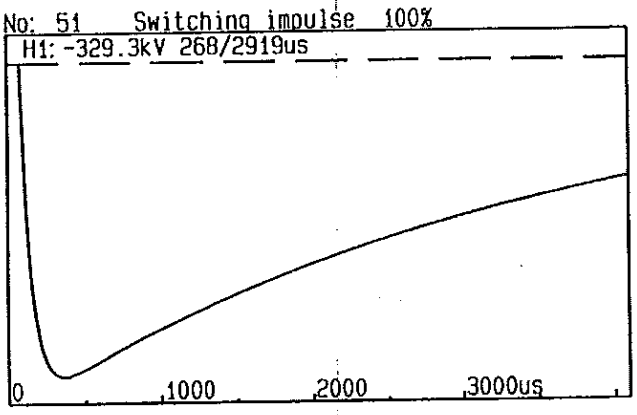
No: 49 Switching impulse 100%
H1: -327.7kV 258/2935us



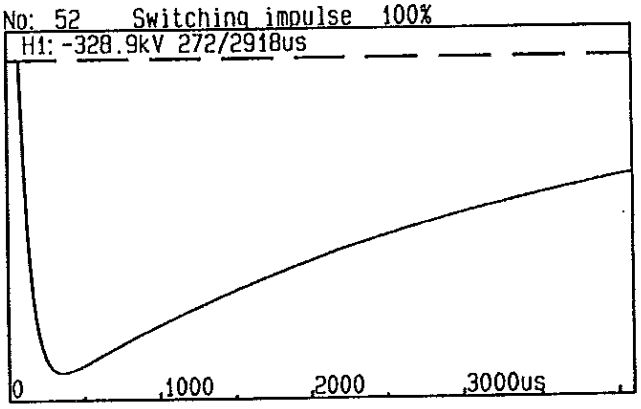
No: 50 Switching impulse 100%
H1: -325kV 260/2918us



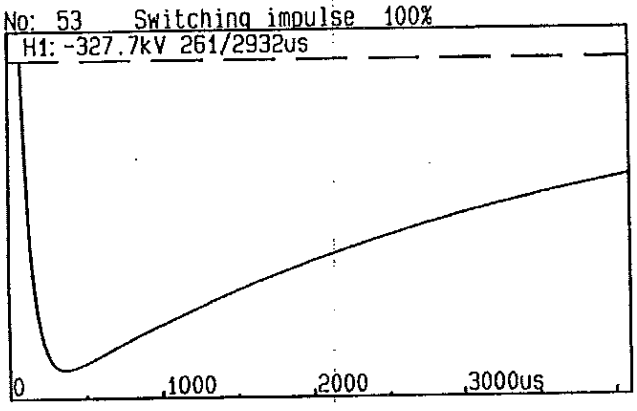
No: 51 Switching impulse 100%
H1: -329.3kV 268/2919us



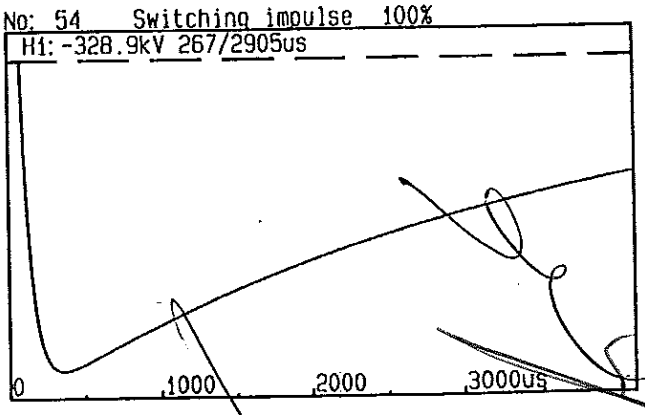
No: 52 Switching impulse 100%
H1: -328.9kV 272/2918us



No: 53 Switching impulse 100%
H1: -327.7kV 261/2932us



No: 54 Switching impulse 100%
H1: -328.9kV 267/2905us

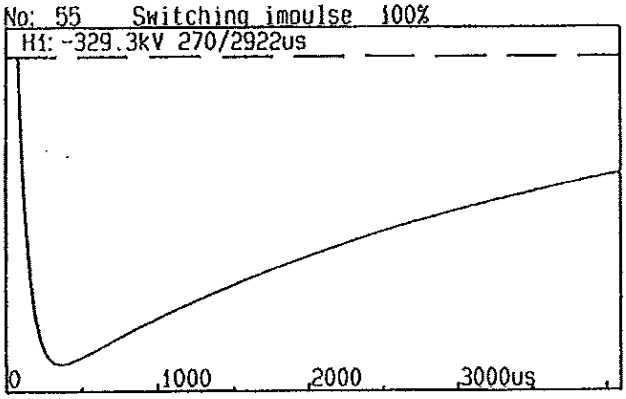


000205

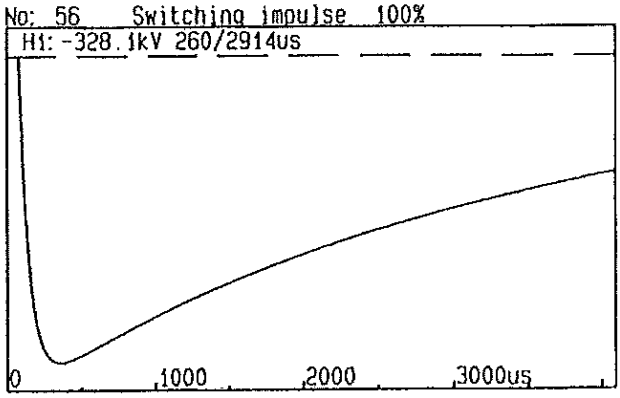
ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

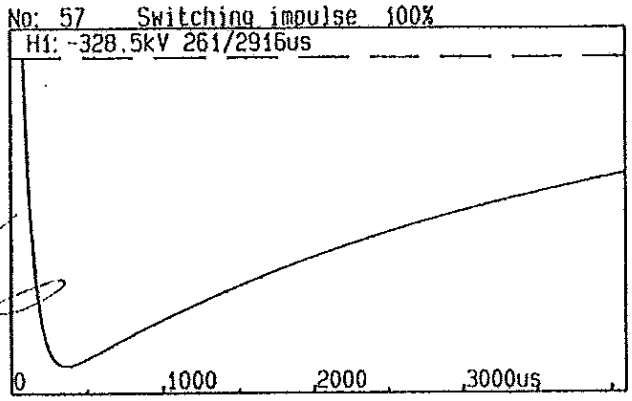
No: 55 Switching impulse 100%
H1: -329.3kV 270/2922us



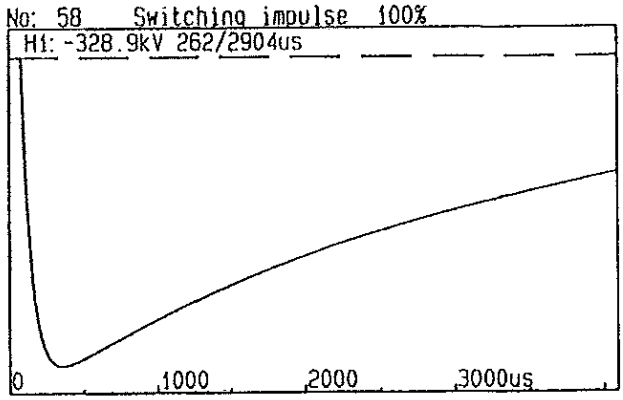
No: 56 Switching impulse 100%
H1: -328.1kV 260/2914us



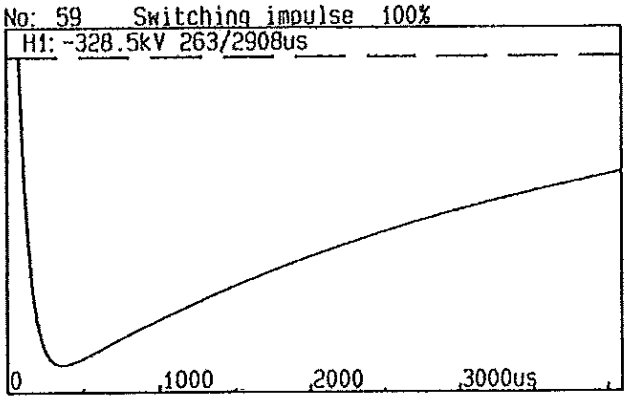
No: 57 Switching impulse 100%
H1: -328.5kV 261/2916us



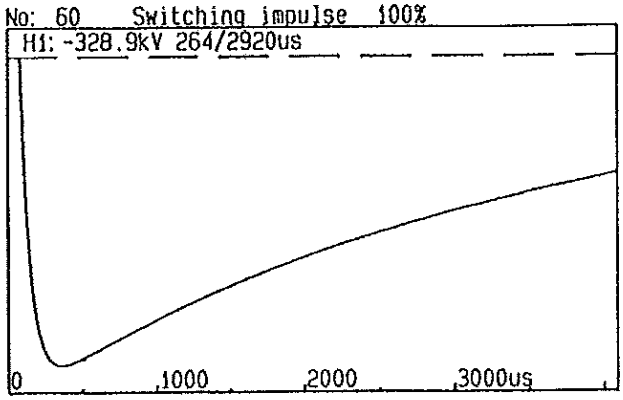
No: 58 Switching impulse 100%
H1: -328.9kV 262/2904us



No: 59 Switching impulse 100%
H1: -328.5kV 263/2908us



No: 60 Switching impulse 100%
H1: -328.9kV 264/2920us



000206

ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

ABB TRANSFORMERS AB

Test Record

Test date 26 Aug 1999

Serial nbr. : Q143

IMPULSE VOLTAGE TEST

MEASUREMENTS

LIGHTNING IMPULSE VOLTAGE TEST on terminal H1
Nominal test voltage 600kV.

Amplitude %	kV	Impulse shape µs	Oscillogram number
100	557	1.33/54	1
100	542	1.34/54	2
100	542	1.33/54	3
100	543	1.34/54	4
100	542	1.33/54	5
100	543	1.34/54	6
100	542	1.33/54	7
100	544	1.34/54	8
100	544	1.33/54	9
100	544	1.33/54	10
100	544	1.34/54	11
100	544	1.33/54	12
100	544	1.34/54	13
100	544	1.34/54	14
100	544	1.33/54	15

LIGHTNING IMPULSE VOLTAGE TEST on terminal H1
Nominal test voltage -600kV.

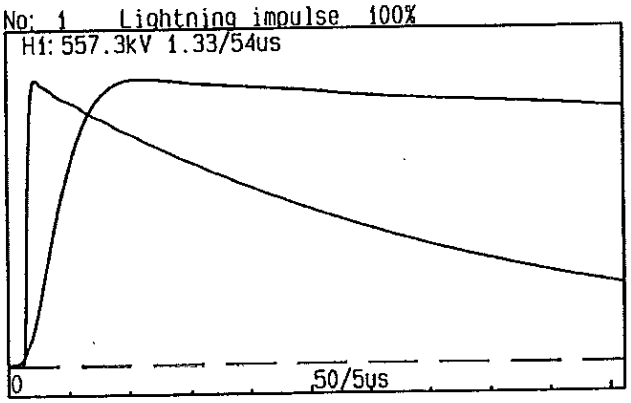
Amplitude %	kV	Impulse shape µs	Oscillogram number
100	-542	1.33/54	16
100	-544	1.33/54	17
100	-544	1.33/54	18
100	-544	1.33/54	19
100	-544	1.32/54	20
100	-544	1.32/54	21
100	-544	1.32/54	22
100	-544	1.32/54	23
100	-544	1.33/54	24
100	-544	1.32/54	25
100	-544	1.32/54	26
100	-544	1.32/54	27
100	-544	1.33/54	28
100	-544	1.32/54	29
100	-543	1.32/54	30

000207

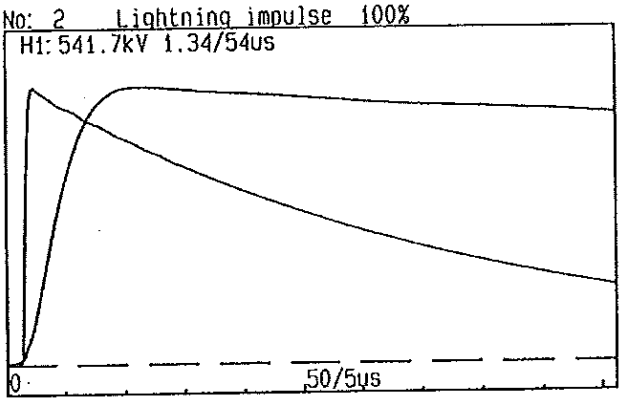
ЗЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

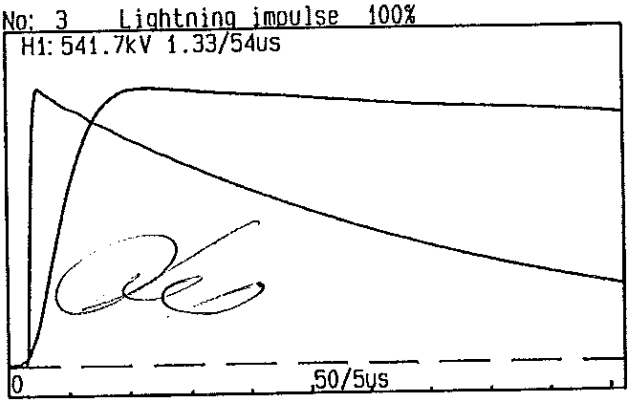
No: 1 Lightning impulse 100%
H1: 557.3kV 1.33/54us



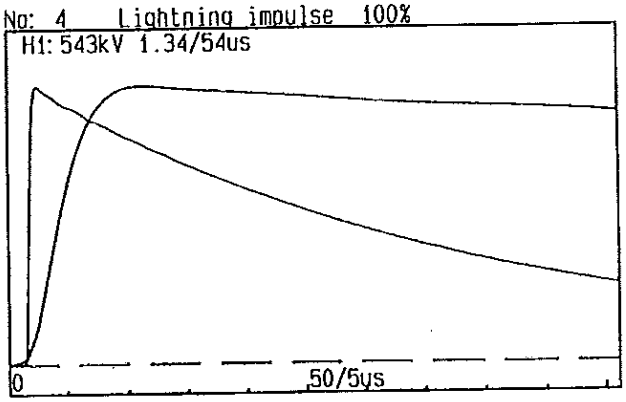
No: 2 Lightning impulse 100%
H1: 541.7kV 1.34/54us



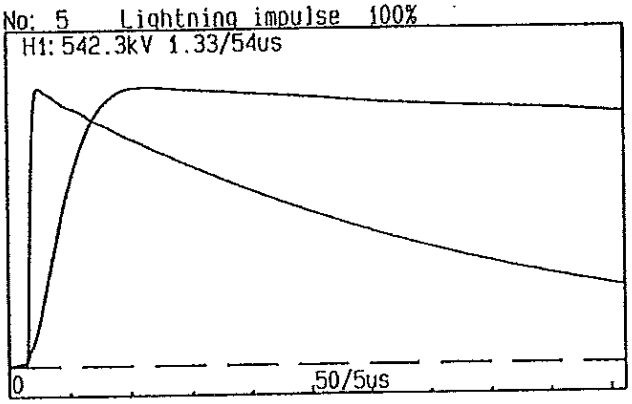
No: 3 Lightning impulse 100%
H1: 541.7kV 1.33/54us



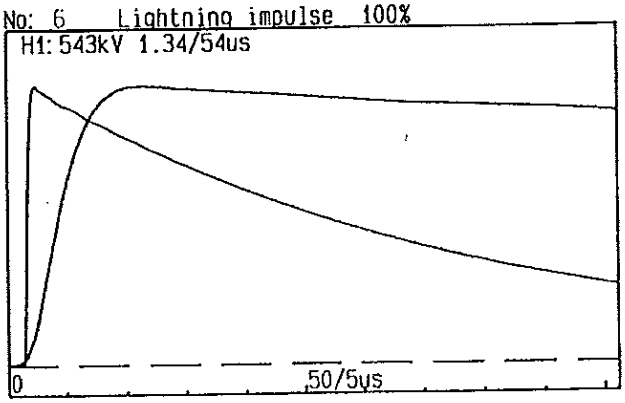
No: 4 Lightning impulse 100%
H1: 543kV 1.34/54us



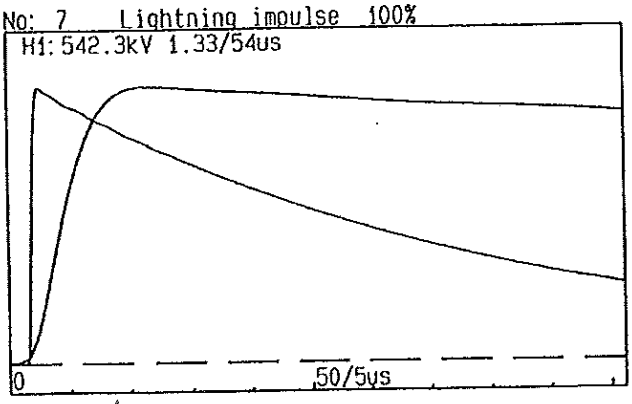
No: 5 Lightning impulse 100%
H1: 542.3kV 1.33/54us



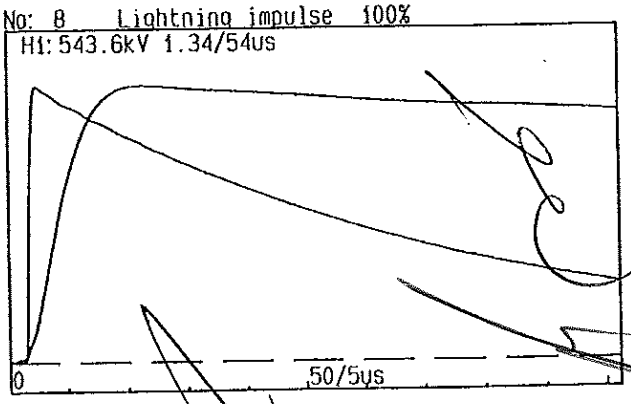
No: 6 Lightning impulse 100%
H1: 543kV 1.34/54us



No: 7 Lightning impulse 100%
H1: 542.3kV 1.33/54us



No: 8 Lightning impulse 100%
H1: 543.6kV 1.34/54us

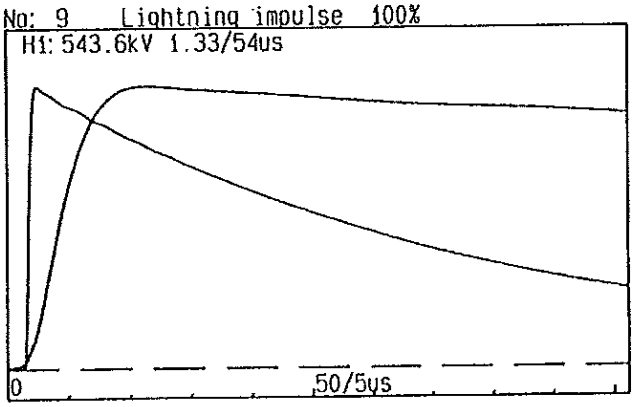


000208

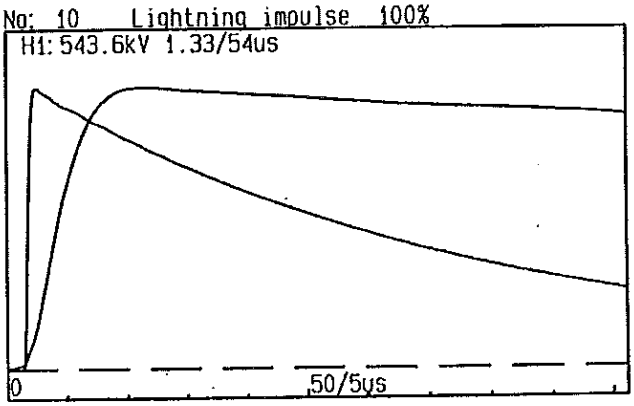
ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

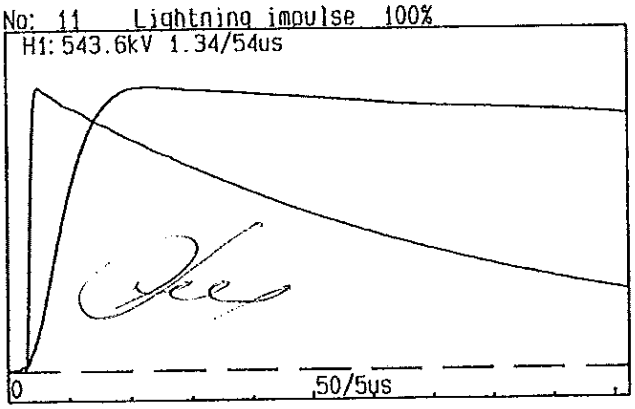
No: 9 Lightning impulse 100%
H1: 543.6kV 1.33/54us



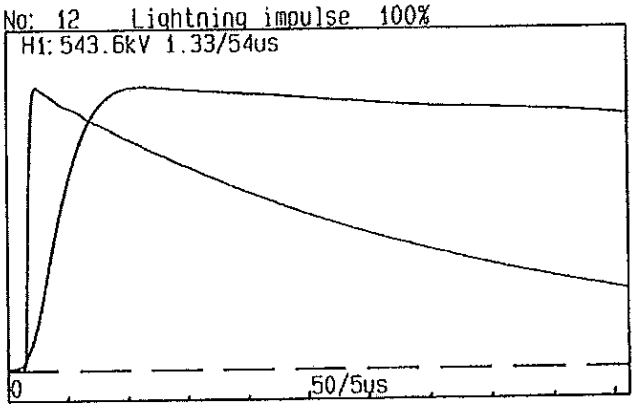
No: 10 Lightning impulse 100%
H1: 543.6kV 1.33/54us



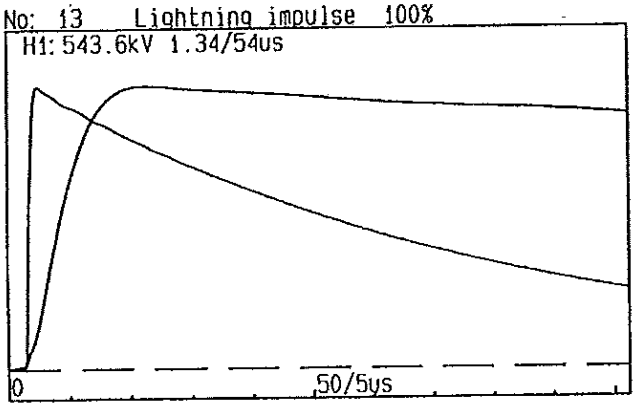
No: 11 Lightning impulse 100%
H1: 543.6kV 1.34/54us



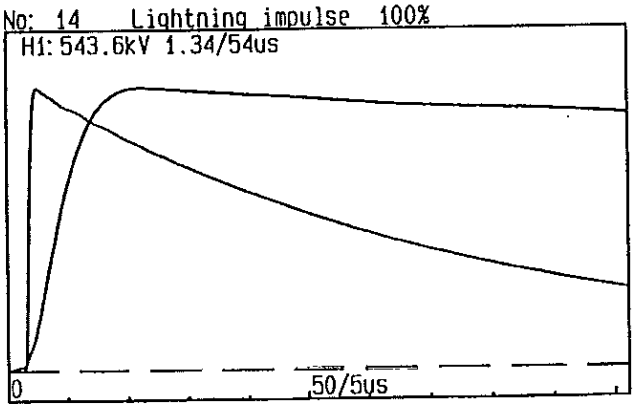
No: 12 Lightning impulse 100%
H1: 543.6kV 1.33/54us



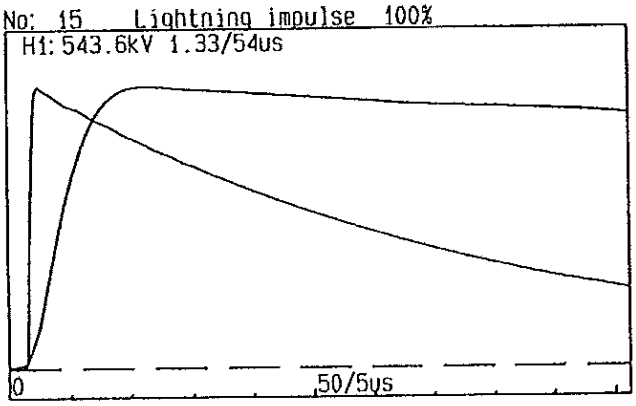
No: 13 Lightning impulse 100%
H1: 543.6kV 1.34/54us



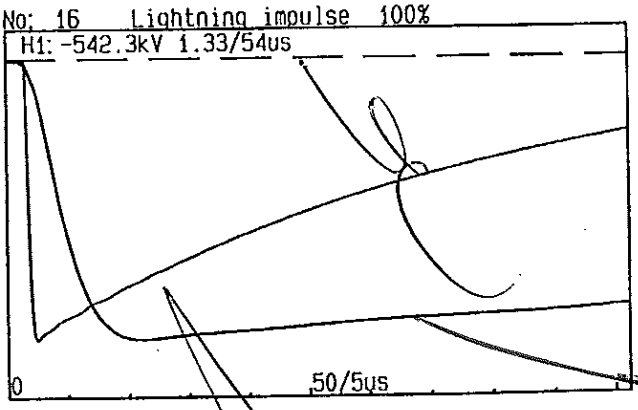
No: 14 Lightning impulse 100%
H1: 543.6kV 1.34/54us



No: 15 Lightning impulse 100%
H1: 543.6kV 1.33/54us



No: 16 Lightning impulse 100%
H1: -542.3kV 1.33/54us

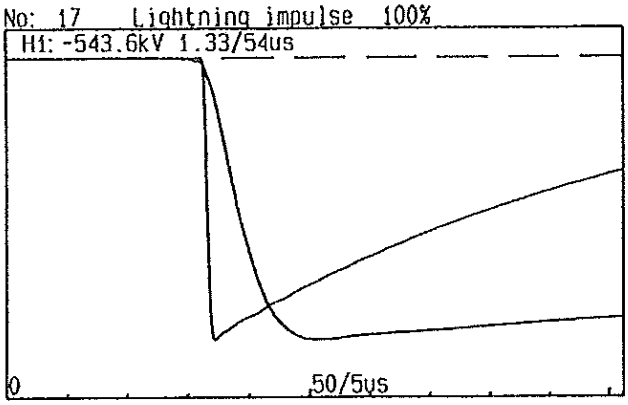


000209

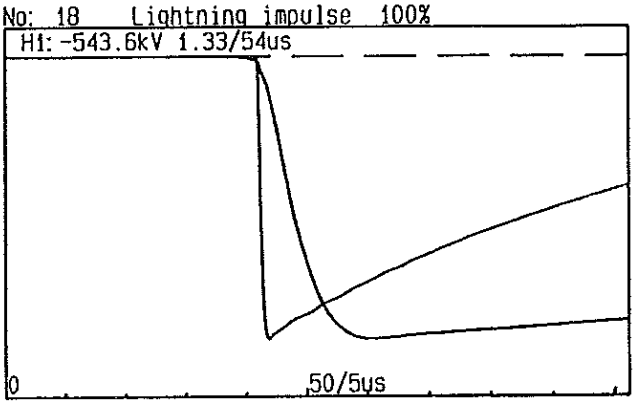
ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

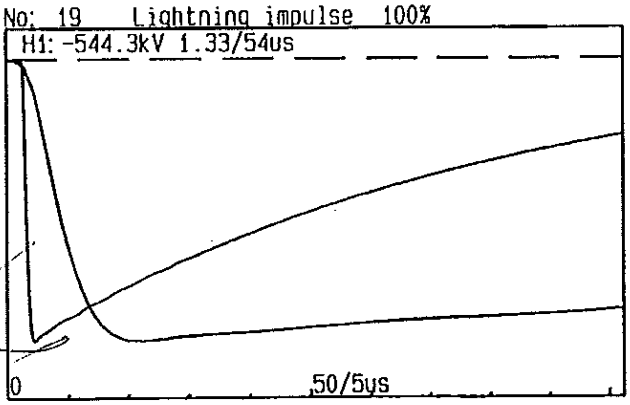
No: 17 Lightning impulse 100%
H1: -543.6kV 1.33/54us



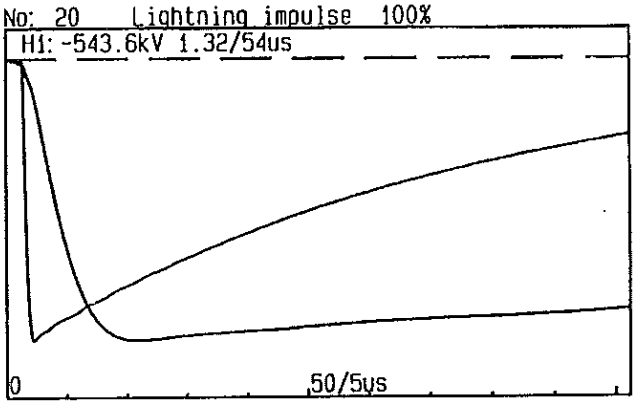
No: 18 Lightning impulse 100%
H1: -543.6kV 1.33/54us



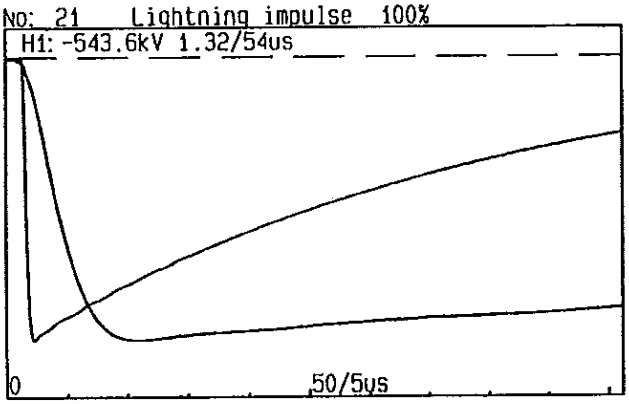
No: 19 Lightning impulse 100%
H1: -544.3kV 1.33/54us



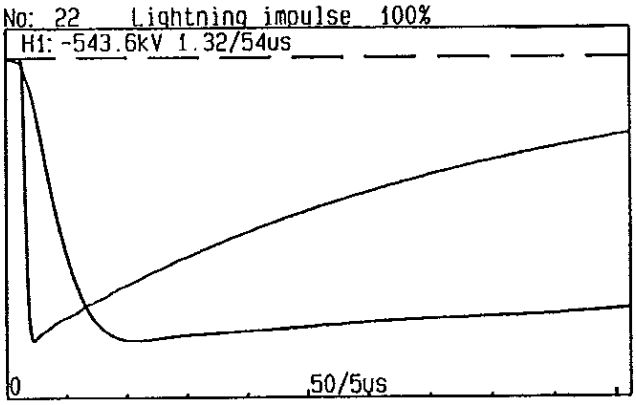
No: 20 Lightning impulse 100%
H1: -543.6kV 1.32/54us



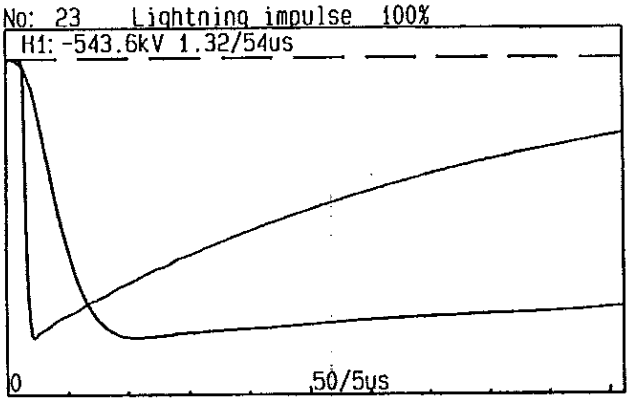
No: 21 Lightning impulse 100%
H1: -543.6kV 1.32/54us



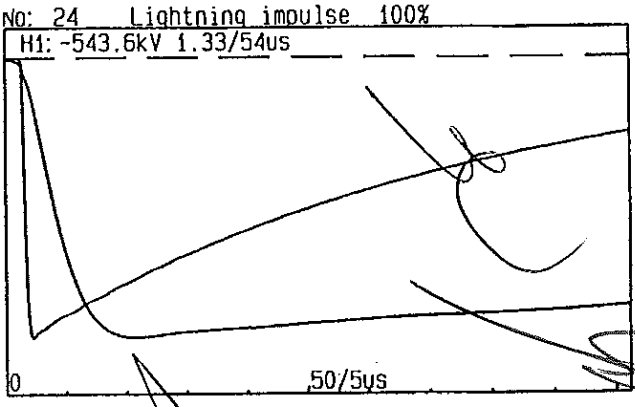
No: 22 Lightning impulse 100%
H1: -543.6kV 1.32/54us



No: 23 Lightning impulse 100%
H1: -543.6kV 1.32/54us



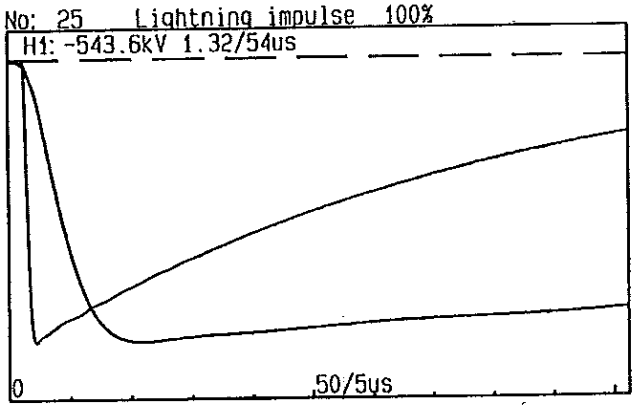
No: 24 Lightning impulse 100%
H1: -543.6kV 1.33/54us

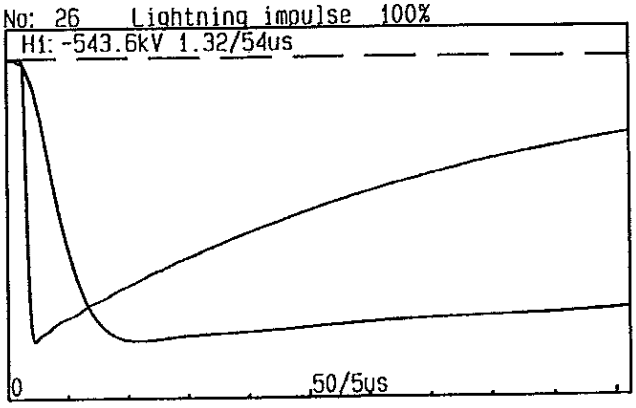


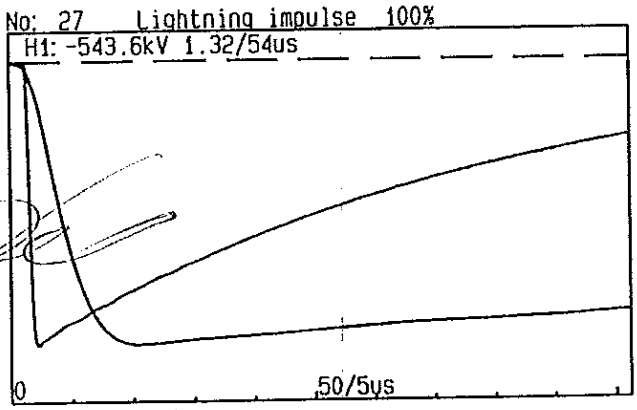
000210

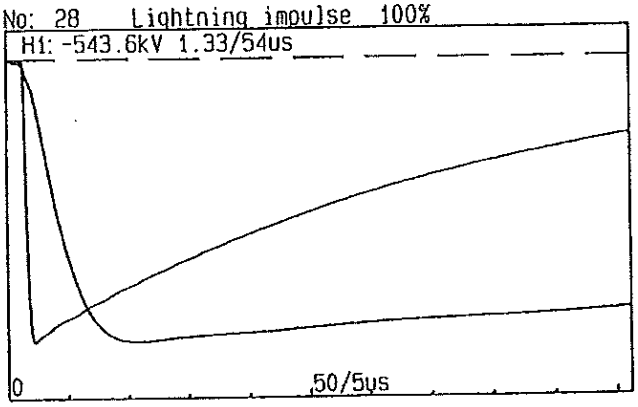
ВЯРНО С ОРИГИНАЛА

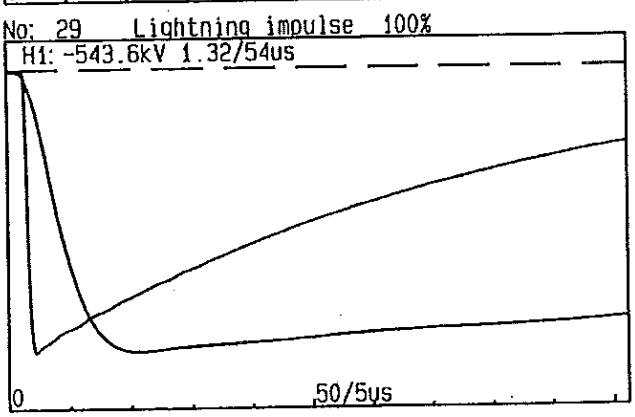
"КРАСИН" СМОЛЯН ООД

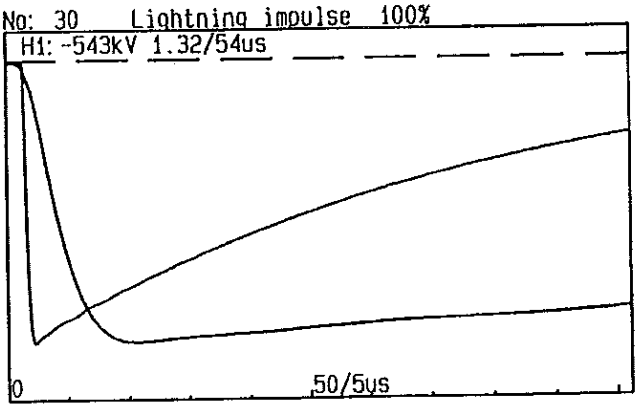












000211

ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

ABB TRANSFORMERS AB

Test Record

Test date 20 Oct 1999

Serial nbr. : Q143

IMPULSE VOLTAGE TEST

MEASUREMENTS

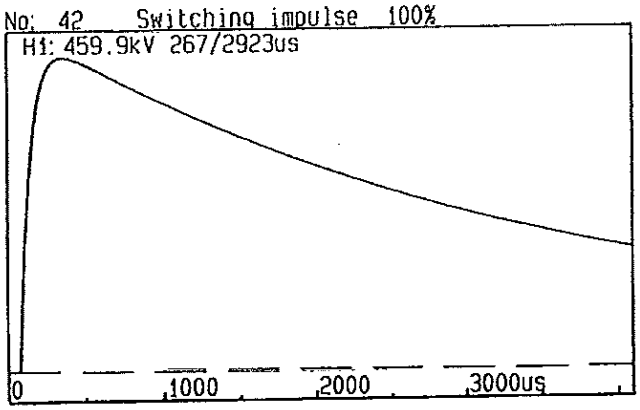
SWITCHING IMPULSE VOLTAGE TEST on terminal H1
Nominal test voltage 458kV.

Amplitude %	kV	Impulse shape µs	Oscillogram number
100	460	267/2923	42
100	457	267/2918	43
100	451	200/204	44
100	459	263/2926	45
100	459	258/274	46
100	459	268/2929	47
100	459	273/2920	48
100	459	256/2923	49
100	459	270/2921	50
100	459	266/2922	51
100	459	269/2926	52
100	459	271/2923	53
100	459	265/2926	54
100	459	266/2925	55
100	459	258/2925	56

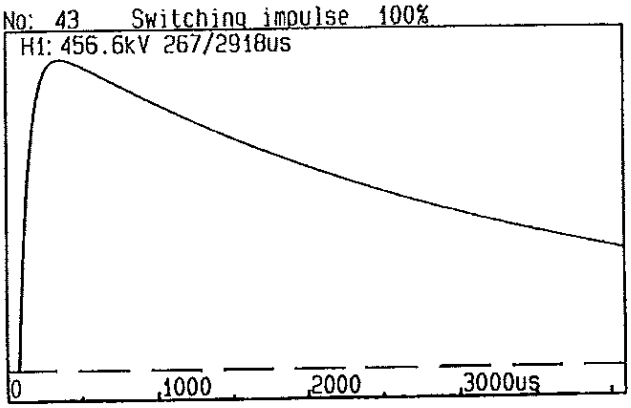
SWITCHING IMPULSE VOLTAGE TEST on terminal H1.
Nominal test voltage -458kV.

Amplitude %	kV	Impulse shape µs	Oscillogram number
100	-458	262/2912	57
100	-458	265/2921	58
100	-458	280/2923	59
100	-458	262/2919	60
100	-458	273/2909	61
100	-458	275/2915	62
100	-459	275/2912	63
100	-458	269/2913	64
100	-459	287/2908	65
100	-459	280/2909	66
100	-458	282/2917	67
100	-458	268/2902	68
100	-458	272/2914	69
100	-458	269/2917	70
100	-458	269/2906	71

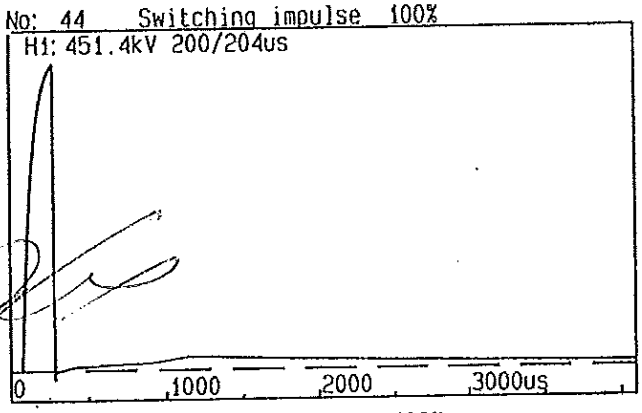
No: 42 Switching impulse 100%
H1: 459.9kV 267/2923us



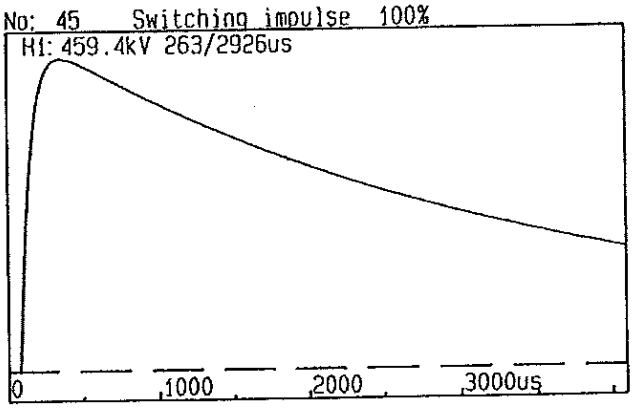
No: 43 Switching impulse 100%
H1: 456.6kV 267/2918us



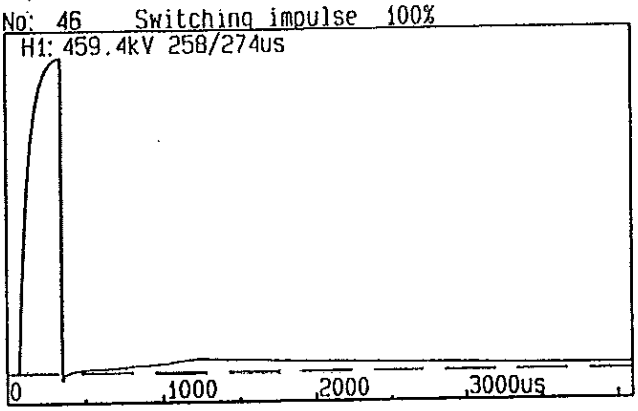
No: 44 Switching impulse 100%
H1: 451.4kV 200/204us



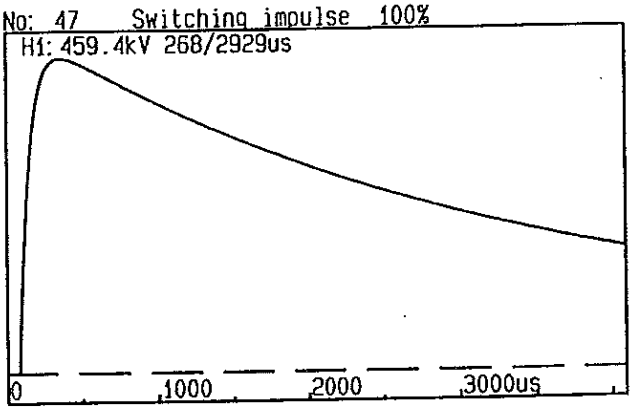
No: 45 Switching impulse 100%
H1: 459.4kV 263/2926us



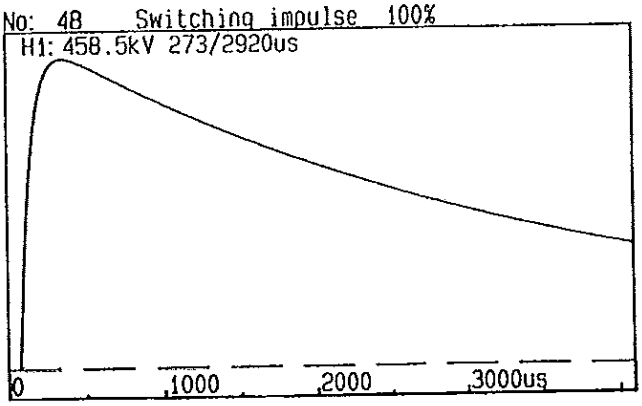
No: 46 Switching impulse 100%
H1: 459.4kV 258/274us



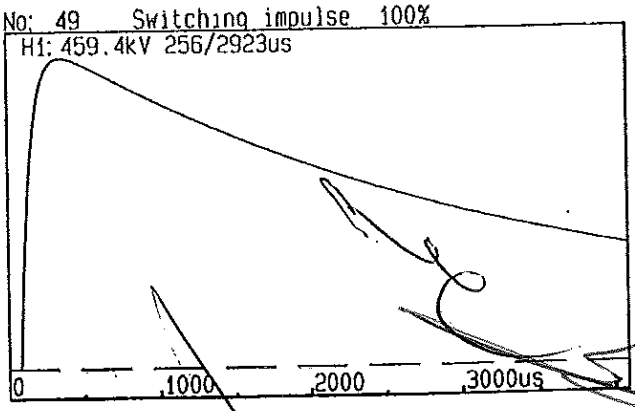
No: 47 Switching impulse 100%
H1: 459.4kV 268/2929us



No: 48 Switching impulse 100%
H1: 458.5kV 273/2920us



No: 49 Switching impulse 100%
H1: 459.4kV 256/2923us

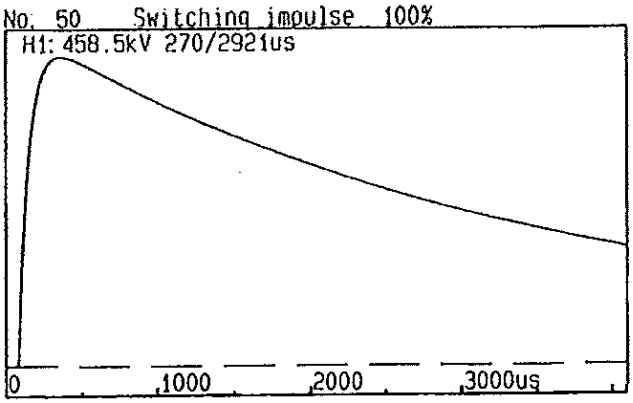


000213

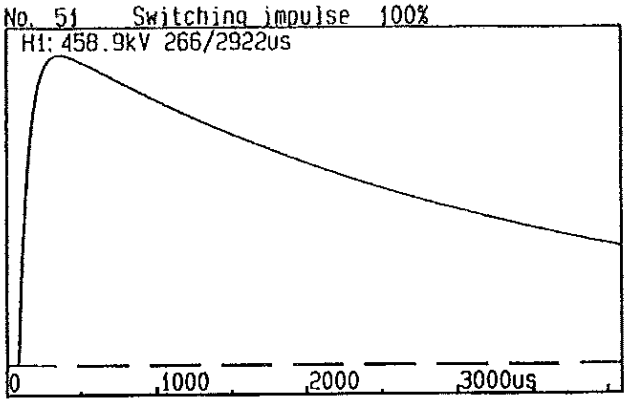
ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

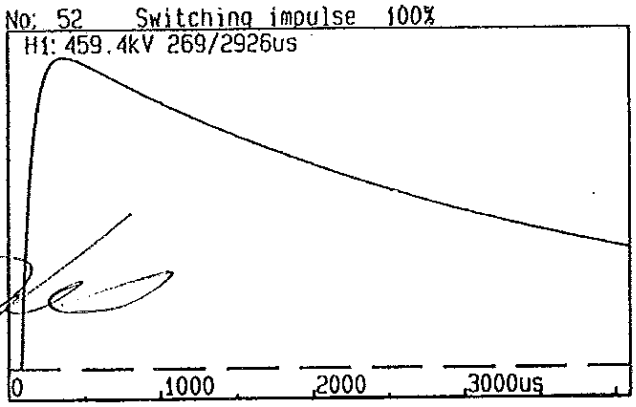
No: 50 Switching impulse 100%
H1: 458.5kV 270/2921us



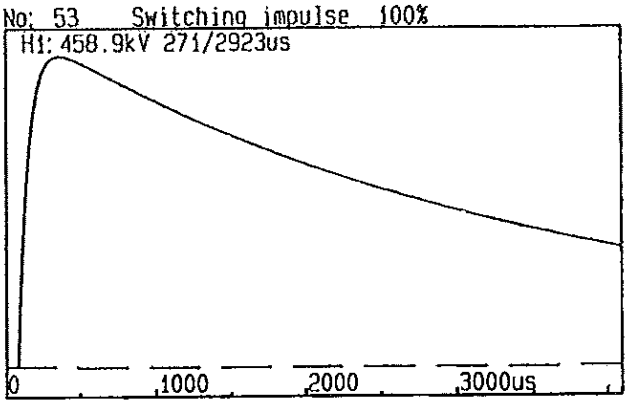
No: 51 Switching impulse 100%
H1: 458.9kV 266/2922us



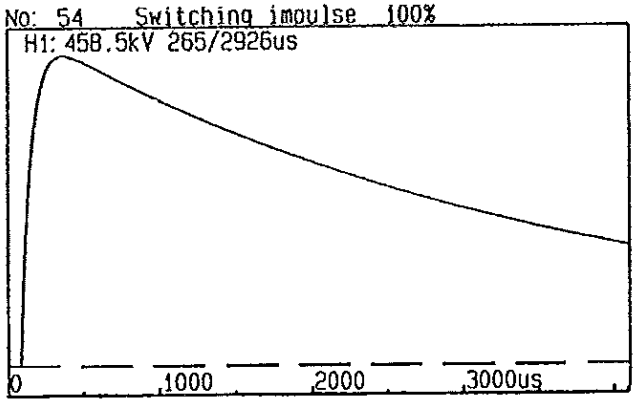
No: 52 Switching impulse 100%
H1: 459.4kV 269/2926us



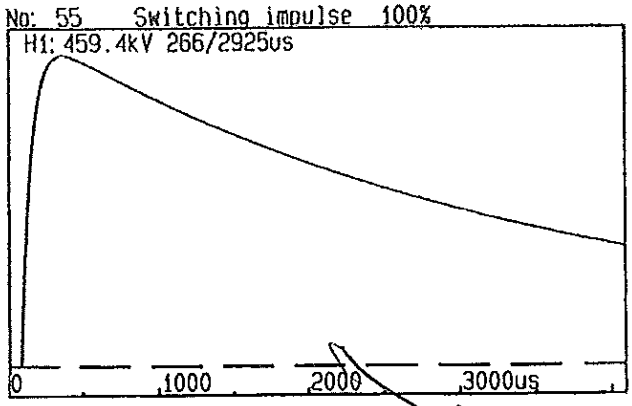
No: 53 Switching impulse 100%
H1: 458.9kV 271/2923us



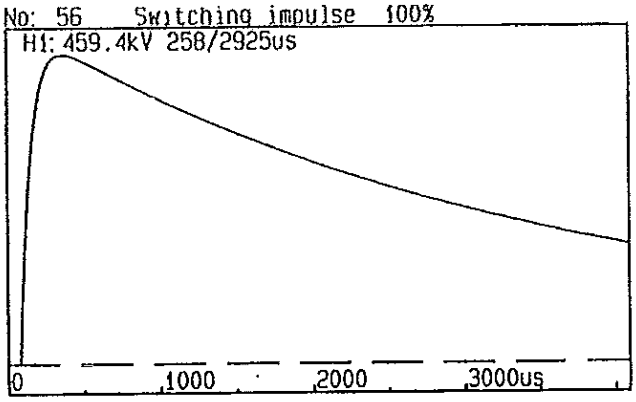
No: 54 Switching impulse 100%
H1: 458.5kV 265/2926us



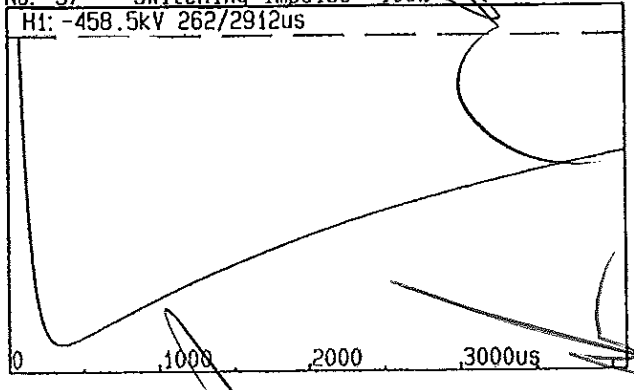
No: 55 Switching impulse 100%
H1: 459.4kV 266/2925us



No: 56 Switching impulse 100%
H1: 459.4kV 258/2925us



No: 57 Switching impulse 100%
H1: -458.5kV 262/2912us

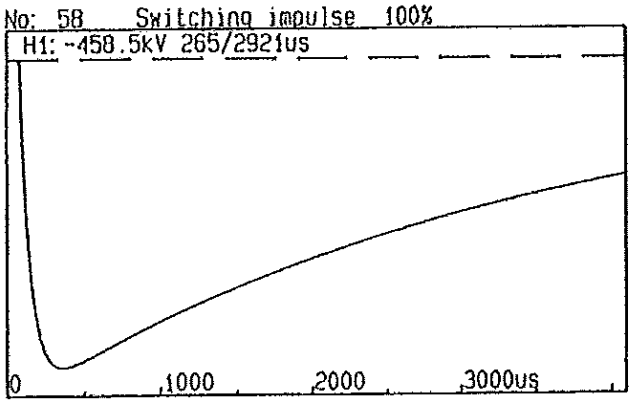


000214

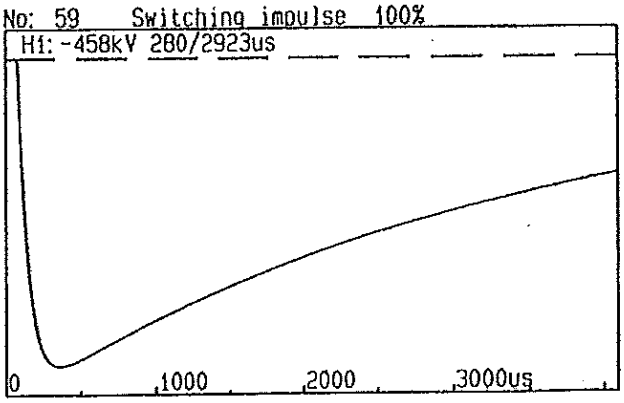
ВЗЯТО С ОРИГИНАЛА

"КРАСНИ" СМОЛЯН ООД

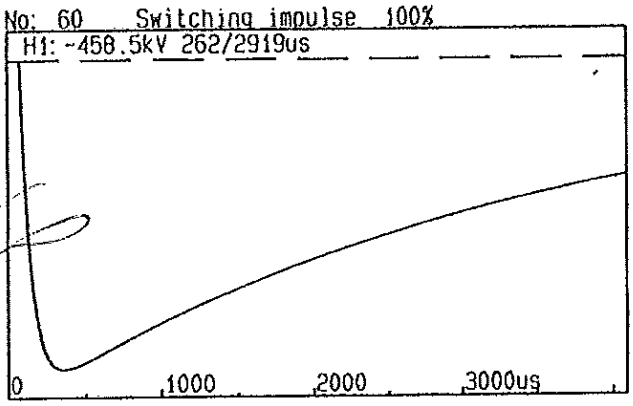
No: 58 Switching impulse 100%
H1: -458.5kV 265/2921us



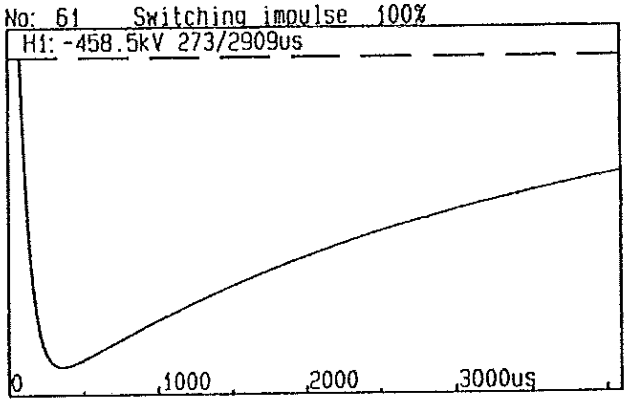
No: 59 Switching impulse 100%
H1: -458kV 280/2923us



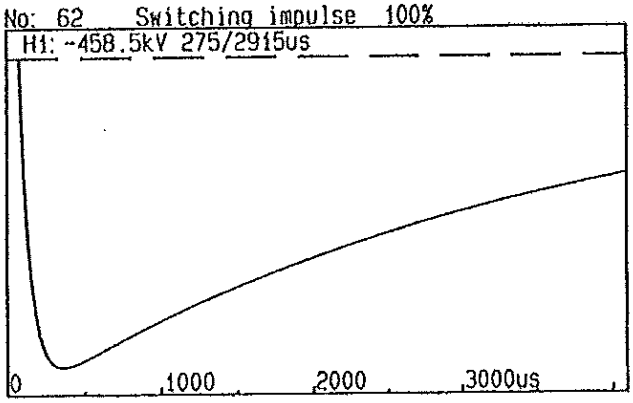
No: 60 Switching impulse 100%
H1: -458.5kV 262/2919us



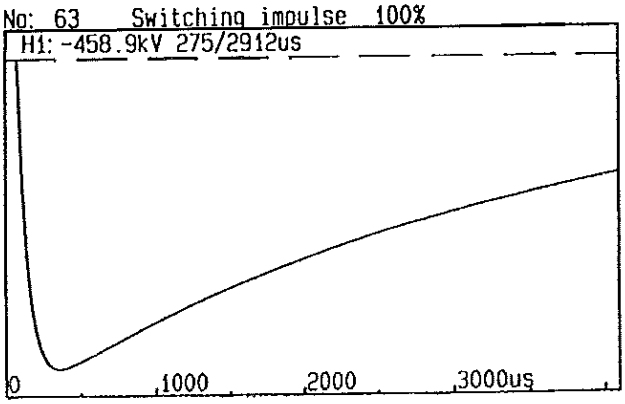
No: 61 Switching impulse 100%
H1: -458.5kV 273/2909us



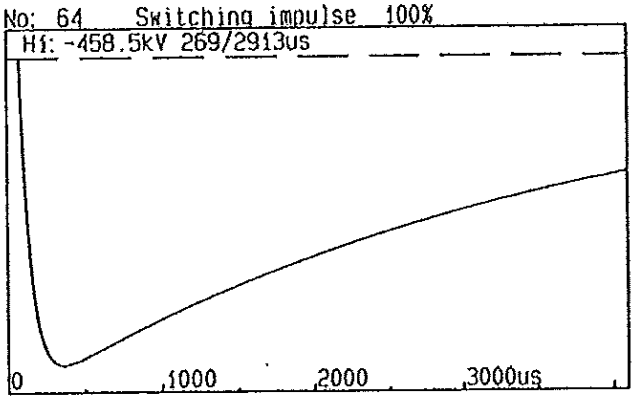
No: 62 Switching impulse 100%
H1: -458.5kV 275/2915us



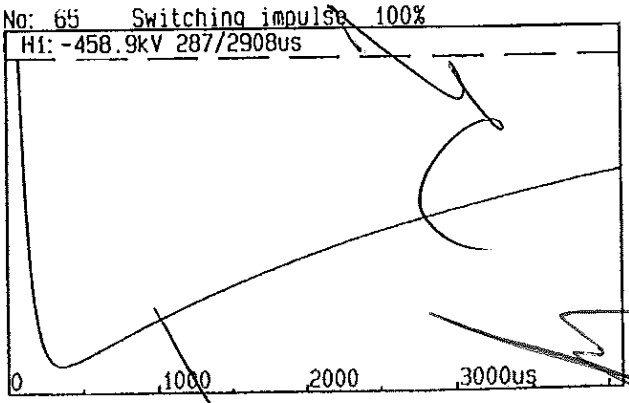
No: 63 Switching impulse 100%
H1: -458.9kV 275/2912us



No: 64 Switching impulse 100%
H1: -458.5kV 269/2913us



No: 65 Switching impulse 100%
H1: -458.9kV 287/2908us

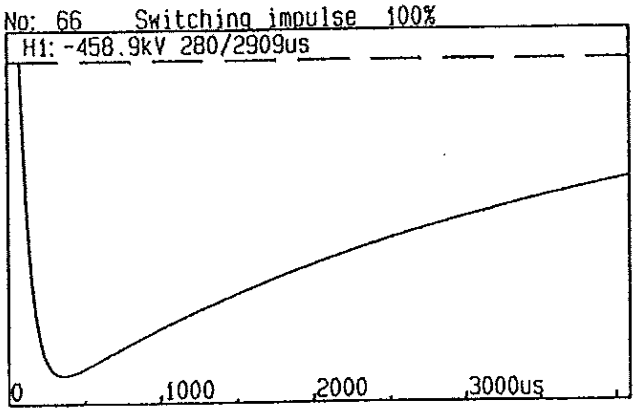


000215

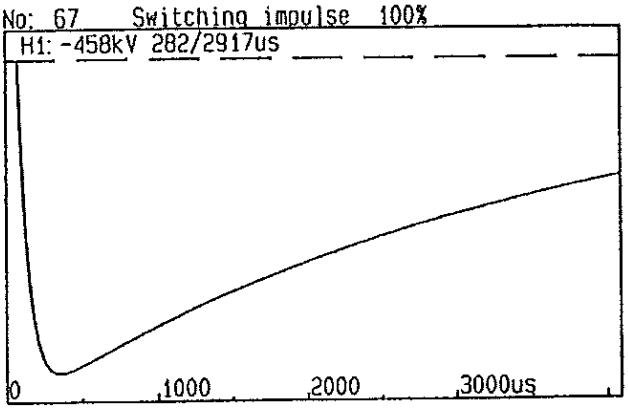
ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

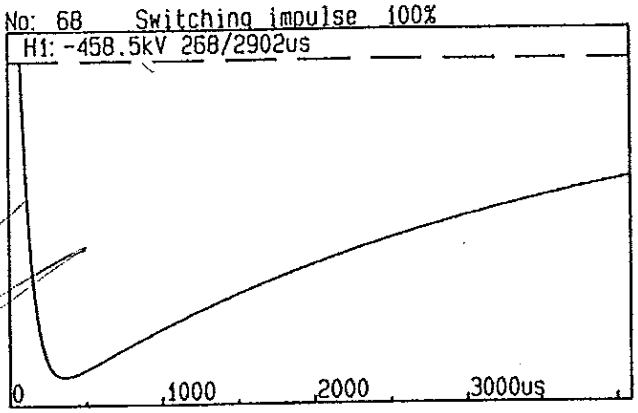
No: 66 Switching impulse 100%
H1: -458.9kV 280/2909us



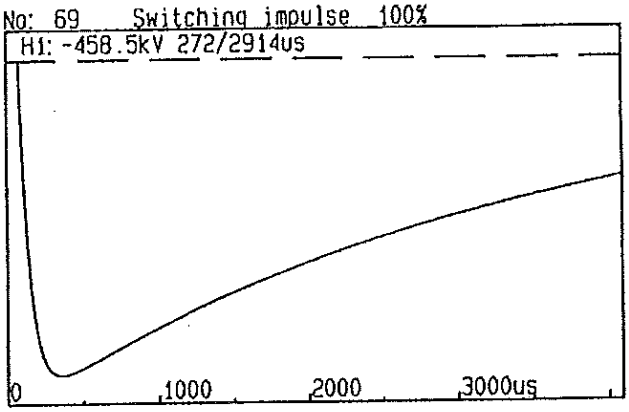
No: 67 Switching impulse 100%
H1: -458kV 282/2917us



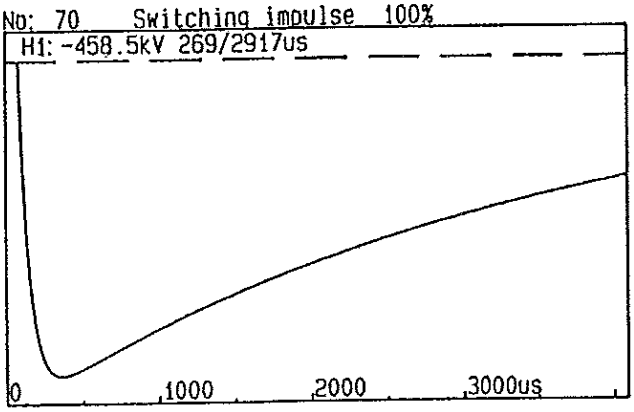
No: 68 Switching impulse 100%
H1: -458.5kV 268/2902us



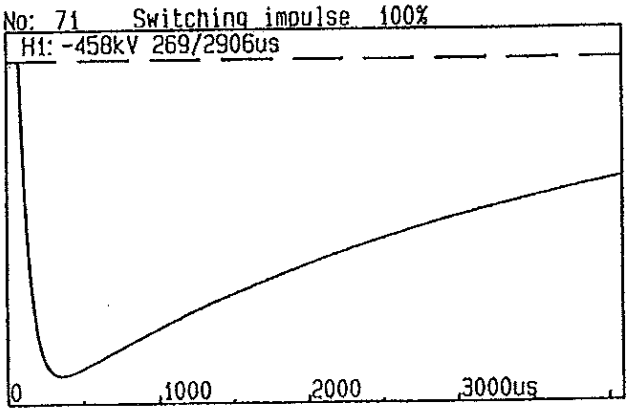
No: 69 Switching impulse 100%
H1: -458.5kV 272/2914us



No: 70 Switching impulse 100%
H1: -458.5kV 269/2917us



No: 71 Switching impulse 100%
H1: -458kV 269/2906us



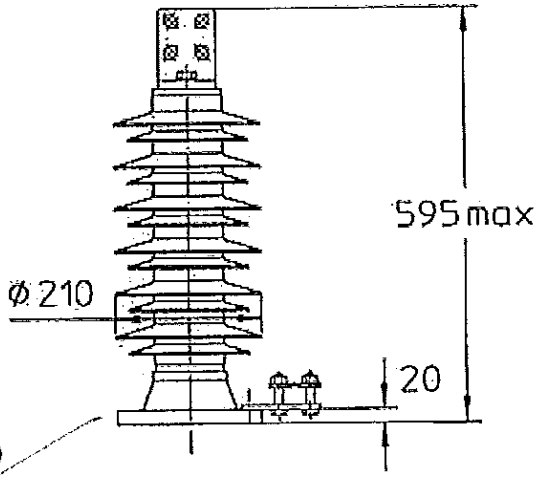
000216

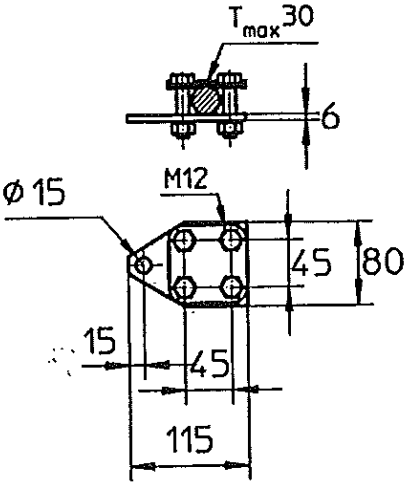
ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

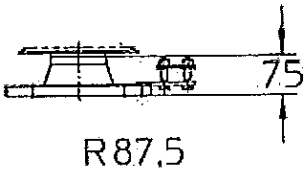
DA TORORIGINAL

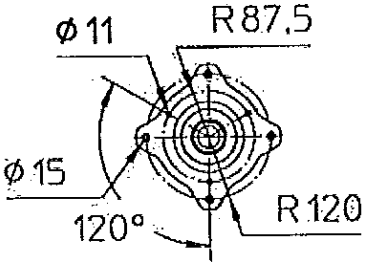
Outer dimension of a PEXLIM Q36/R36 arrester module, used in insulation withstand tests.



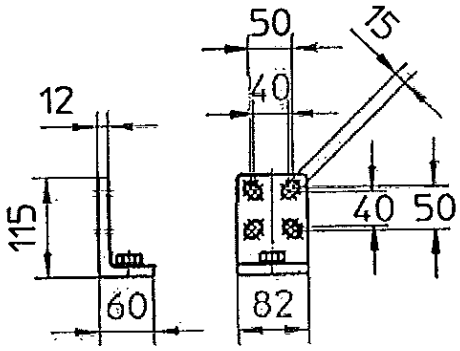


EARTH TERMINAL
LB 910 408-D





DRILLING PLAN



LINE TERMINAL
LB 910 329-A

Prepared: I DAHLBOM 99-08-26	Responsible department: AKK	Title: DIMENSION DRAWING SURGE ARRESTER	Language
Approved: RÖGER SILJEHOLM 99-08-27	Take over department		Sheet: 1
Revision			Cont. –
ABB Switchgear		Document no. LAK 5476	

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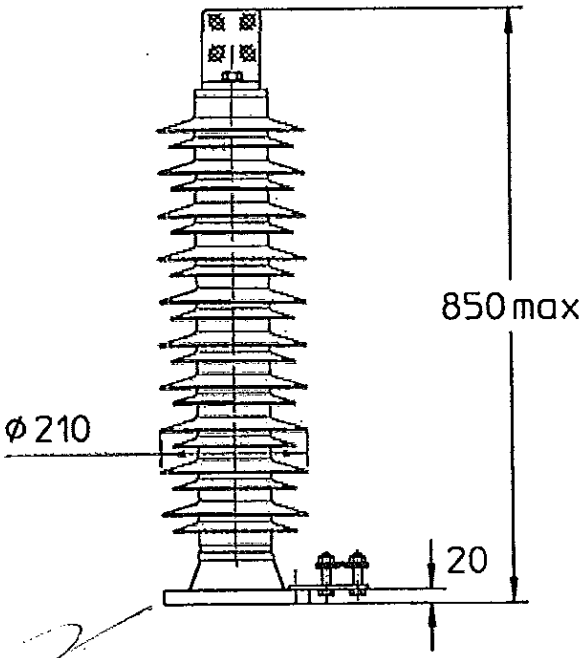
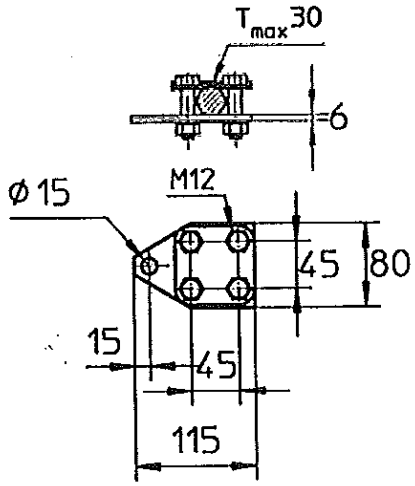
6917 026-PA(A4)Rev1

000217

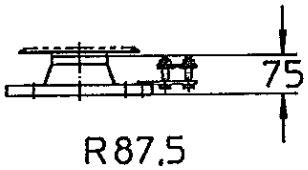
DATORORIGINAL

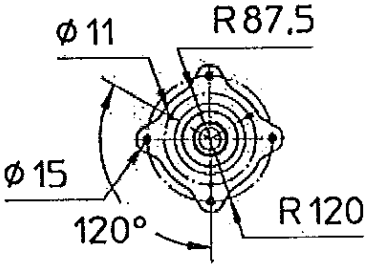
Outer dimension of a PEXLIM Q72/R72 arrester module, used in insulation withstand tests.



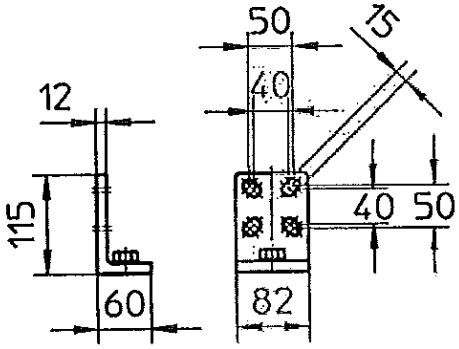


EARTH TERMINAL
LB 910 408-D





DRILLING PLAN



LINE TERMINAL
LB 910 329-A

Prepared: I DAHLBOM 99-08-26	Responsible department: AKK	Title: DIMENSION DRAWING SURGE ARRESTER	Language
Approved: ROGER SILJEHOLM 99-08-27	Take over department:		Sheet: 1 (Total)
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ABB Switchgear			

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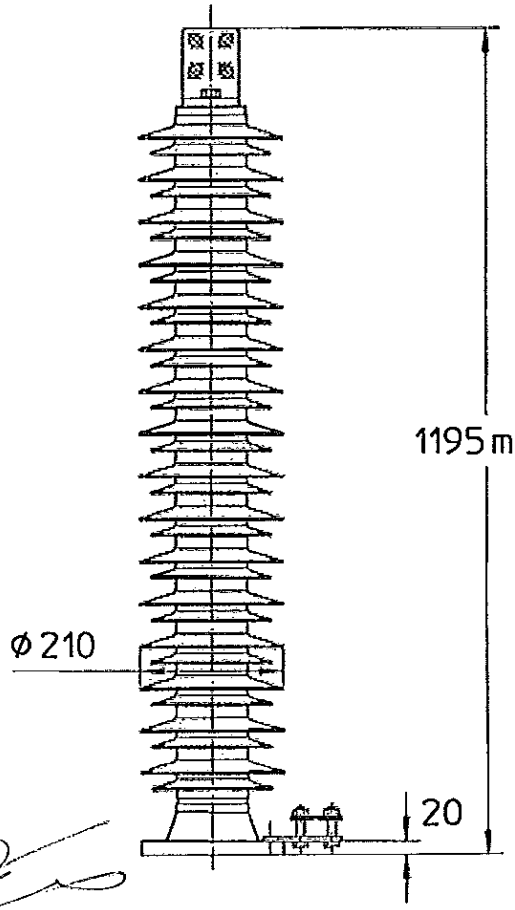
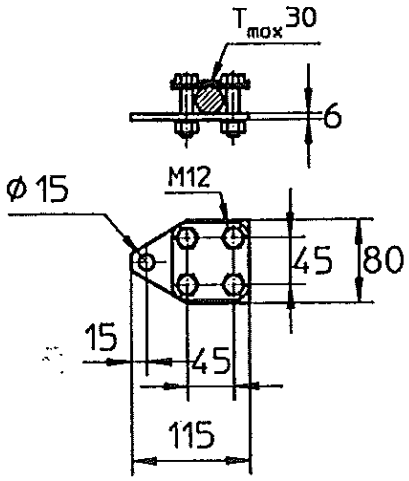
6917 028-PA(A4)Rev1

000218

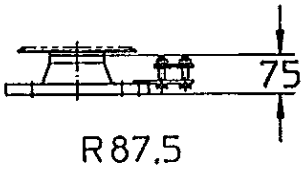
DATORORIGINAL

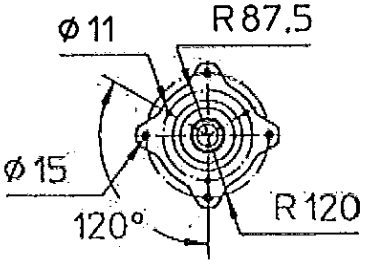
Outer dimension of a PEXLIM Q120/R120 arrester module, used in insulation withstand tests.





EARTH TERMINAL
LB 910 408-D





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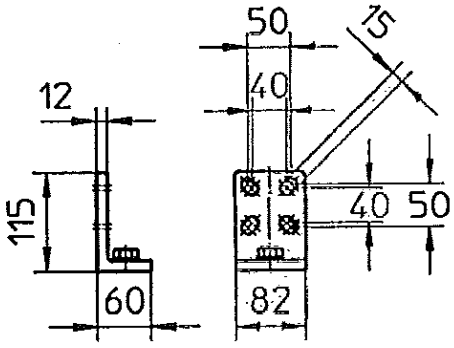

LINE TERMINAL
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Prepared: I DAHLBOM 99-08-26	Responsible department: AKK	Title: DIMENSION DRAWING SURGE ARRESTER		
Approved: ROGER SILJEHOLM 99-08-27	Take over department:		Language: -	
Revision:			Sheet: 1	
ABB Switchgear		Document no.: LAK 5478		

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000219

Type tests on PEXLIM P-X surge arresters.

Test objects	Prorated arrester sections acc. to IEC, rated voltage 6.29 to 10.85 kV
Standard	IEC 60099-4, Edition 1.2, 2001-12
Test performed	Residual voltage test Long duration current impulse withstand test, class 4 Operating duty test, nominal current 20 kA
Tests completed	2004-04-23
Tests performed at	ABB Power Technologies AB -Surge Arrester Laboratory
Tests reported by	Jan-Erik Almén
Report approved by	: Lennart Stenström
Report consists of	: 69 pages
Witnessing	:The tests were witnessed by SATS Inspector Mr Minoo Mobedjina.

SATS Certification
Minoo Mobedjina
Inspector

About SATS :SATS "Scand... Electric Power Equip-ment" is a me...) and a member of EOTC, Europ... SECOM, Agreement Group No. 00...

We hereby certify that the objects s... passed the test herein

ABB Power Technologies AB

CONTENTS

1 GENERAL

Type tests on prorated sections of ZnO arresters type PEXLIM P-X have been performed. The sections were tested in accordance with the standard for metal-oxide surge arresters, IEC 60099-4, Edition 1.2, 2001-12.

The following tests have been performed (Clause No:s refer to the above mentioned Standard):

- Power Frequency Reference Voltage Test (this test is included in the Long Duration Current Impulse Withstand Test and the Operating Duty Test and used to determine the rated voltage of the test sections).

- Residual Voltage Tests. Clause 9.7.3.

- Long Duration Current Impulse Withstand Test. Clause 9.7.4.

- Operating Duty Test. Clause 9.7.5.

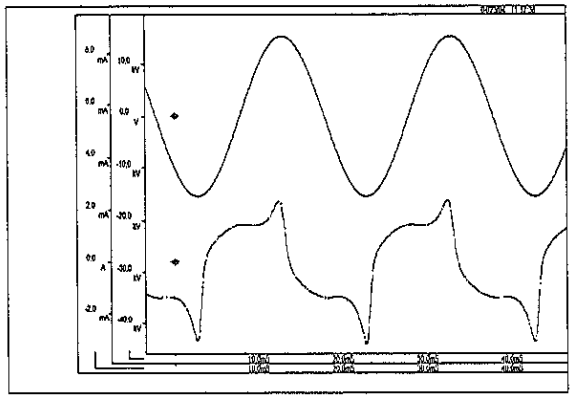
Tables and oscillograms are presented from the different tests. Representative oscillograms from tests of one section are shown from the Residual Voltage Tests. For the Long Duration Current Impulse Withstand Test and the Operating Duty Test oscillograms from tests of all sections are presented.

2 POWER FREQUENCY REFERENCE VOLTAGE TEST

The reference current for PEXLIM P-X surge arresters is defined at a peak value of 3 mA of the resistive component of power frequency current. The reference voltage (U_{ref}) is the peak value of power frequency voltage divided by $\sqrt{2}$ measured at the reference current. The resistive current may be slightly asymmetrical in this current region. The reference voltage, therefore, always is defined as the minimum voltage measured at the reference current independent of polarity.

The reference voltage measured at 23 ± 5 °C is checked on all complete assembled arrester units and must be equal to or higher than the nominal rated voltage, (U_r).
Furthermore, the reference voltage test is used to determine rated voltage of prorated test sections. The rated voltage of a prorated section is determined as $U_r = U_{ref}$ in order to ensure that the prorated section is exposed to higher than or equal stresses than any complete arrester.

An oscillogram from a Power Frequency Reference Voltage Test is shown below. Section rated 10.85 kVrms. (Maximum resistive current occurs by definition at the peak of the voltage wave and maximum capacitive component at voltage zero).



Voltage: 10.0 kV/div
(10.85 kVrms)

Current: 2.0 mA/div
(3.0 mA resistive peak)

Time scale: 10.0 ms/div

In Table 1 electrical data for the 9 used test sections are shown.The sections 1 to 3 consisted of one non-encapsulated varistor element (one 6 kV ZnO) block. Sections 4 to 9 consisted of two varistor elements in series (one 4.5 kV and one 6 kV block) on to which an insulator had been moulded like for the real surge arrester. Sections 4 to 9 therefore represent cross sections of a complete arrester.

Drawings for the blocks are 5681 018-501 (4.5 kV block) and 5681 018-601 (6 kV block)

Section No	Reference voltage at 3 mA peak kV rms	Rated voltage kV rms	ZnO block volume cm^3	ZnO block diameter mm	Switching Impulse Residual Voltage at 500 A kV peak
1	6.30	6.30	181.8	73.8	11.27
2	6.29	6.29	"	"	11.24
3	6.30	6.30	"	"	11.25
4	10.82	10.82	318.2	73.8	19.31
5	10.82	10.82	"	"	19.33
6	10.85	10.85	"	"	19.29
7	10.83	10.83	318.2	73.8	19.29
8	10.83	10.83	"	"	19.26
9	10.83	10.83	"	"	19.39

Tablo 1. Electrical data for test sections

3 RESIDUAL VOLTAGE TESTS

All varistor elements intended for use in PEXLIM P-X surge arresters are in routine tests classified according to their residual voltage at an impulse current of 10 kA with wave shape 8/20 µs.
For the complete arresters, the varistor elements are chosen in such a way that the protective level at 10 kA 8/20 µs current wave is equal to or below 2.275 times the rated voltage of the arrester.
Specified protection values for other current amplitudes and wave shapes valid for PEXLIM P-X arresters are shown in Diagram 1 on page 8 given as percentage of the residual voltage at 10 kA 8/20 µs.

The purpose of the residual voltage type test is to verify the specified protection values by establishing the ratio between the residual voltages at specified impulse currents and the voltage checked in routine tests i.e. the discharge voltage at 10 kA 8/20 µs. In order to compare with specified values in Diagram 1 all measured discharge voltages were normalized to the measured residual voltages at 10 kA 8/20 µs current impulse for each test section. The highest ratios independent of test section were thereafter plotted in Diagram 1.

3.1 Steep Current Impulse Residual Voltage Test

The test was performed on the 3 sections 1, 2 and 3 as per Table 1. Four current impulses were applied to each section with current amplitudes of approximately 1, 5, 10 and 20 kA. The virtual current front time was 1.0 µs. Before the residual voltage test , as per clause 7.3.1 of the IEC standard, a steep current impulse was applied to a metal block of the same dimensions as the ZnO varistor elements. The peak voltage measured was less than 2% of the residual voltage measured on the ZnO varistor elements, thus no correction for inductive effect was necessary.

Test results are shown in Table 2 and on osc. pages 1 and 2.

Section No	1 kA readings kA	kV	%*)	5 kA readings kA	kV	%*)	10 kA readings kA	kV	%*)
1	1.00	11.99	86.88	4.94	13.40	97.10	10.06	14.34	103.91
2	1.02	11.88	86.46	5.00	13.36	97.23	9.97	14.20	103.35
3	1.00	11.89	86.41	4.98	13.38	97.24	9.98	14.21	103.27

Section No	20 kA readings kA	kV	%*)
1	20.43	15.58	112.90
2	20.07	15.44	112.37
3	19.94	15.46	112.35

Table 2

*) Percentage of the residual voltage at 10 kA 8/20 µs

3.2 Lightning Impulse Residual Voltage Test

The test was carried out on the same sections as for the Steep Current Impulse Residual Voltage Test. Six current impulses were applied to each test section with current amplitudes of approximately 0,5 1, 5, 10, 20, 40, 50 and 65 kA and with wave shape 8/20 µs. Test results are shown in Table 3 and on osc pages 3, 4, 5 and 6.

Section No	0.5 kA readings kA	kV	%*)	1 kA readings kA	kV	%*)	5 kA readings kA	kV	%*)
1	0.50	11.38	82.46	1.02	11.76	85.22	4.92	13.01	94.28
2	0.50	11.33	82.46	1.05	11.73	85.37	4.99	12.96	94.32
3	0.51	11.34	82.41	1.02	11.73	85.25	4.98	12.97	94.26

Section No	10 kA readings kA	kV	%*)	20 kA readings kA	kV	%*)	40 kA readings kA	kV	%*)
1	9.86	13.80	100	19.86	14.85	107.61	40.21	16.30	118.12
2	9.93	13.74	100	19.97	14.79	107.64	40.14	16.21	117.98
3	9.96	13.76	100	20.01	14.81	107.63	40.05	16.22	117.88

Section No	50 kA readings kA	kV	%*)	65 kA readings kA	kV	%*)
1	50.51	16.80	121.74	64.90	17.57	127.32
2	50.35	16.70	121.54	65.42	17.50	127.36
3	50.03	16.71	121.44	64.80	17.51	127.25

Table 3

*) Percentage of the residual voltage at 10 kA 8/20 µs

3.3 Switching Impulse Residual Voltage Test

The test was carried out on the same section as used for tests according to clauses 3.1 and 3.2. Six current impulses were applied to each section with current amplitudes of approximately 0.125, 0.25, 0.5, 1, 2 and 3 kA and with a virtual front time of 32.0 µs. Test results are shown in Table 4 and on osc pages 7, 8 and 9.

Section No	0.125 kA readings kA	kV	%*)	0.25 kA readings kA	kV	%*)	0.5 kA readings kA	kV	%*)
1	0.121	10.71	77.61	0.249	10.97	79.49	0.496	11.27	81.67
2	0.130	10.68	77.73	0.261	10.94	79.62	0.505	11.24	81.80
3	0.121	10.71	77.83	0.255	10.96	79.65	0.501	11.25	81.76

Section No	1 kA readings kA	kV	%*)	2 kA readings kA	kV	%*)	3 kA readings kA	kV	%*)
1	1.016	11.65	84.42	1.968	12.07	87.46	3.019	12.39	89.78
2	1.023	11.62	84.57	2.003	12.04	87.63	3.037	12.36	89.96
3	1.012	11.62	84.45	2.000	12.05	87.57	3.038	12.37	89.90

Tablo 4

*) Percentage of the residual voltage at 10 kA 8/20 µs

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3.4 Summary of Residual Voltage Tests

The highest ratios in percentage of the measured 10 kA 8/20 µs residual voltage for each current amplitude and wave shape and for any of the three test sections were plotted in Diagram 1. As seen from the diagram the specified values for PEXLIM P-X surge arresters are verified since the measured ratios do not exceed the presented curves.

RESIDUAL VOLTAGES FOR ARRESTERS TYPE PEXLIM P-X

Specified protection levels and test results. Test result shown as markers

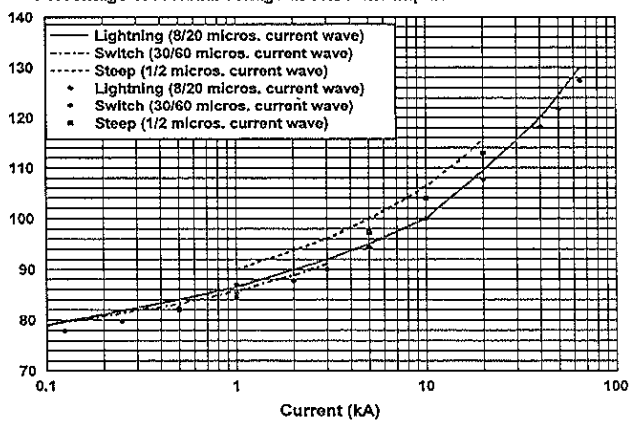


Diagram 1

4 LONG DURATION CURRENT IMPULSE WITHSTAND TEST

The three prorated sections 4, 5 and 6 used in the Long Duration Current Impulse Withstand Test each consisted of two varistor elements in series on to which an insulator had been moulded. The dimensions of the varistor elements were D=73.8 mm, H=31.9 mm (4.5 kV block) and D=73.8 mm, H=42.5 mm (6 kV block). The varistor elements had not been subjected previously to any tests except that for evaluation purposes i.e. the Lightning Impulse Residual Voltage Test at nominal discharge current, Switching Impulse Residual Voltage Test and the Power Frequency Reference Voltage Test. The rated voltages of the test sections were set to 10.85 kVrms equal to the maximum reference voltage as per clause 2 for any of the sections 4 to 6. The test was run in open air at a temperature of 23 ± 5 °C. Each Long Duration Current Impulse Withstand Test was in accordance with line discharge class 4 and consisted of 18 discharge operations divided into 6 groups of 3 operations. Intervals between operations were 50-60 s and between groups sufficiently long to permit the sections to cool to near ambient temperature. Oscillographic records of the voltage across and the current through the test samples were made on the 1st and 18th operation of each test sequence.

Since the varistor elements could not be dismantled for inspection an additional Long Duration Current Impulse was applied as per the requirements in clause 9.7.4.

For test results see Table 5 and 6 and osc.pages 10 to 15.

Section No	Application No	Current peak A	Voltage peak kV	Energy kJ
4	1	953.3	19.81	57.47
4	18	921.8	20.32	56.93
5	1	934.4	19.79	57.64
5	18	915.5	20.32	56.73
6	1	956.4	19.81	57.68
6	18	918.6	20.33	56.79

Table 5. Long Duration Current Impulse Withstand Test on PEXLIM P-X sections rated 10.85 kVrms. Actual charging voltage 28.44 kV.

Note: According to clause 9.7.4 in the IEC standard the test energy must be higher than or equal to a value determined by a formula based on specified test parameters and the switching impulse residual voltage of the test sections. With the lowest relative residual voltage for any of the test sections as per Table 1 the formula results in a minimum required energy of 5.15 kJ/kV rated voltage which for a rated voltage of 10.85 kVrms corresponds to 55.92 kJ. Actual test energies exceed this value.

Section No	Application No	Current peak A	Voltage peak kV	Energy kJ
4	19	930.4	19.93	56.57
5	19	932.8	19.93	56.58
6	19	932.0	19.93	56.54

Table 6. Additional Long Duration Current Impulse Withstand Test on PEXLIM P-X sections rated 10.85 kVrms. Actual charging voltage 28.23 kV.

Parameters for the line discharge test according to class 4 on 10.85 rated test section are.

Surge impedance : 0.8 x 10.85 = 8.68 Ω

Virtual duration : 2800 µs

Charging voltage : 2.6 x 10.85 = 28.21 kV

A calibration oscillogram from the actual test circuit used with short-circuit test section is shown in Figure 1.

Current scale : 200.0 A/Div

Time scale : 1000.0 µs/div

Charging voltage : 3.0 kV

Virtual duration of current peak : 2800 µs

Transmission line length : 420.0 km/261.03 miles
(Corresponding to virtual duration)

Transmission line surge impedance: 8.63 Ω

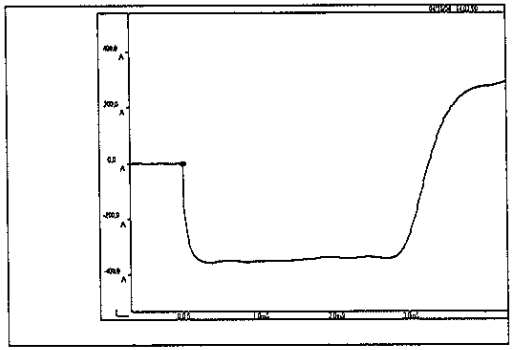


Figure 1. Calibration of test circuit with short-circuited test section

Before and after the complete Long Duration Current Impulse Withstand Test the residual voltage at 20 kA 8/20 µs and the reference voltage were checked to indicate any possible changes in the arrester performance. Test result is shown in Table 7.

Section No	Difference after/before in residual voltage at 20 kA (%)	Difference after/before in reference voltage at 3.0 mA (%)
4	+ 0.1	+ 0.6
5	+ 0.1	+ 1.2
6	+ 0.1	+ 0.7

Tablo 7

Examination of the test samples after the test revealed no evidence of puncture, flashover, cracking or other significant damage of the varistor elements.

5 OPERATING DUTY TEST

The three prorated sections 7, 8 and 9 used in the Operating Duty Test each consisted of two varistor elements in series on to which an insulator had been moulded.The dimensions of the varistors elements were D=73.8 mm, H=31.9 mm (4.5 kV block) and D=73.8 mm, H=42.5 mm (6kV block). The test was carried out on new varistor elements which had not been subjected to any previous tests except that for evaluation purposes i.e. Lightning Impulse Residual Voltage Test at nominal discharge current, Switching Impulse Residual Volltage Test and the Power Frequency Reference Voltage Test. The series of stresses which the sections were exposed to are illustrated in Figure 2 on page 19. Some of these tests as shown in figure 2 were performed on the test sections thermally insulated at top and bottom ends as shown in Enclosure 1:11 in order to represent true thermal models of he complete arrester. The thermally prorated sections for arresters type PEXLIM P-X are verified in test report HVP/AK 04-24. The rated voltages of the test sections were set to 10.83 kVrms equal to the maximum reference voltage for any of the sections 7 to 9 as per clause 2.

5.1 Conditioning test

The three test sections were first exposed to 20 current impulses with peak values of 20 kA and wave shape 8/20 µs in four groups of 5 impulses. The impulses were superimposed on a power frequency voltage not less than the reference voltage of the samples*). The interval between the impulses was 50-60 s and the interval between groups 25-30 minutes. Between groups of impulses the test samples were not energized. The polarity of the current impulse was the same as that of the half cycle of power frequency voltage during which it occurred and it was applied 60 ± 15 electrical degrees before the peak of the power frequency voltage. The test was carried out on the sections without thermal insulation at top and bottom ends in open air at a temperature of 23 ± 5°C. This test was followed by two high current impulses with an impulse shape of 4/10 µs and a peak value of 100 kA. The sections were allowed to cool to ambient temperature between the impulses. The sections were not preheated and the test was carried out at an ambient temperature of 23 ± 5°C. The test result from the conditioning test is shown in Tables 8 and 9 and on osc. pages 16 to 21.

*) The required voltage as per IEC 60099-4 is the Continuous Operating Voltage, U_c, +20%. With a maximum U_c for PEXLIM P-X arresters of 80% of rated voltage the applied voltage represents U_c +25%.

Section No	Application No	Impulse Current kA peak	Power frequency voltage kV rms
7	1	20.22	10.83
7	20	20.74	10.84
8	1	20.21	10.83
8	20	20.74	10.86
9	1	20.23	10.83
9	20	20.48	10.86

Table 8. Conditioning test with 20 kA, 8/20 µs impulse.
Sections rated 10.83 kVrms. Impulse current shape 8/20 µs

Section No	Application No	Current peak kA	Voltage peak kV
7	1	101.11	33.47
7	2	101.43	33.51
8	1	101.04	33.47
8	2	100.85	33.39
9	1	100.66	33.46
9	2	100.27	33.39

Table 9. High current conditioning test
Sections rated 10.83 kVrms. Current wave shape 4/10 µs.

5.2 Switching Surge Operating Duty Test

At the beginning of the Switching Surge Operating Duty Test the test sections were equipped with thermally insulating covers at the top and bottom ends as shown in Enclosure 1:11 in order to represent true thermal models of the complete arrester and preheated to 60 ± 3 °C. Thereafter the sections were rapidly brought to the test chamber which had an ambient temperature of 23 ± 5 °C and subjected to two long duration current impulses according to class 4 with a time interval between the impulses of 50-60 seconds. In less than 100 ms (actually 66.9 ms) after the second current impulse a power frequency voltage not less than the rated voltage was applied for 10 seconds. After 10 seconds the voltage was decreased to 0.87 times the rated voltage*) and applied during 30 minutes before the sections were disconnected from the voltage source and permitted to cool to ambient temperature 23 ± 5 °C.
Leakage current and temperature were measured during the test sequence to prove thermal stability and ability of the test sections to cool after the switching surges and overvoltage application against 0.87 times the rated voltage.
Oscillograms from the test are shown on osc pages 22 to,30. Temperature increase and cooling are shown in Figure 3, 4 and 5 for test sections No.7, 8 and 9. The test result from the two long duration current impulses is given in Table 10.

Section No	Application No	Current peak A	Voltage peak kV	Energy kJ
7	1	1077.0	20.36	66.40
7	2	1064.0	20.71	66.65
8	1	1080.0	20.35	66.68
8	2	1066.0	20.70	66.67
9	1	1075.0	20.43	66.55
9	2	1057.0	20.78	66.26

Table 10. Long Duration Current Impulse Withstand Test on PEXLIM P-X sections rated 10.83 kVrms. Actual charging voltage 30.08 kV. The total energy in the two line discharges corresponds to at least 12.2 kJ/ kV rated voltage.

*) With a maximum U_c for PEXLIM P-X arresters of 80% of rated voltage the applied voltage is 1.10 times higher.

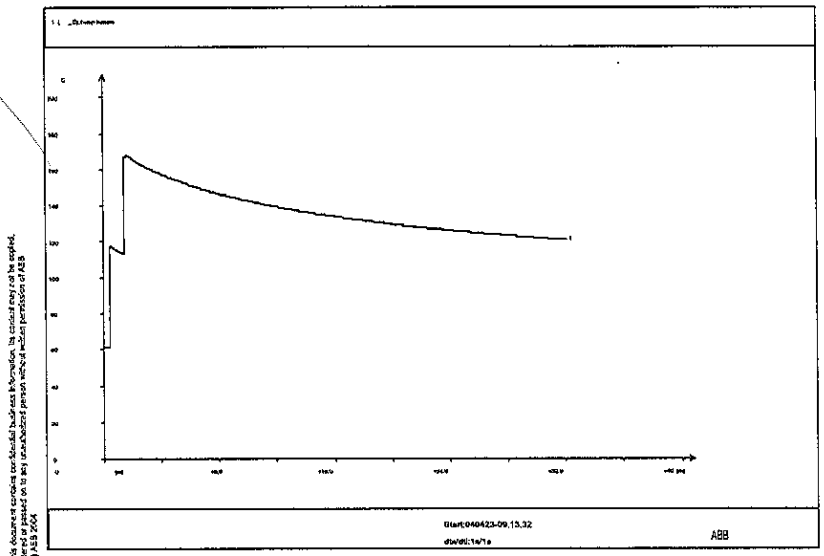


Figure 3. Temperature increase and cooling during the test sequence on section No.7.
(Temperature measured on the surface of the bottom varistor in the test section.)

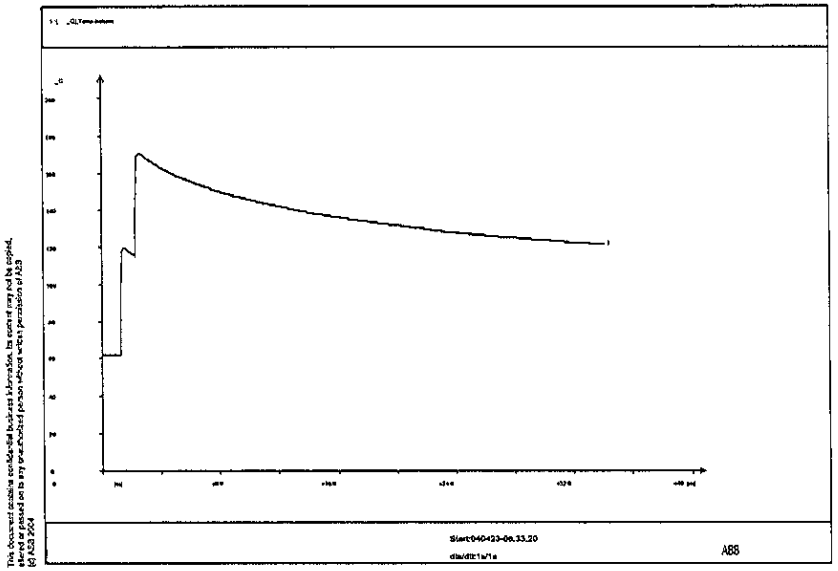


Figure 4. Temperature increase and cooling during the test sequence on section No.8.
(Temperature measured on the surface of the bottom varistor in the test section.)

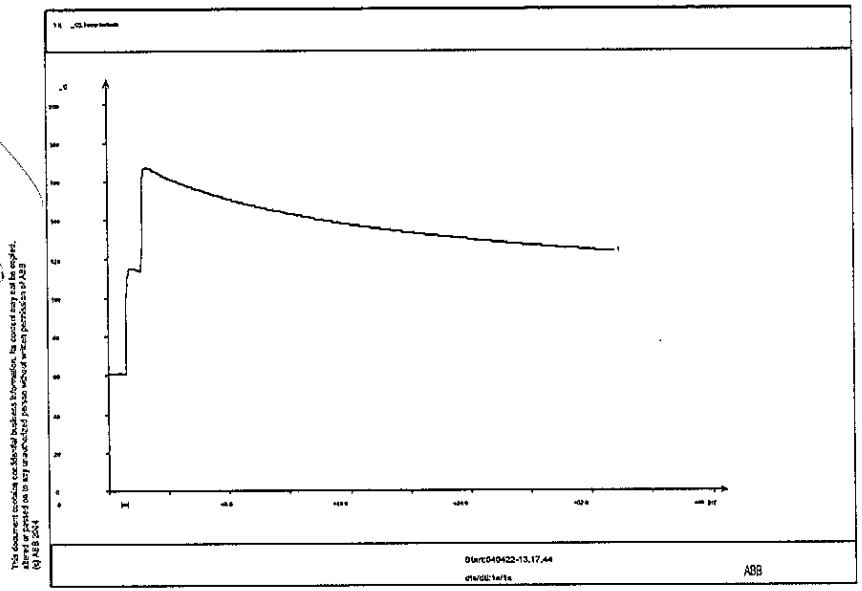


Figure 5. Temperature increase and cooling during the test sequence on section No.9. (Temperature measured on the surface of the bottom varistor in the test section.)

Since the varistor elements could not be dismantled for inspection an additional Long Duration Current Impulse was applied, after the complete operating duty test as per the requirements in clause 9.7.5

Test results are shown in table 12 and on oscillogram pages 31 to 32.

Section No	Application No	Current peak A	Voltage peak kV	Energy kJ
7	3	917.8	20.03	55.93
8	3	928.1	19.98	56.52
9	3	919.4	20.05	56.00

Table 12. Additional Long Duration Current Impulse Withstand Test on PEXLIM P-X sections rated 10.83 kVrms. Actual charging voltage 28.30 kV.

Before the complete operating duty test the residual voltage at 20 kA 8/20 µs and the reference voltage were measured. After the tests as per the requirements in clause 9.7.5 two shots at 20 kA 8/20 µs were applied on the sections after they had been permitted to cool to ambient temperature, and the second shot in less than 60 seconds after the first shot. The reference voltages also were measured to check if any possible changes in the arrester performance had occured.

Test results are shown in tables 13 and 14 and on oscillogram pages 33 to 38.

Section No	Application No	Current peak kA	Voltage peak kV
7	1 *)	20.22	25.64
7	2	19.81	25.95
7	3	19.93	25.98
8	1 *)	20.22	25.60
8	2	19.94	25.92
8	3	20.06	25.95
9	1 *)	20.15	25.67
9	2	20.01	25.95
9	3	19.97	25.97

Table 13

*) Application No.1 was measured before operating duty test.

Section No	Difference after/before in residual voltage at 20 kA (%)	Difference after/before in reference voltage at 3.0 mA (%)
7	+ 1.2	+ 2.0
8	+ 1.3	+ 2.2
9	+ 1.1	+ 2.3

Table 14

Examination of the test samples after the test revealed no evidence of puncture, flashover, cracking or other significant damage of the varistor elements.

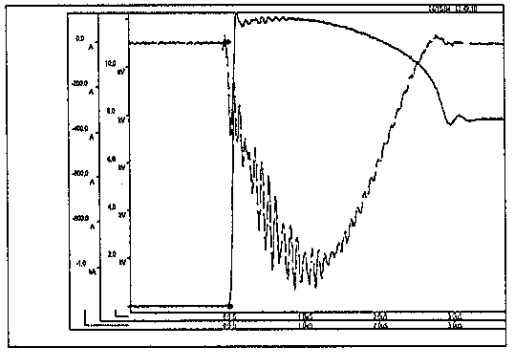
OPERATING DUTY TEST ON PEXLIM P-X - COMPLETE SEQUENCE

SEQUENCE No	EXPLANATION OF PROCEDURE
1	Reference voltage measurement at 3.0 mA resistive current
2	Residual voltage measurement at 20 kA 8/20 µs
3	Conditioning test 4 groups of 5 impulses at 20 kA 8/20 µs superimposed on rated voltage (continuous operating voltage, U_c, +25 %) (Required as per IEC: U_c +20%)
4	High current impulse (100 kA, 4/10 µs) Cooling to ambient temperature High current impulse (100 kA, 4/10 µs)
5	Sections mounted in thermally prorated sections
6	Preheating to 60 ± 3 °C
7	Rapidly brought to test chamber (23 ± 5 °C)
8	Long duration current impulse Class 4
9	50 - 60 seconds
10	Long duration current impulse Class 4
11	Time space less than 100 milliseconds
12	Rated voltage, 10 seconds
13	0.87 times rated voltage (1.10*Uc), 30 minutes (Required as per IEC: U_c)
14	Cooling to ambient temperature, (23 ± 5 °C)
15	Additional long duration current impulse - Class 4, and examination of test samples
16	cooling to ambient temperature, (23 ± 5 °C)
17	Reference voltage measurement at 3.0 mA resistive current
18	Residual voltage measurement at 20 kA, 8/20 µs Less than 60 seconds Residual voltage measurement at 20 kA, 8/20 µs
19	Examination of test samples and oscillographic records from residual voltage measurements

Figure 2.
Sequence No. 1 - 2 : Initial measurement - sections not thermally insulated
3 - 4 : Conditioning - sections not thermally insulated
5 - 13 : Switching surge operating duty test
14 - 19 : Measurement and examination - sections not thermally insulated.

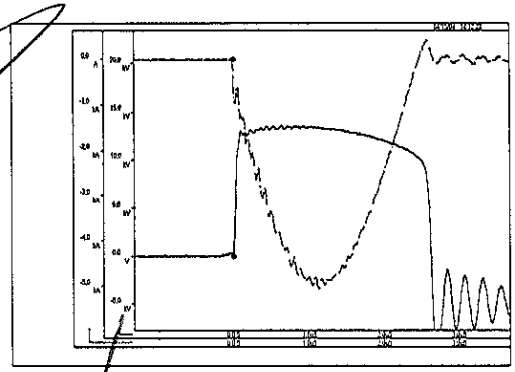
OSCILLOGRAM PAGES

Steep current impulse residual voltage test
Section rated 6.30 kVrms
Section No. 1
Time scale: 1.0 µs/div



Voltage: 2.00 kV/div
(11.99 kV)

Current: 200.0 A/div
(1.00 kA)

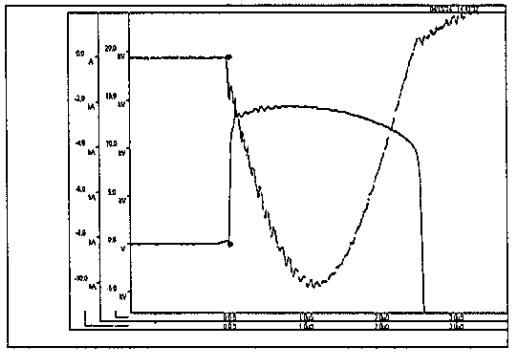


Voltage: 5.00 kV/div
(13.40 kV)

Current: 1.00 kA/div
(4.94 kA)

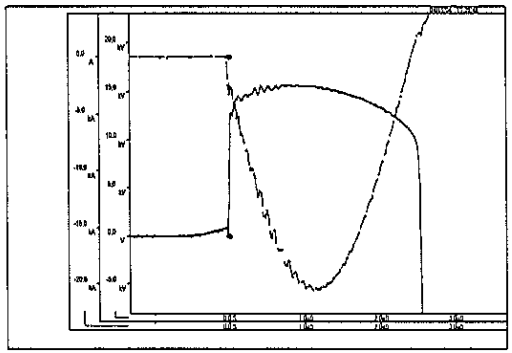
Steep current impulse residual voltage test
Section rated 6.30 kVrms

Section No. 1
Time scale: 1.0 µs/div



Voltage: 5.00 kV/div
(14.34 kV)

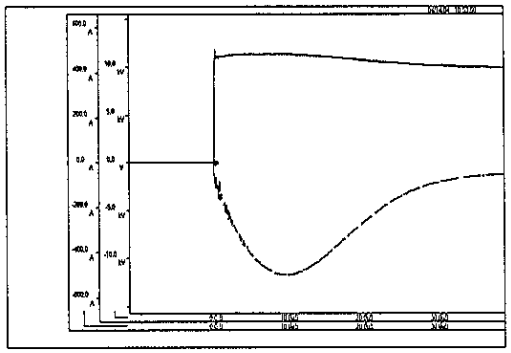
Current: 2.00 kA/div
(10.06 kA)



Voltage: 5.00 kV/div
(15.58 kV)

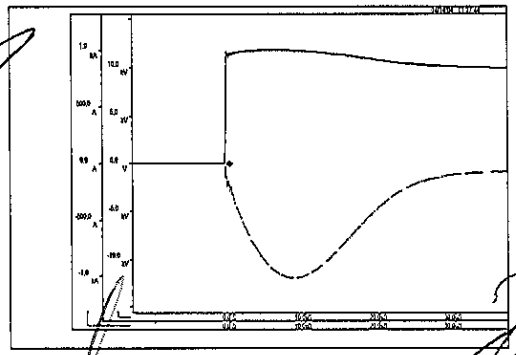
Current: 5.00 kA/div
(20.43 kA)

Lightning impulse residual voltage test
Section rated 6.30 kVrms
Section No. 1
Time scale: 10.0 µs/div



Voltage: 5.00 kV/div
(11.38 kV)

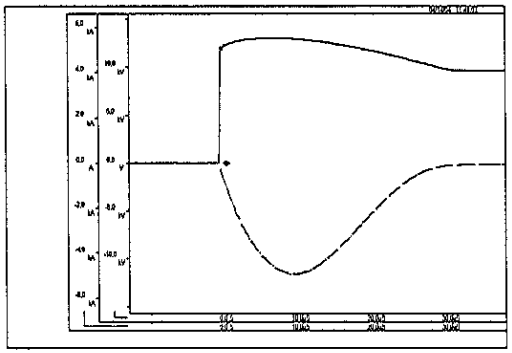
Current: 200.0 A/div
(0.50 kA)



Voltage: 5.00 kV/div
(11.76 kV)

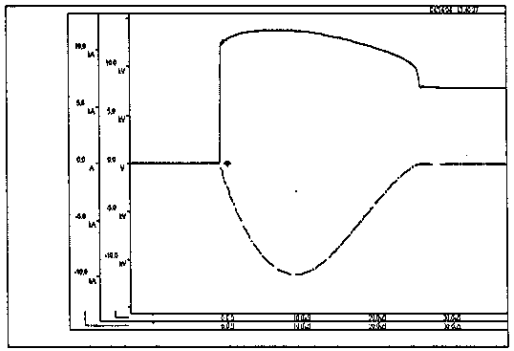
Current: 500.0 A/div
(1.02 kA)

Lightning impulse residual voltage test
Section rated 6.30 kVrms
Section No. 1
Time scale: 10.0 µs/div



Voltage: 5.00 kV/div
(13.01 kV)

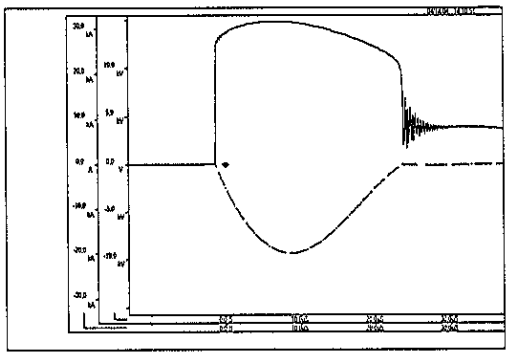
Current: 2.00 kA/div
(4.92 kA)



Voltage: 5.00 kV/div
(13.80 kV)

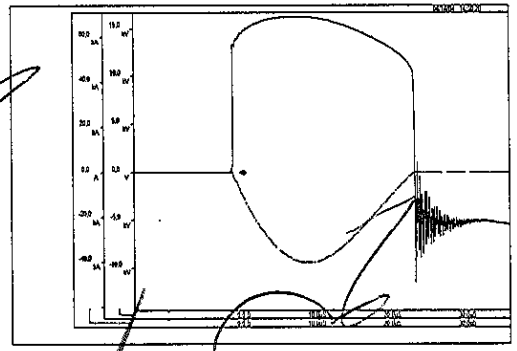
Current: 5.00 kA/div
(9.86 kA)

Lightning impulse residual voltage test
Section rated 6.30 kVrms
Section No. 1
Time scale: 10.0 µs/div



Voltage: 5.00 kV/div
(14.85 kV)

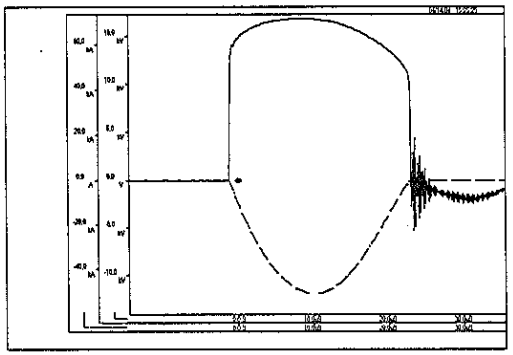
Current: 10.00 kA/div
(19.86 kA)



Voltage: 5.00 kV/div
(16.30 kV)

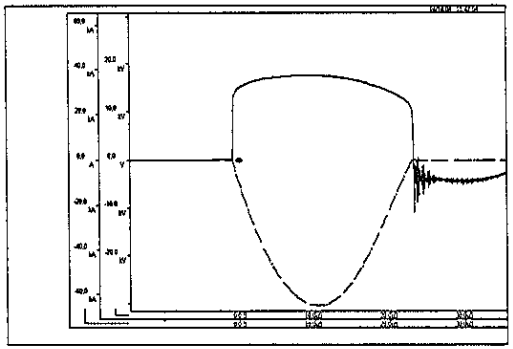
Current: 20.00 kA/div
(40.21 kA)

Lightning impulse residual voltage test
Section rated 6.30 kVrms
Section No. 1
Time scale: 10.0 µs/div



Voltage: 5.00 kV/div
(16.80 kV)

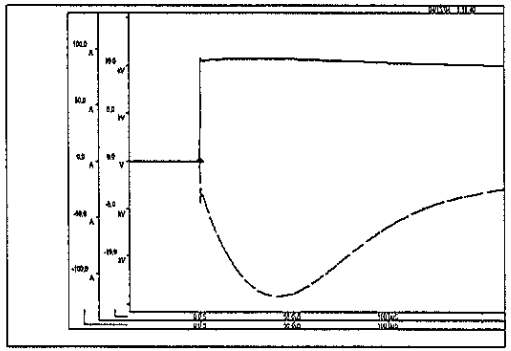
Current: 20.00 kA/div
(50.51 kA)



Voltage: 10.00 kV/div
(17.57 kV)

Current: 20.00 kA/div
(64.90 kA)

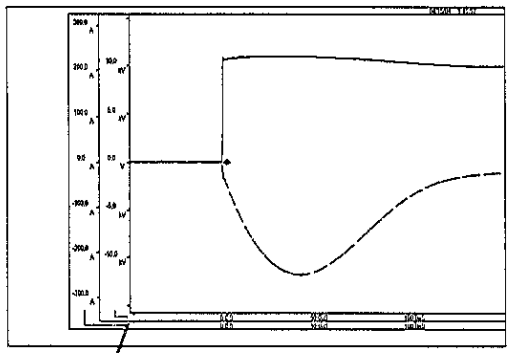
Switching impulse residual voltage test
Section rated 6.30 kVrms
Section No. 1



Voltage: 5.00 kV/div
(10.71 kV)

Current: 50.00 A/div
(0.121 kA)

Time scale: 50.0 µs/div



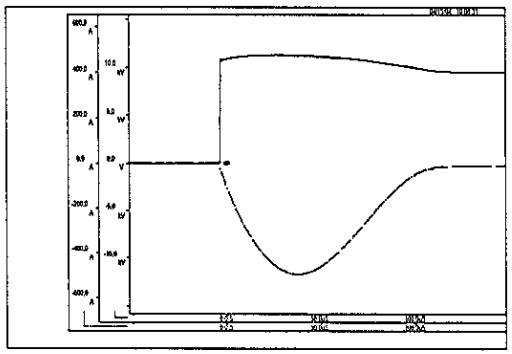
Voltage: 5.00 kV/div
(10.97 kV)

Current: 100.00 A/div
(0.249 kA)

Time scale: 50.0 µs/div

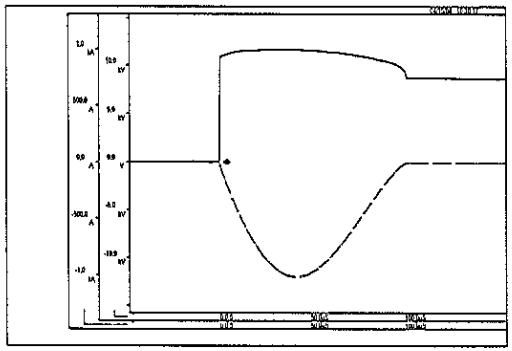
0002233

Switching impulse residual voltage test
Section rated 6.30 kVrms
Section No. 1
Time scale: 50.0 µs/div



Voltage: 5.00 kV/div
(11.27 kV)

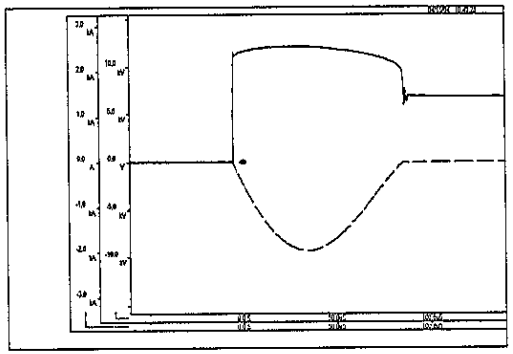
Current: 200.00 A/div
(0.496 kA)



Voltage: 5.00 kV/div
(11.65 kV)

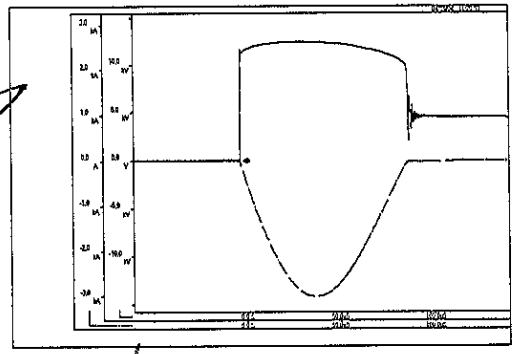
Current: 500.0 A/div
(1.016 kA)

Switching impulse residual voltage test
Section rated 6.30 kVrms
Section No. 1
Time scale: 50.0 µs/div



Voltage: 5.00 kV/div
(12.07 kV)

Current: 1.00 kA/div
(1.968 kA)

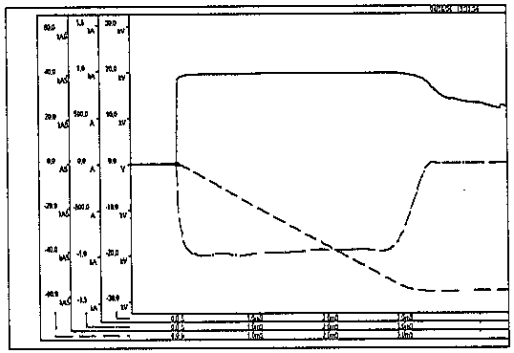


Voltage: 5.00 kV/div
(12.39 kV)

Current: 1.00 kA/div
(3.019 kA)

Long duration current impulse withstand test
Section rated 10.82 kVrms

Section No. 4
Time scale: 1000.0 µs/div
Voltage scale: 10.0 kV/div
Current scale: 500.0 A/div
Energy scale : 20.0 kJ/div

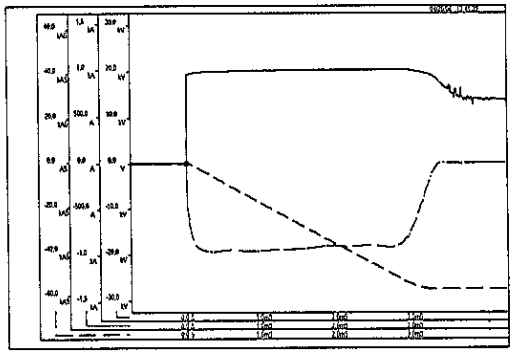


1st application

Voltage: 19.81 kV

Current: 953.3 A

Energy: 57.47 kJ



18th application

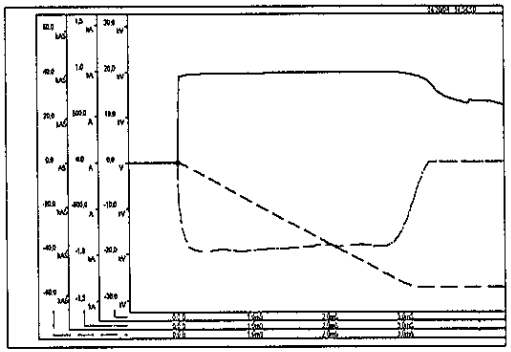
Voltage: 20.32 kV

Current: 921.8 A

Energy: 56.93 kJ

Long duration current impulse withstand test
Section rated 10.82 kVrms

Section No. 4
Time scale: 1000.0 µs/div
Voltage scale: 10.0 kV/div
Current scale: 500.0 A/div
Energy scale : 20.0 kJ/div



19th application

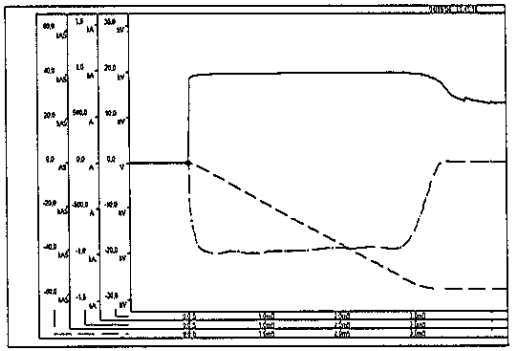
Voltage: 19.93 kV

Current: 930.4 A

Energy: 56.57 kJ

Long duration current impulse withstand test
Section rated 10.82 kVrms

Section No. 5
Time scale: 1000.0 µs/div
Voltage scale: 10.0 kV/div
Current scale: 500.0 A/div
Energy scale : 20.0 kJ/div

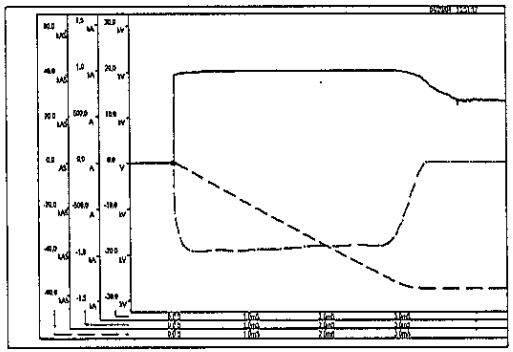


1st application

Voltage: 19.79 kV

Current: 934.4 A

Energy: 57.64 kJ



18th application

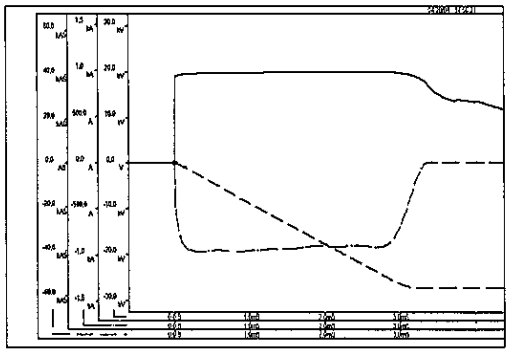
Voltage: 20.32 kV

Current: 915.5 A

Energy: 56.73 kJ

Long duration current impulse withstand test
Section rated 10.82 kVrms

Section No. 5
Time scale: 1000.0 µs/div
Voltage scale: 10.0 kV/div
Current scale: 500.0 A/div
Energy scale : 20.0 kJ/div



19th application

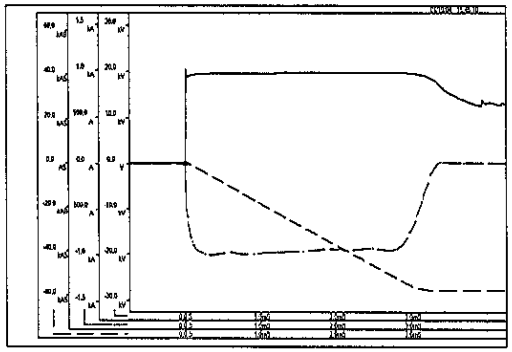
Voltage: 19.93 kV

Current: 932.8 A

Energy: 56.58 kJ

Long duration current impulse withstand test
Section rated 10.85 kVrms

Section No. 6
Time scale: 1000.0 µs/div
Voltage scale: 10.0 kV/div
Current scale: 500.0 A/div
Energy scale : 20.0 kJ/div

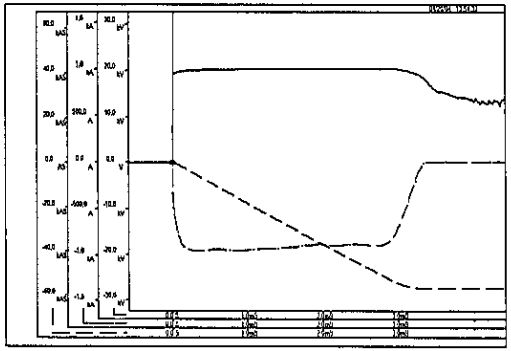


1st application

Voltage: 19.81 kV

Current: 956.4 A

Energy: 57.68 kJ



18th application

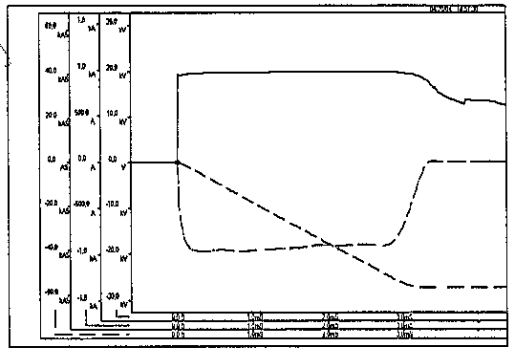
Voltage: 20.33 kV

Current: 918.6 A

Energy: 56.79 kJ

Long duration current impulse withstand test
Section rated 10.85 kVrms

Section No. 6
Time scale: 1000.0 µs/div
Voltage scale: 10.0 kV/div
Current scale: 500.0 A/div
Energy scale : 20.0 kJ/div



19th application

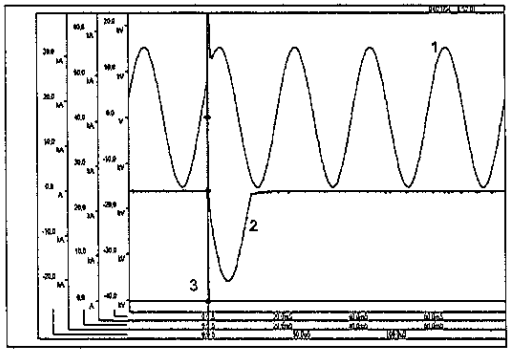
Voltage: 19.93 kV

Current: 932.0 A

Energy: 56.54 kJ

0002237

Operating duty test
Conditioning test with 20 kA 8/20 µs superimposed
on continuous operating voltage +25%
Section No.7. rated 10.83 kVrms



1st application

(1) Voltage scale: 10.0 kV/div
(10.83 kVrms)

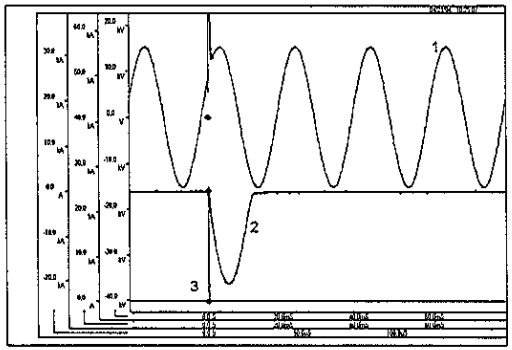
Time scale: 20.0 ms/div

(2)Currentscale:10.0 kA/div
(20.22 kA)

Time scale: 50.0 µs/div

(3)Currentscale:10.0 kA/div
(20.22 kA)

Time scale: 20.0 ms/div



20th application

(1) Voltage scale: 10.0 kV/div
(10.84 kVrms)

Time scale: 20.0 ms/div

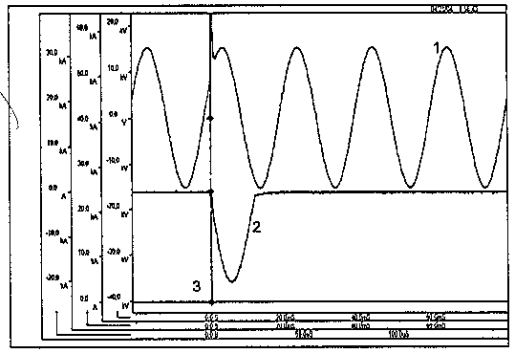
(2)Currentscale:10.0 kA/div
(20.74 kA)

Time scale: 50.0 µs/div

(3)Currentscale:10.0 kA/div
(20.74 kA)

Time scale: 20.0 ms/div

Operating duty test
Conditioning test with 20 kA 8/20 µs superimposed
on continuous operating voltage +25%
Section No.8. rated 10.83 kVrms



1st application

(1) Voltage scale: 10.0 kV/div
(10.83 kVrms)

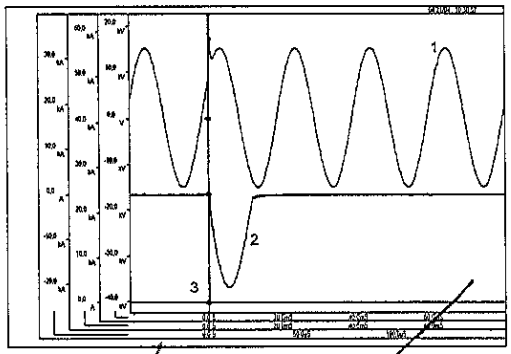
Time scale: 20.0 ms/div

(2)Currentscale:10.0 kA/div
(20.22 kA)

Time scale: 50.0 µs/div

(3)Currentscale:10.0 kA/div
(20.22 kA)

Time scale: 20.0 ms/div



20th application

(1) Voltage scale: 10.0 kV/div
(10.86 kVrms)

Time scale: 20.0 ms/div

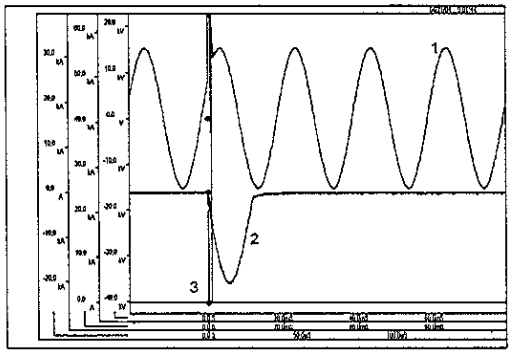
(2)Currentscale:10.0 kA/div
(20.74 kA)

Time scale: 50.0 µs/div

(3)Currentscale:10.0 kA/div
(20.74 kA)

Time scale: 20.0 ms/div

Operating duty test
Conditioning test with 20 kA 8/20 µs superimposed
on continuous operating voltage +25%
Section No.9. rated 10.83 kVrms



1st application

(1) Voltage scale: 10.0 kV/div
(10.83 kVrms)

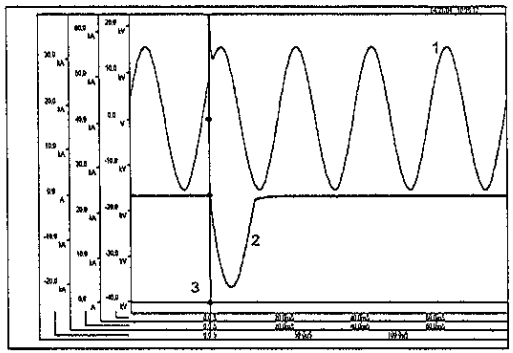
Time scale: 20.0 ms/div

(2)Currentscale:10.0 kA/div
(20.23 kA)

Time scale: 50.0 µs/div

(3)Currentscale:10.0 kA/div
(20.23 kA)

Time scale: 20.0 ms/div



20th application

(1) Voltage scale: 10.0 kV/div
(10.86 kVrms)

Time scale: 20.0 ms/div

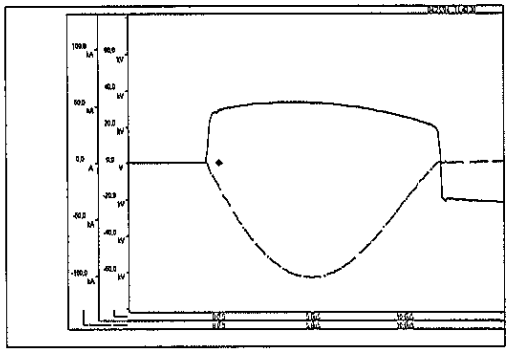
(2)Currentscale:10.0 kA/div
(20.48 kA)

Time scale: 50.0 µs/div

(3)Currentscale:10.0 kA/div
(20.48 kA)

Time scale: 20.0 ms/div

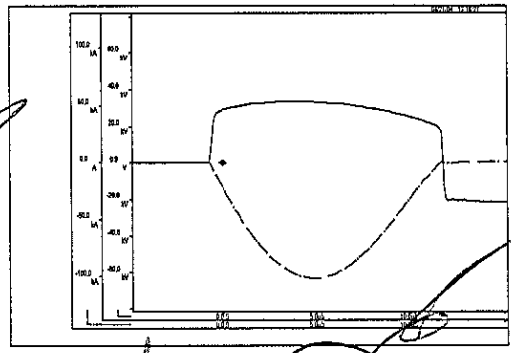
Operating duty test
Conditioning test with high current impulse (100 kA 4/10 µs)
Section No.7 rated 10.83 kVrms
Time scale : 5.0 µs/div
Voltage scale: 20.0 kV/div
Current scale: 50.0 kA/div



1st application

Voltage: 33.47 kV

Current: 101.11 kA

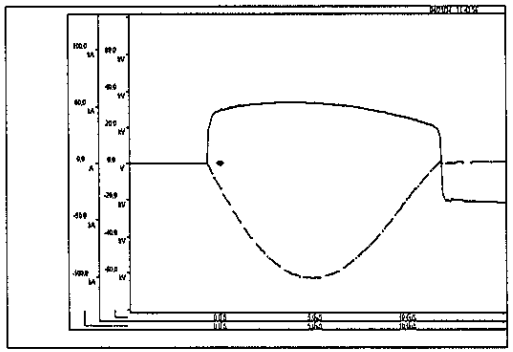


2nd application

Voltage: 33.51 kV

Current: 101.43 kA

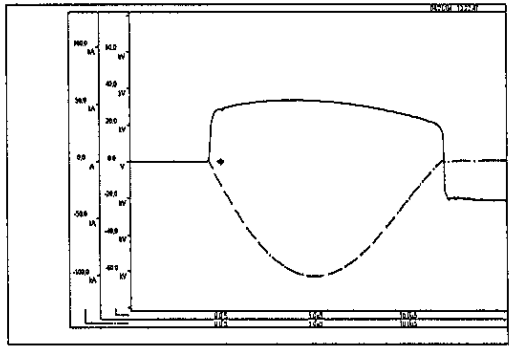
Operating duty test
Conditioning test with high current impulse (100 kA 4/10 µs)
Section No.8 rated 10.83 kVrms
Time scale : 5.0 µs/div
Voltage scale: 20.0 kV/div
Current scale: 50.0 kA/div



1st application

Voltage: 33.47 kV

Current: 101.04 kA

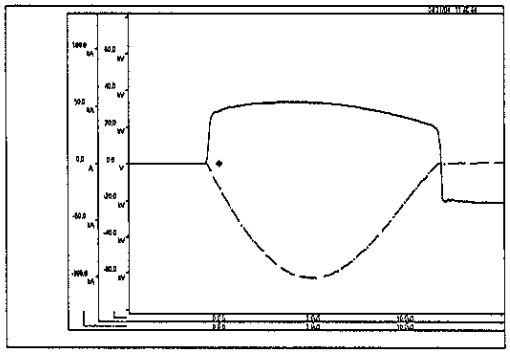


2nd application

Voltage: 33.39 kV

Current: 100.85 kA

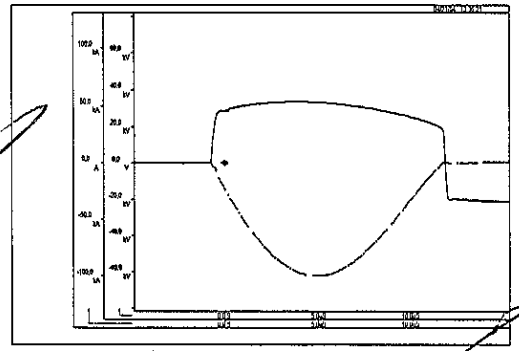
Operating duty test
Conditioning test with high current impulse (100 kA 4/10 µs)
Section No.9 rated 10.83 kVrms
Time scale : 5.0 µs/div
Voltage scale: 20.0 kV/div
Current scale: 50.0 kA/div



1st application

Voltage: 33.47 kV

Current: 100.66 kA

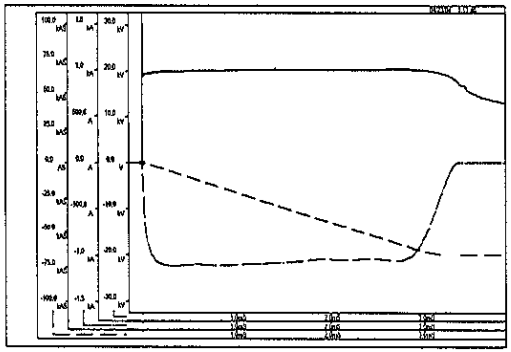


2nd application

Voltage: 33.39 kV

Current: 100.27 kA

Switching surge operating duty test
Long duration current impulse
Section No.7., rated 10.83 kVrms
Time scale : 1000.0 µs/div
Voltage scale: 10.0 kV/div
Current scale: 500.0 A/div
Energy scale : 25.0 kJ/div

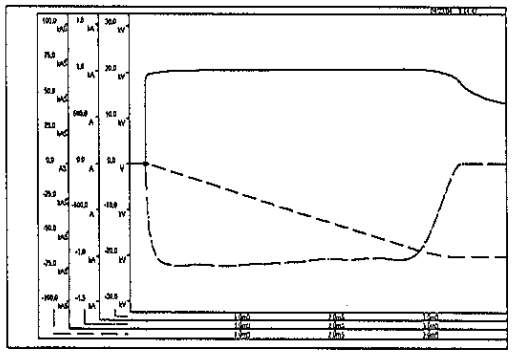


1st application

Voltage: 20.36 kV

Current: 1077.0 A

Energy: 66.40 kJ



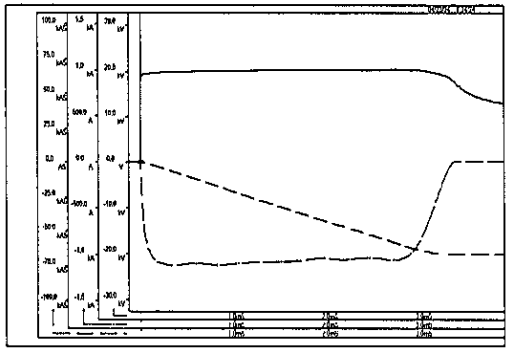
2nd application

Voltage: 20.71 kV

Current: 1064.0 kA

Energy : 66.65 kJ

Switching surge operating duty test
Long duration current impulse
Section No.8., rated 10.83 kVrms
Time scale : 1000.0 µs/div
Voltage scale: 10.0 kV/div
Current scale: 500.0 A/div
Energy scale : 25.0 kJ/div

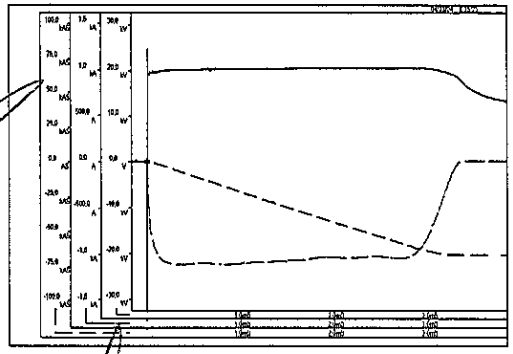


1st application

Voltage: 20.35 kV

Current: 1080.0 kA

Energy : 66.68 kJ



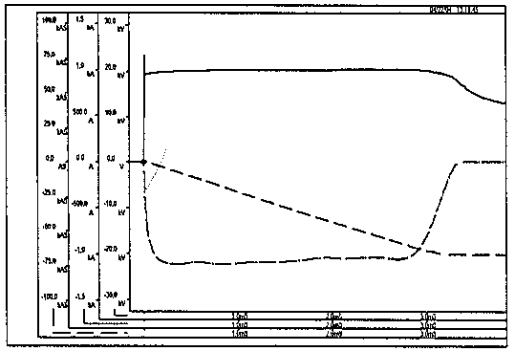
2nd application

Voltage: 20.70 kV

Current: 1066.0 A

Energy: 66.67 kJ

Switching surge operating duty test
Long duration current impulse
Section No.9., rated 10.83 kVrms
Time scale : 1000.0 µs/div
Voltage scale: 10.0 kV/div
Current scale: 500.0 A/div
Energy scale : 25.0 kJ/div

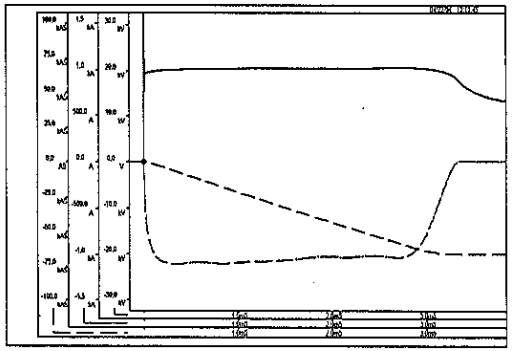


1st application

Voltage: 20.43 kV

Current: 1075.0 kA

Energy: 66.55 kJ



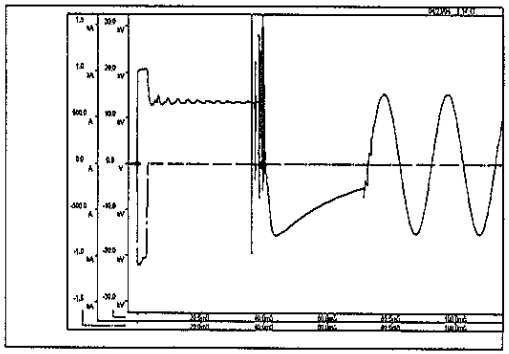
2nd application

Voltage: 20.78 kV

Current: 1057.0 kA

Energy: 66.26 kJ

Switching surge operating duty test
Section No.7., rated 10.83 kVrms

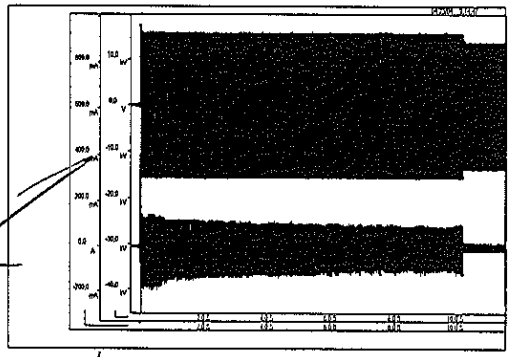


Second long duration current impulse followed by TOV

Time scale: 20.0 ms/div

Voltage scale: 10.0 kV/div

Current scale: 500.0 A/div



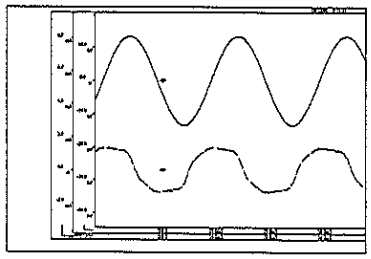
Temporary overvoltage (TOV)
during 10 sec followed by
0.87 x rated voltage.

Time scale: 2.0 sec/div

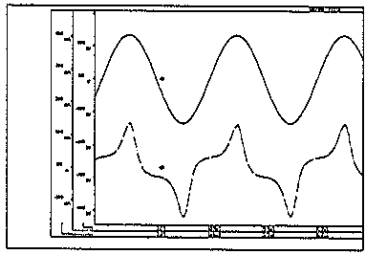
Voltage scale: 10.0 kV/div
(10.86 kVrms,
9.53 kVrms)

Current scale: 200.0 mA/div

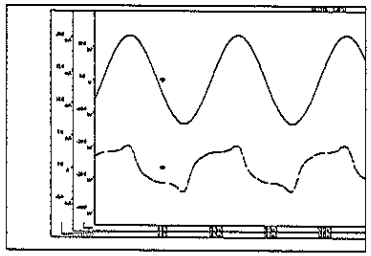
Switching surge operating duty test
Leakage current measurements
Power frequency voltage 9.53 kVrms
Section No.7., rated 10.83 kVrms
Time scale : 10.0 ms/div
Voltage scale: 10.0 kV/div



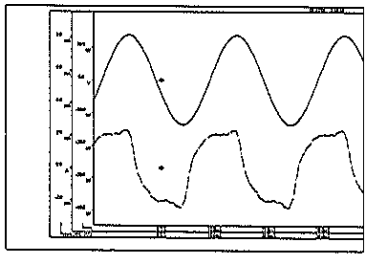
Current scale: 2.0 mA/div
Before 1st discharge at 60.9 °C.



Current scale: 10.0 mA/div
Immediately after 2nd discharge.

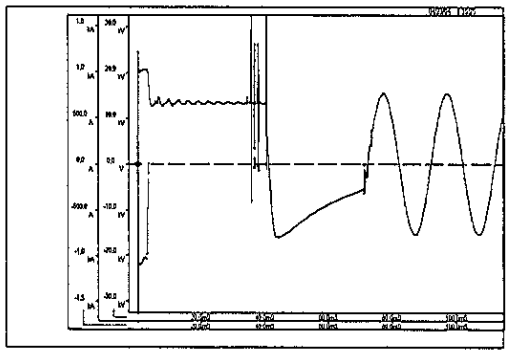


Current scale: 5.0 mA/div
10 min after 2nd discharge.



Current scale: 2.0 mA/div
30 min after 2nd discharge.

Switching surge operating duty test
Section No.8., rated 10.83 kVrms

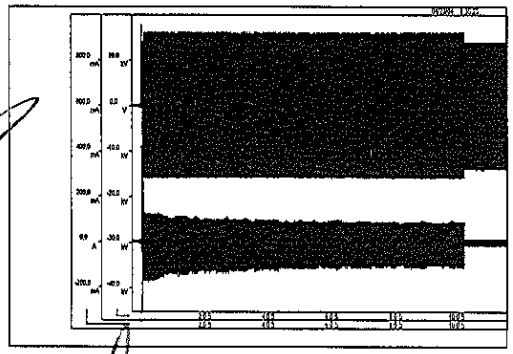


Second long duration current impulse followed by TOV

Time scale: 20.0 ms/div

Voltage scale: 10.0 kV/div

Current scale: 500.0 A/div



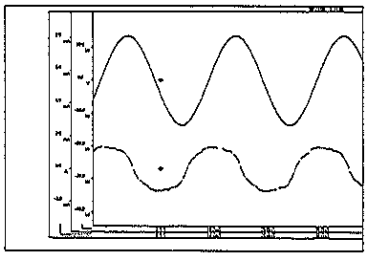
Temporary overvoltage (TOV) during 10 sec followed by 0.87 x rated voltage.

Time scale: 2.0 sec/div

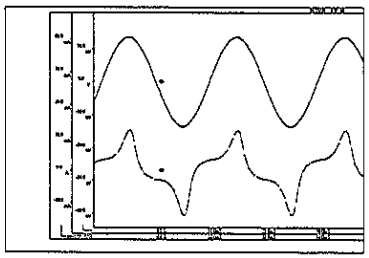
Voltage scale: 10.0 kV/div
(10.94 kVrms,
9.62 kVrms)

Current scale: 200.0 mA/div

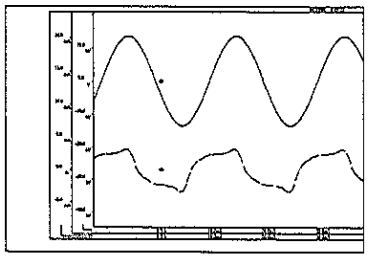
Switching surge operating duty test
Leakage current measurements
Power frequency voltage 9.62 kVrms
Section No.8., rated 10.83 kVrms
Time scale : 10.0 ms/div
Voltage scale: 10.0 kV/div



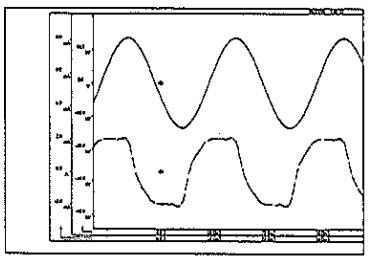
Current scale: 2.0 mA/div
Before 1st discharge at 61.7 °C.



Current scale: 10.0 mA/div
Immediately after 2nd discharge.



Current scale: 5.0 mA/div
10 min after 2nd discharge.



Current scale: 2.0 mA/div
30 min after 2nd discharge.