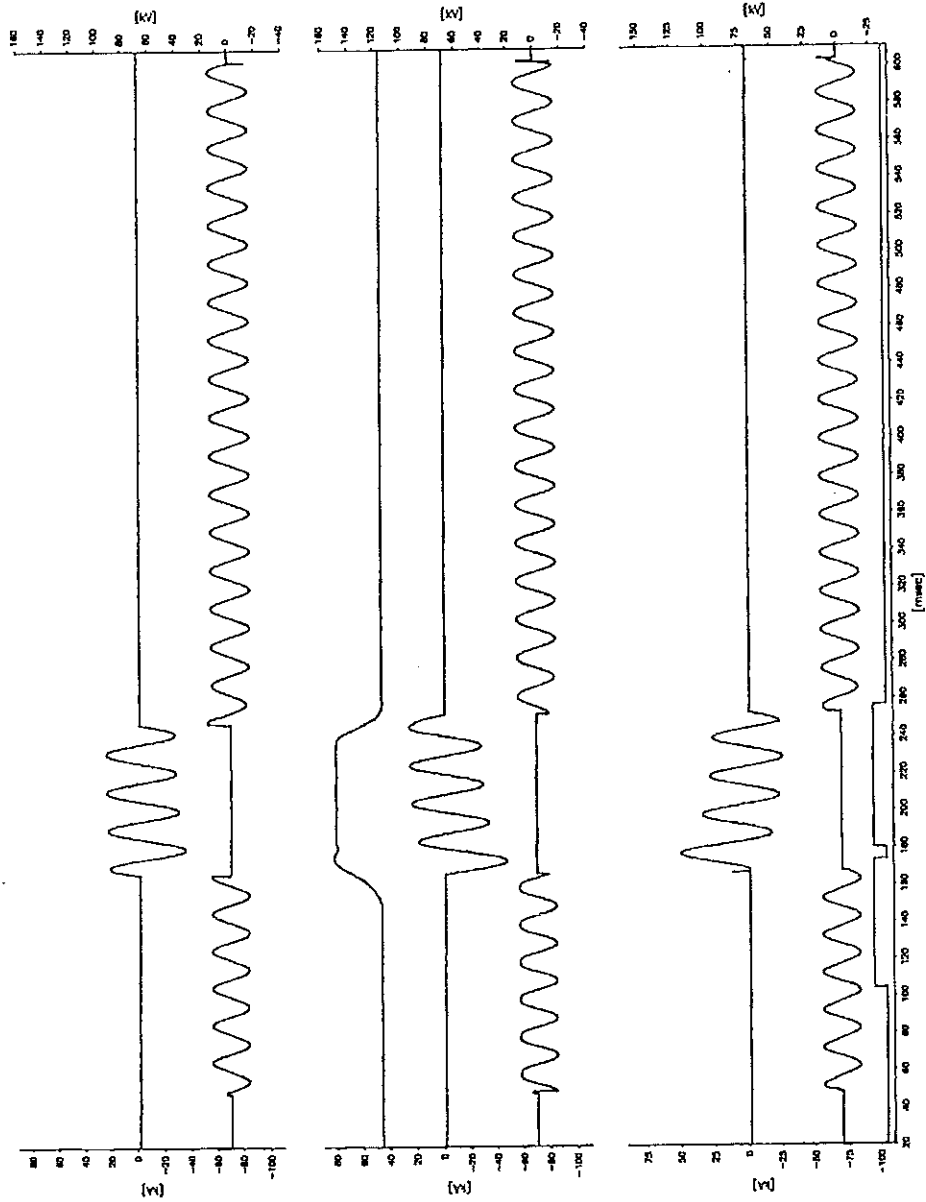
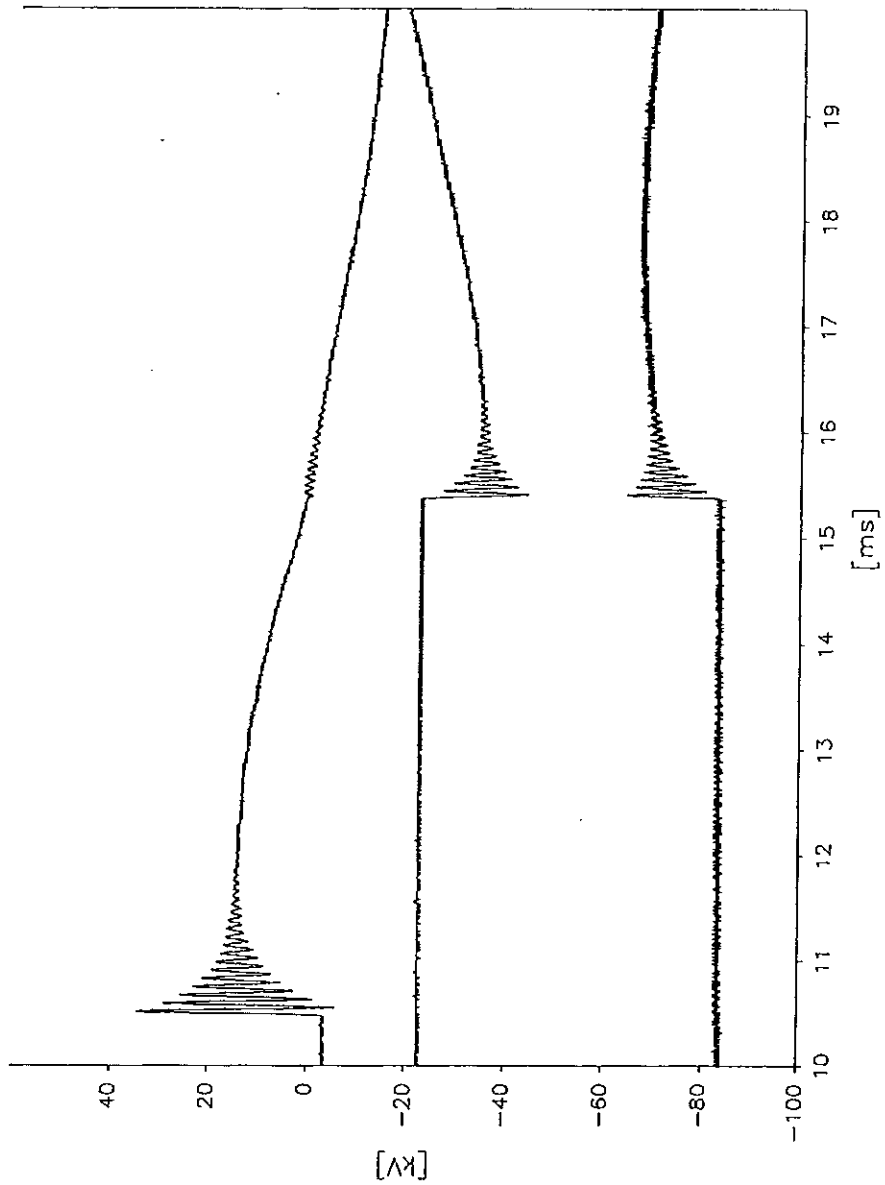


Test no.
PEHLA 0231Ra / 07

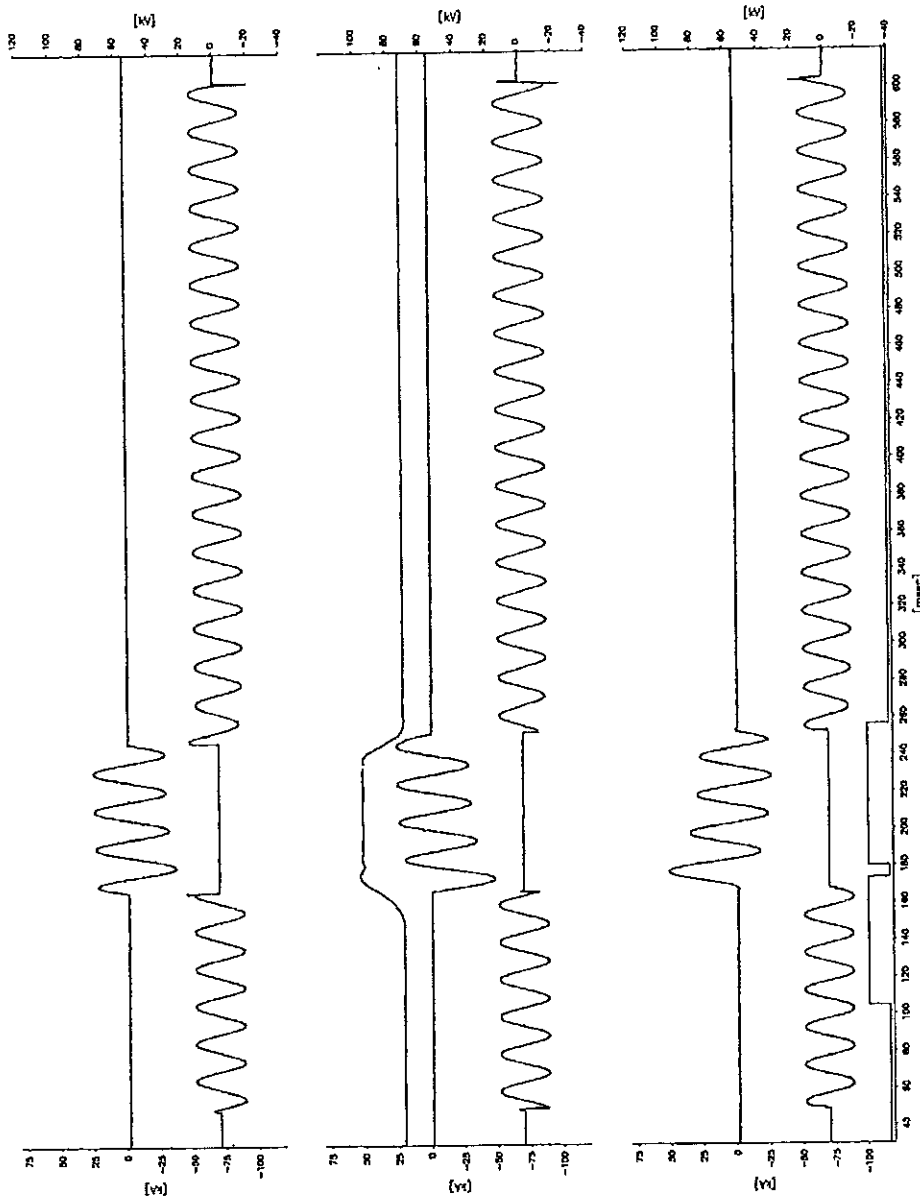




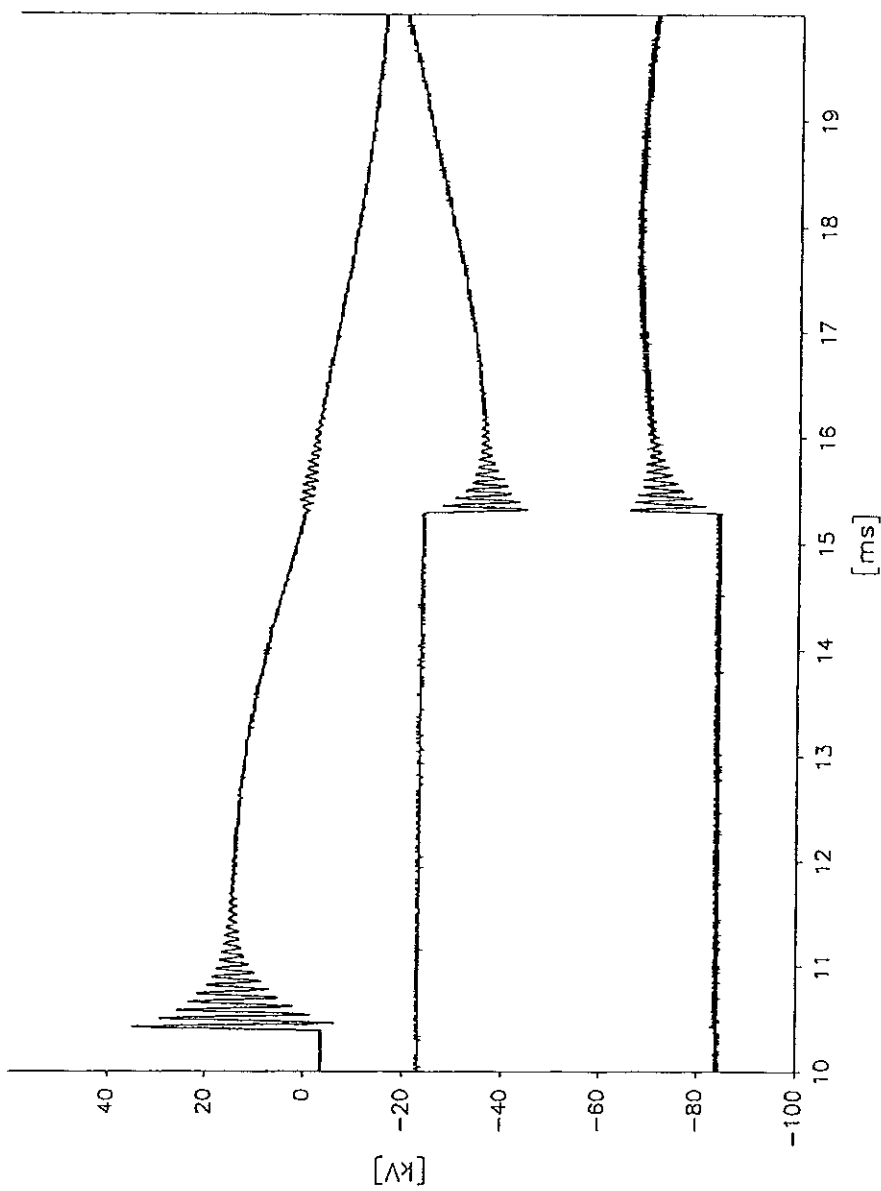
Test no.
PEHLA 0231Ra / 07
Transient Recovery Voltage



Test no.
PEHLA 0231Ra / 08



Test no.
PEHLA 0231Ra / 08
Transient Recovery Voltage



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Short-Circuit Making and Breaking Tests

Circuit-breaker

Test duty: T100s
Date of test: 19th December 2002
Condition of test object before test: As after test PEHLA 0231Ra / 08.
Connections to test object: By means of copper bars to the upper terminals of the circuit-breaker. Lower terminals of the circuit-breaker short-circuited and earthed.
Arc extinguishing medium: Vacuum

Test No. PEHLA 0231Ra		10		11
Operating sequence		O – 0.3s – CO – 3min – CO		
Applied voltage	kV	-	20.1	19.9
Short-circuit making current	L1	-	65.7	61.0
	L2	-	79.6	76.8
	L3	-	84.5	87.1
Short-circuit breaking current	Short-circuit current	L1	32.4	31.6
		L2	32.7	32.5
		L3	32.8	31.9
	Average value	kA	32.6	32.0
d.c. component	%	L1	< 20	< 20
		L2	< 20	< 20
		L3	< 20	< 20
Recovery voltage	kV	L1	10.5	10.0
		L2	11.0	10.2
		L3	10.7	10.3
Average value (phase-to-phase)	kV	-	18.6	17.6
Transient Recovery Voltage (TRV), first-pole-to-clear	kV	-	32.2	35.2
Arcing time	ms	L1	9.4	1.8
		L2	4.2	7.1
		L3	9.4	6.8
Closing time	ms	-	62.0	65.6
Opening time	ms	63.4	66.4	67.4
Result		P	P	P

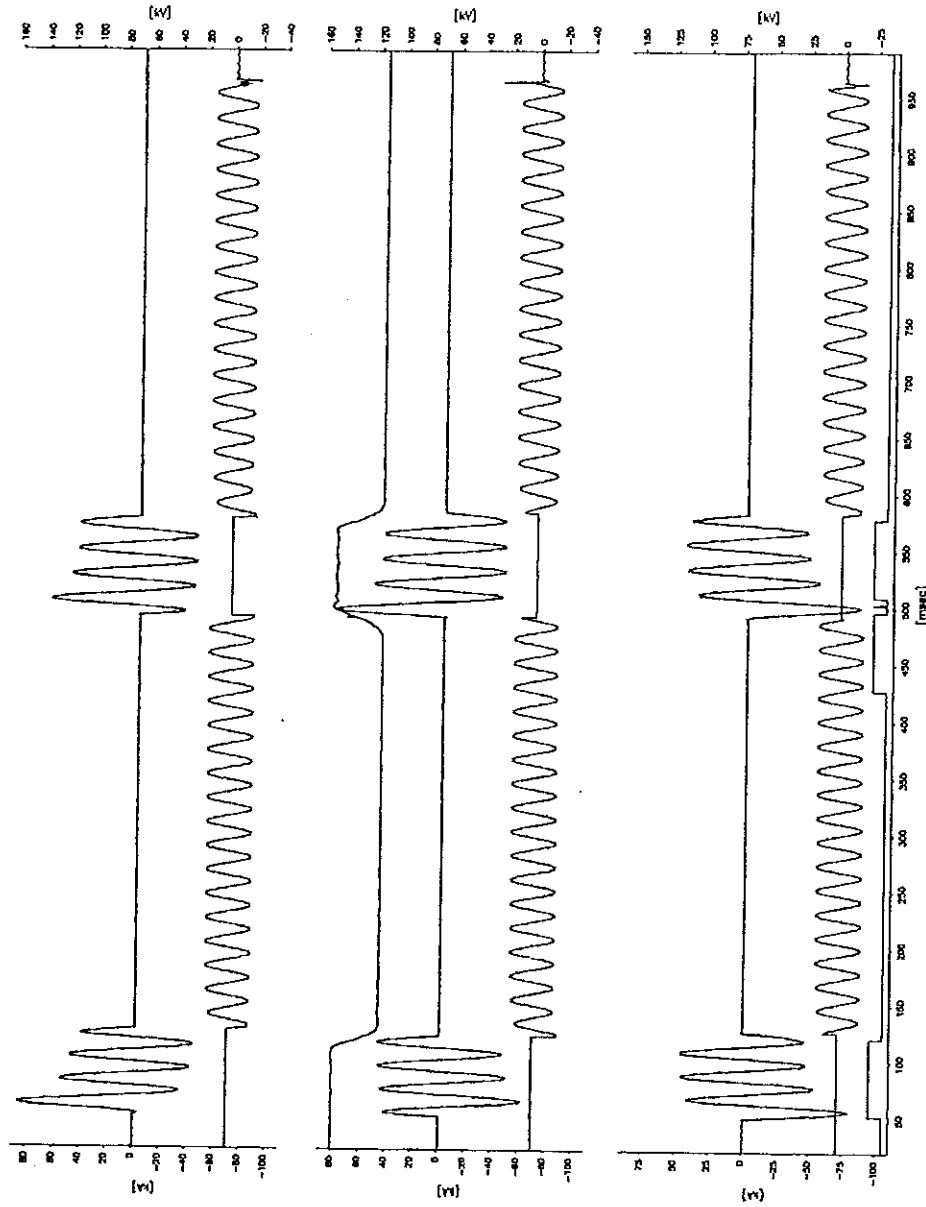
Legend: P: Positive, breaker cleared or breaker closed and cleared N: Negative, breaker failed

Remarks:

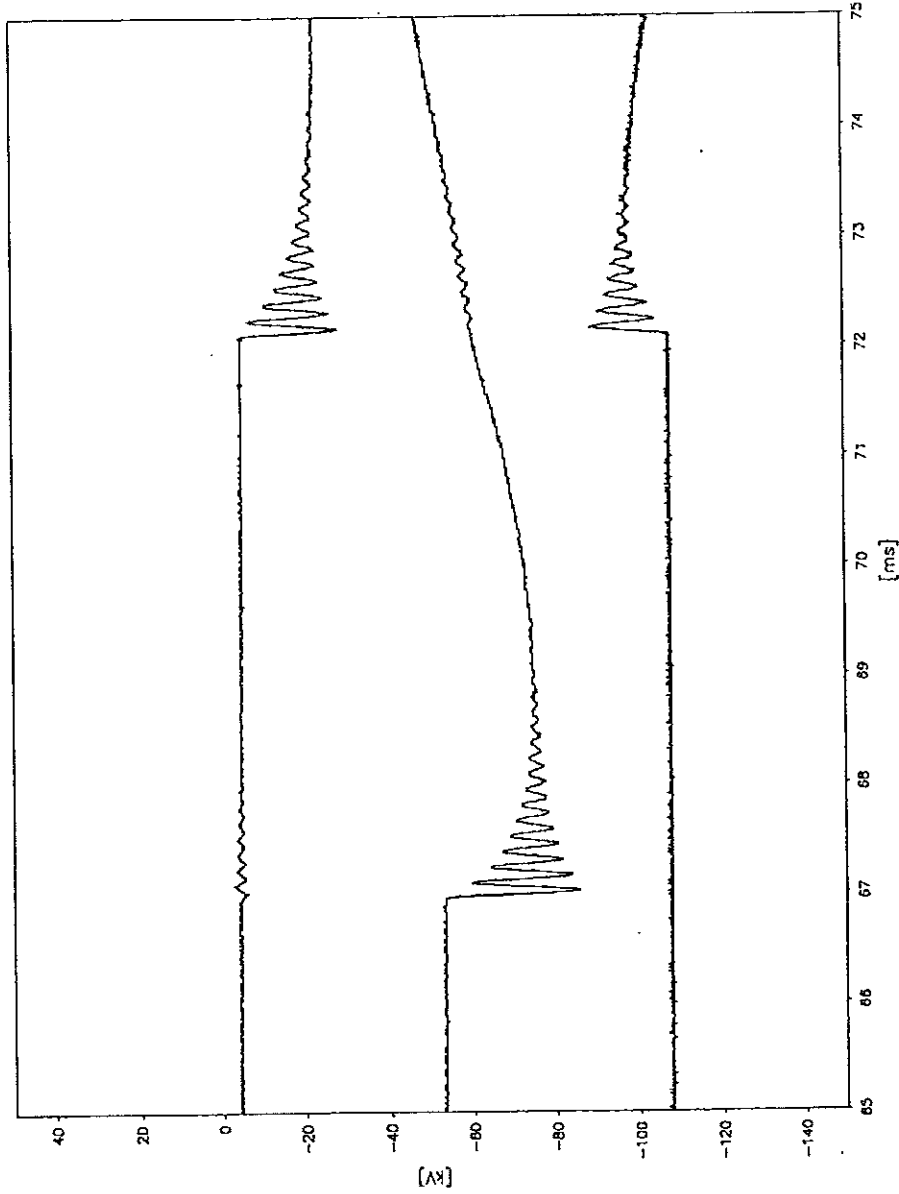
PEHLA 0231Ra / 09: Test with reduced values
 PEHLA 0231Ra / 10 and 11: The operating devices are supplied at their minimum voltage

Condition of test object after test: Circuit-breaker without functional or visible change.

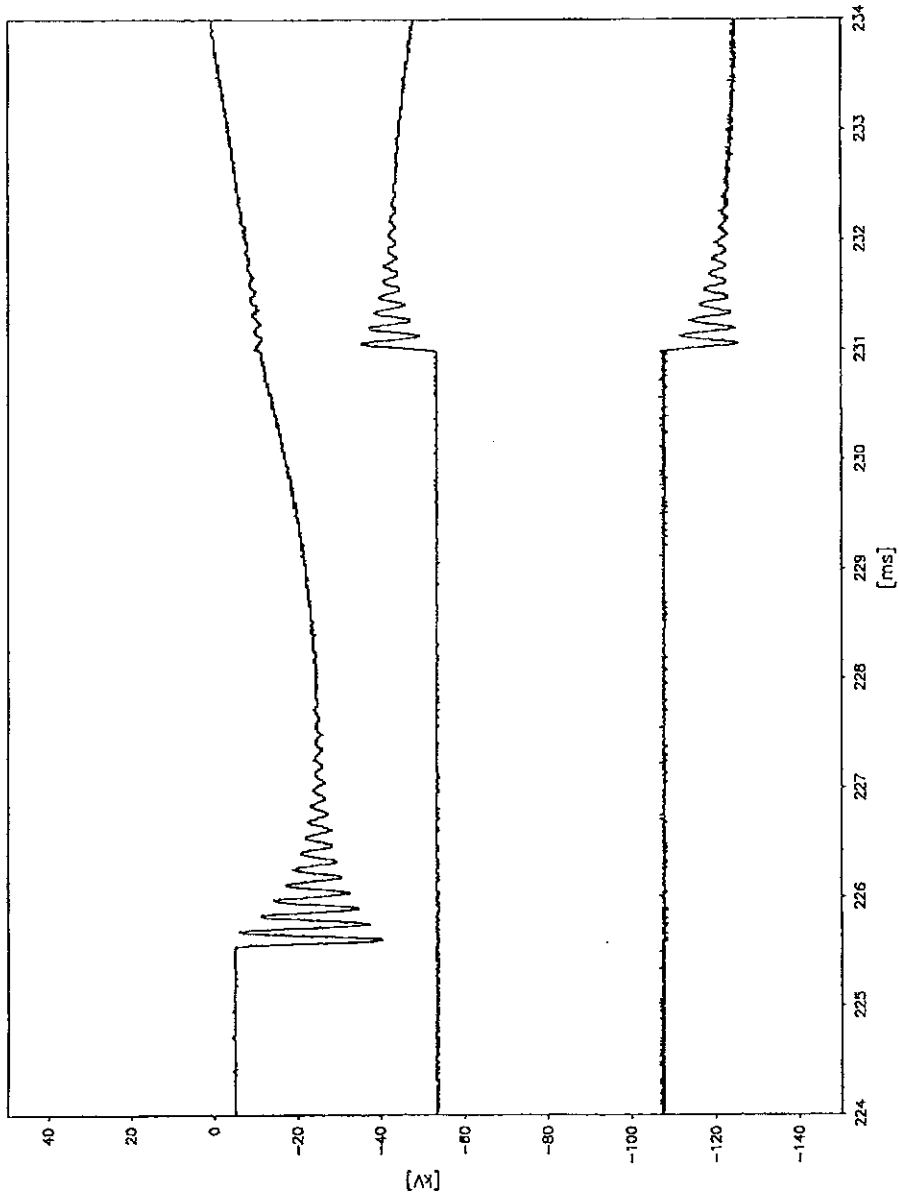
Test no.
PEHLA 0231Ra / 10



Test no.
PEHLA 0231Ra / 10
Transient Recovery Voltage, First O



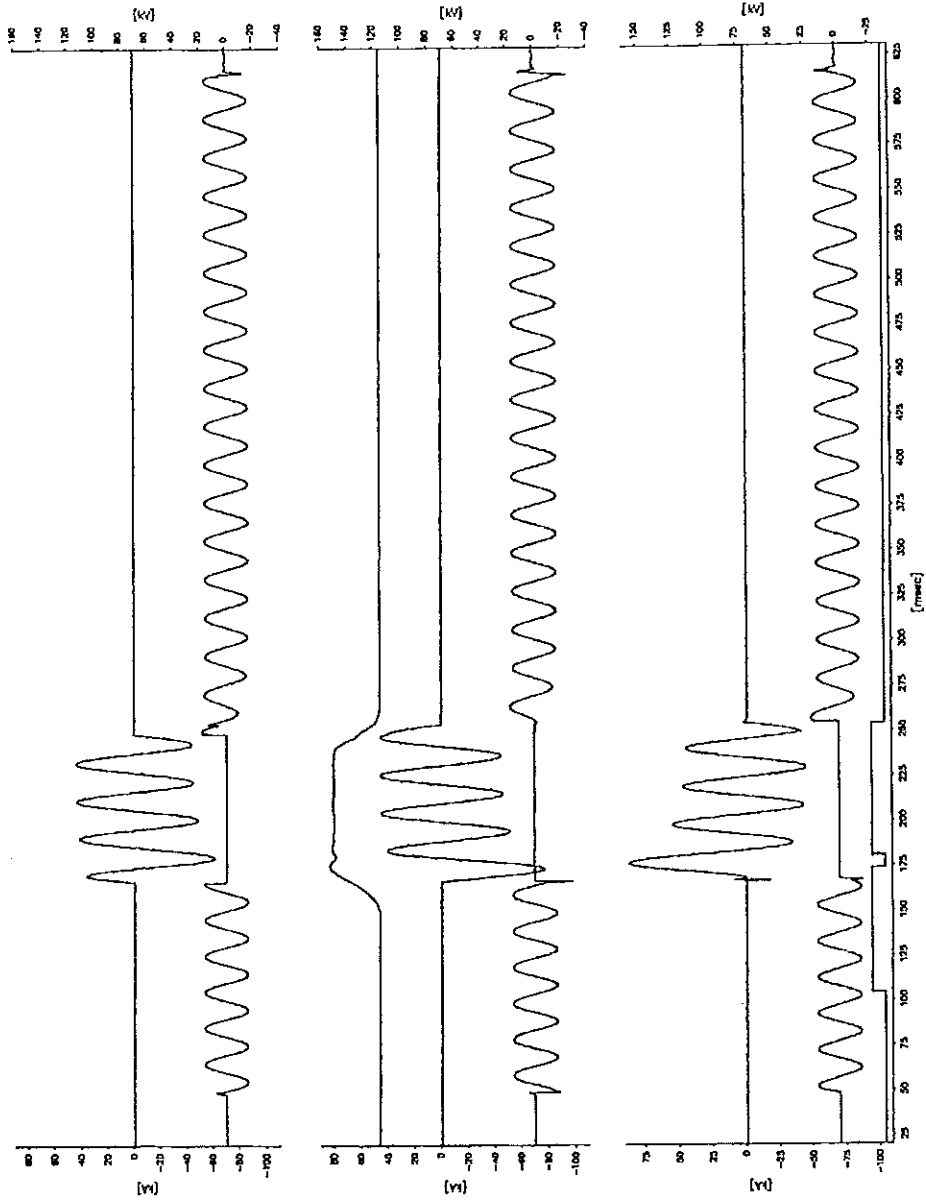
Test no.
PEHLA 0231Ra / 10
Transient Recovery Voltage, Second O



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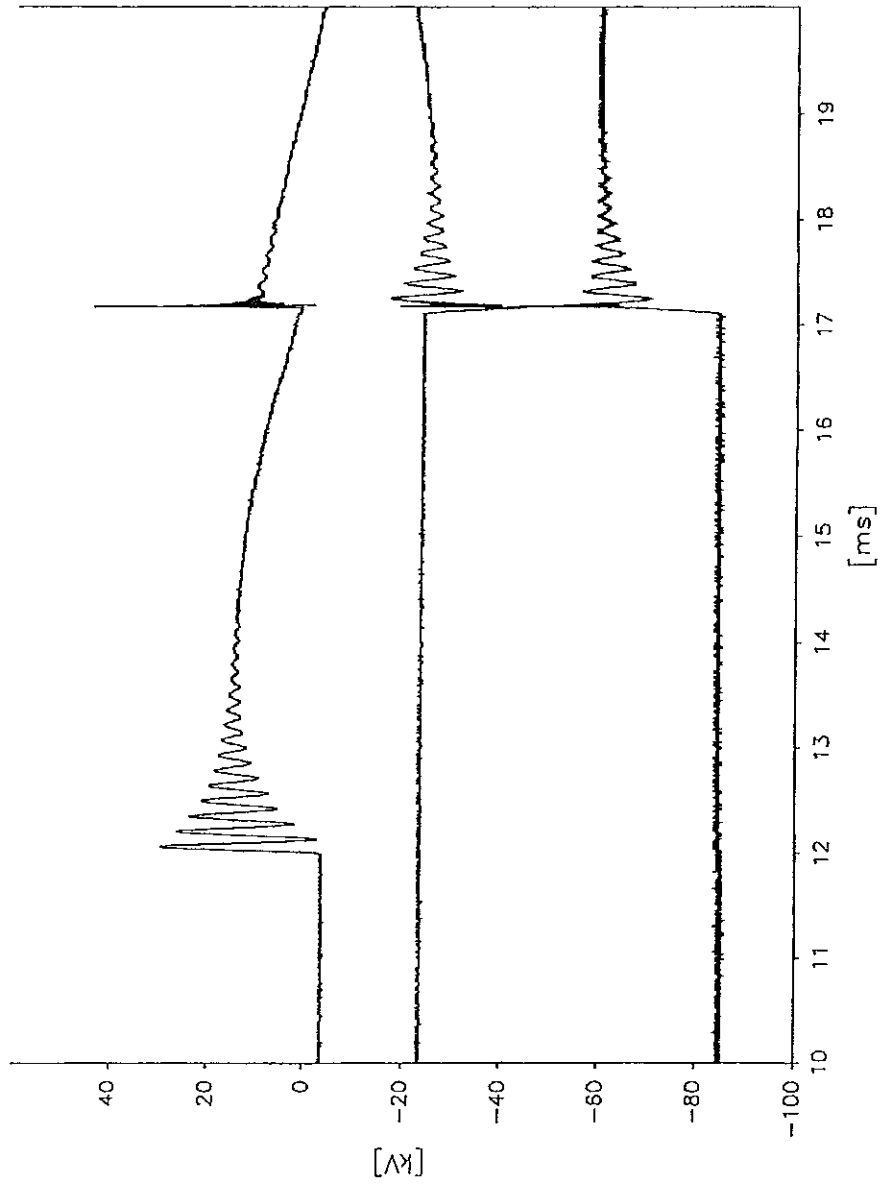
Test no.
PEHLA 0231Ra / 11



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Test no.
PEHLA 0231Ra / 11
Transient Recovery Voltage



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Short-Circuit Making and Breaking Tests

Circuit-breaker

Test duty: T100a
Date of test: 19th December 2002
Condition of test object before test: As after test PEHLA 0231Ra / 11.
Connections to test object: By means of copper bars to the upper terminals of the circuit-breaker. Lower terminals of the circuit-breaker short-circuited and earthed.
Arc extinguishing medium: Vacuum

Test No. PEHLA 0231Ra		21	22	23	24
Operating sequence		O	O	O	O
Applied voltage		kV	-	-	-
Short-circuit making current		L1	-	-	-
		kA L2	-	-	-
		L3	-	-	-
Short-circuit breaking current	Short-circuit current	kA L1	33.0	32.6	32.3
		L2	33.2	33.7	33.5
		L3	33.7	33.1	33.0
	Average value	kA	33.3	33.1	33.0
d.c. component	%	L1	< 20	24.7	23.7
		L2	30.3	< 20	< 20
		L3	26.6	27.9	26.7
Δt1	ms	L1	-	-	-
		L2	12.3	-	-
		L3	-	12.0	12.0
Peak last loop	kA	L1	-	-	-
		L2	58.8	-	-
		L3	-	56.8	56.8
Recovery voltage	kV	L1	10.8	11.2	11.3
		L2	11.3	11.2	11.1
		L3	11.2	11.2	10.9
Average value (phase-to-phase)		kV -	19.2	19.4	19.2
Transient Recovery Voltage (TRV), first-pole-to-clear		kV	34.1	31.3	31.7
Arcing time	ms	L1	5.4	2.2	12.5
		L2	10.1	7.0	12.9
		L3	10.9	7.2	8.4
Opening time		ms	43.2	42.8	43.1
Result			P	P	P

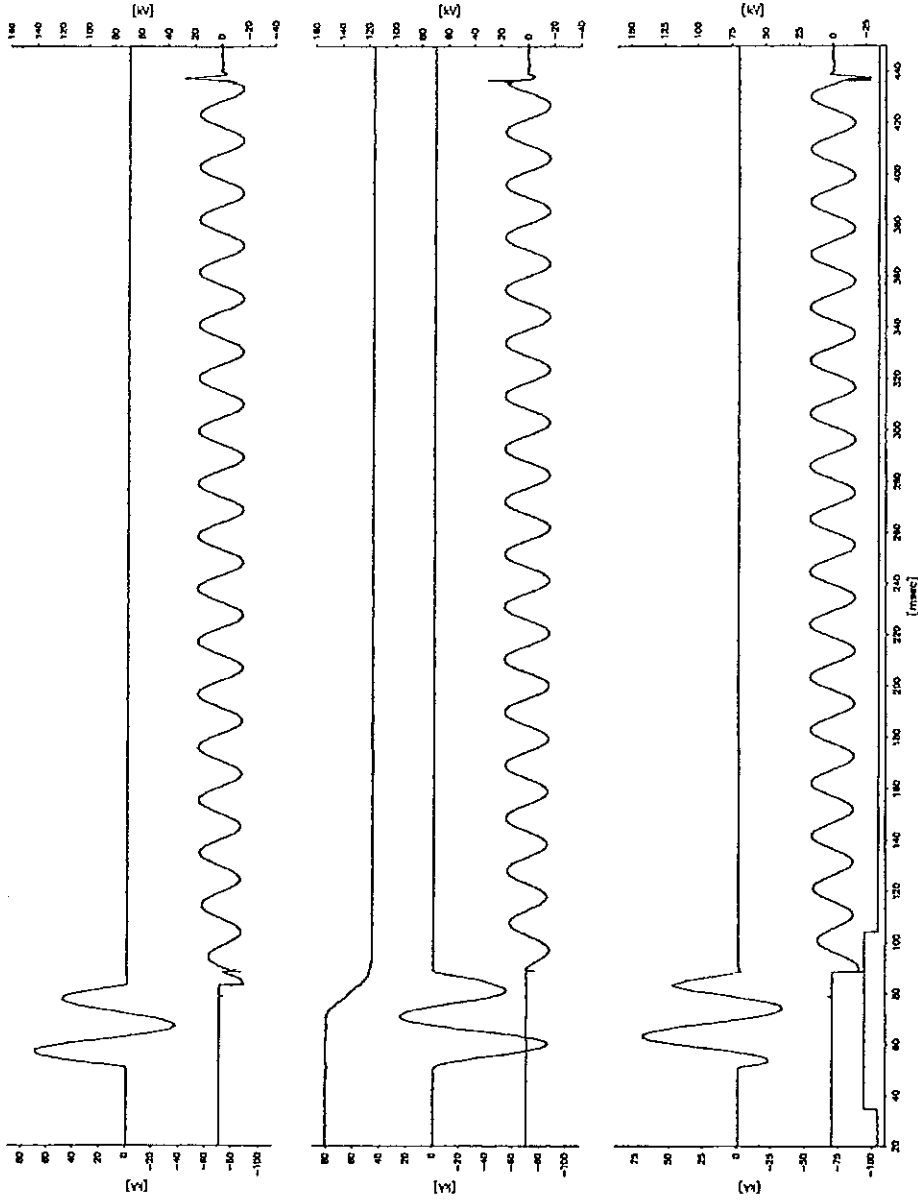
Legend: P: Positive, breaker cleared or breaker closed and cleared N: Negative, breaker failed

Remarks:

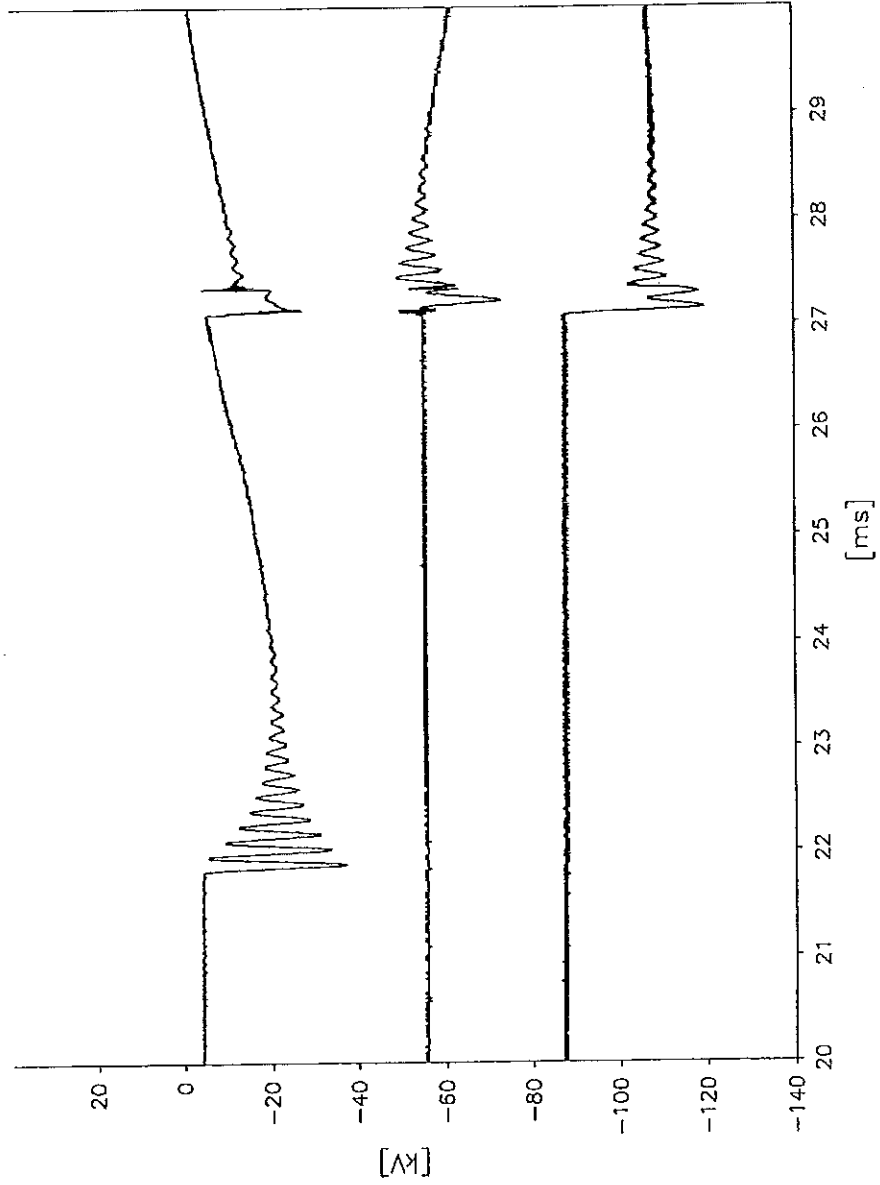
PEHLA 0231Ra / 12 to 16: Tests with reduced values
 PEHLA 0231Ra / 17 to 20: Tests for determination of prospective dc components
 PEHLA 0231Ra / 21 to 24: The operating devices are supplied at their maximum voltage

Condition of test object after test: Circuit-breaker without functional or visible change.

Test no.
PEHLA 0231Ra / 21



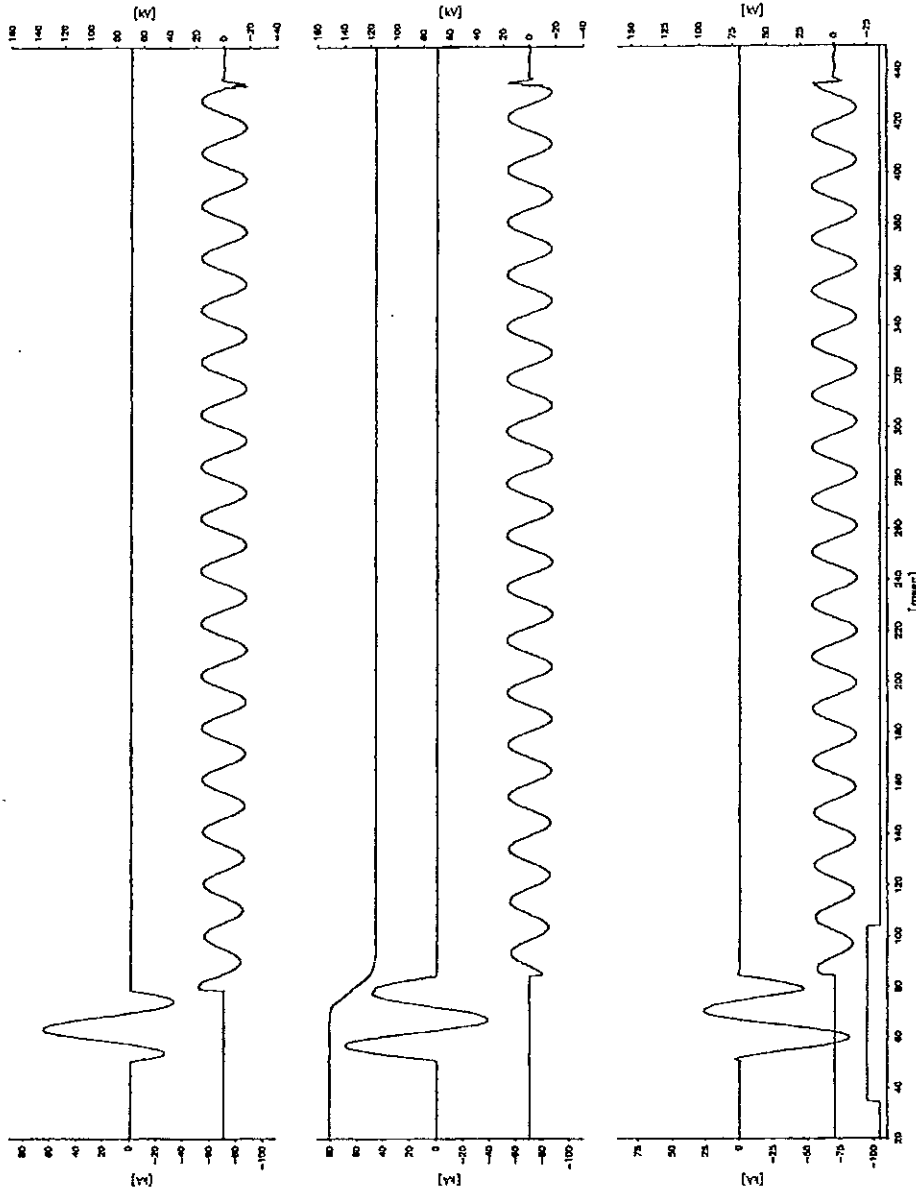
Test no.
PEHLA 0231Ra / 21
Transient Recovery Voltage



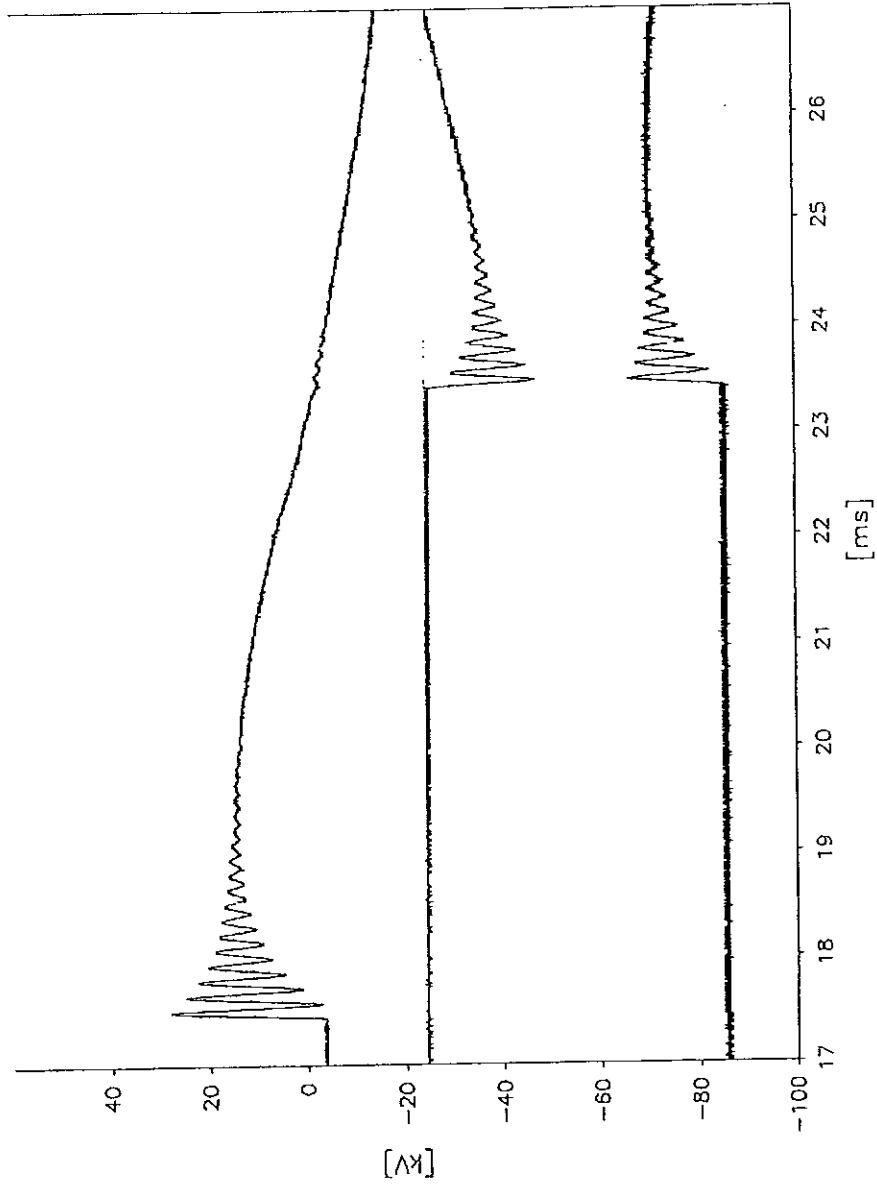
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Test no.
PEHLA 0231Ra / 22



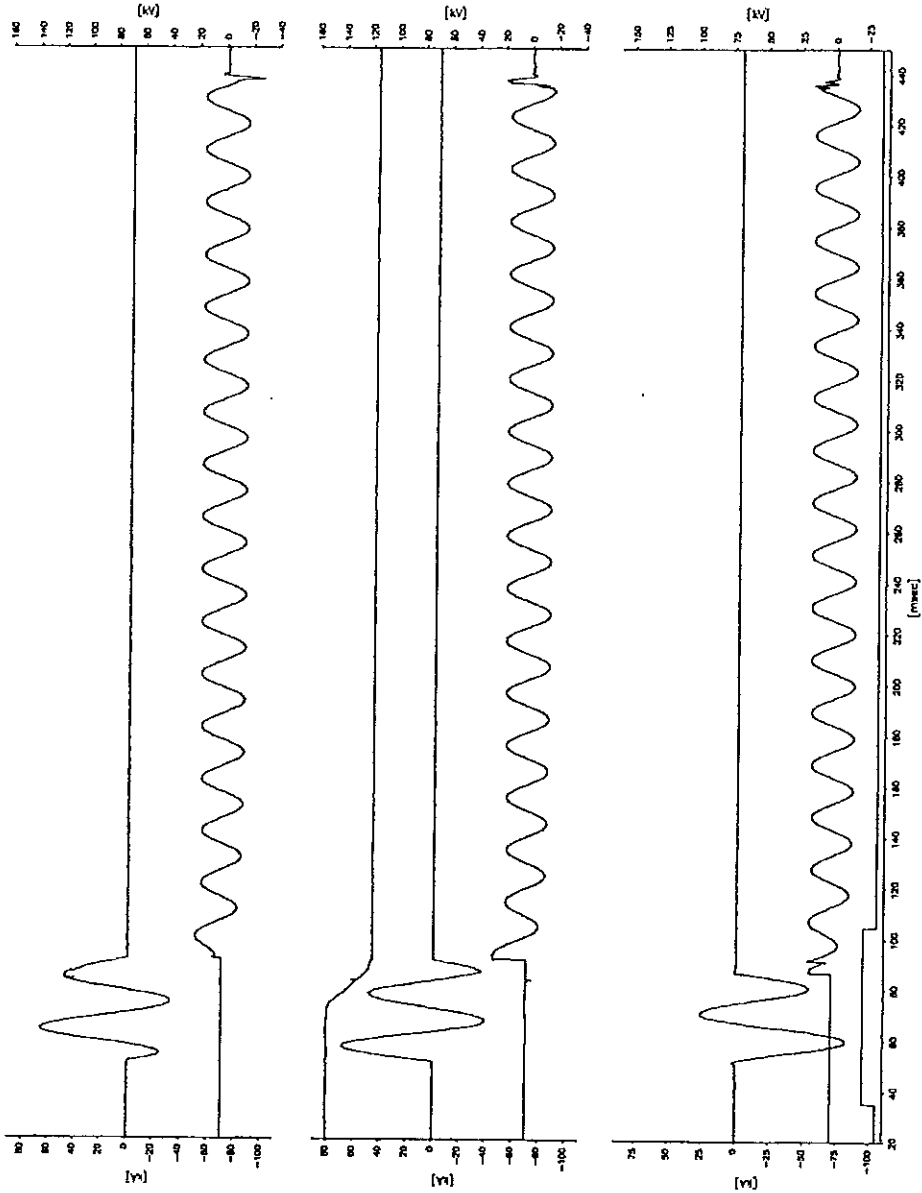
Test no.
PEHLA 0231Ra / 22
Transient Recovery Voltage



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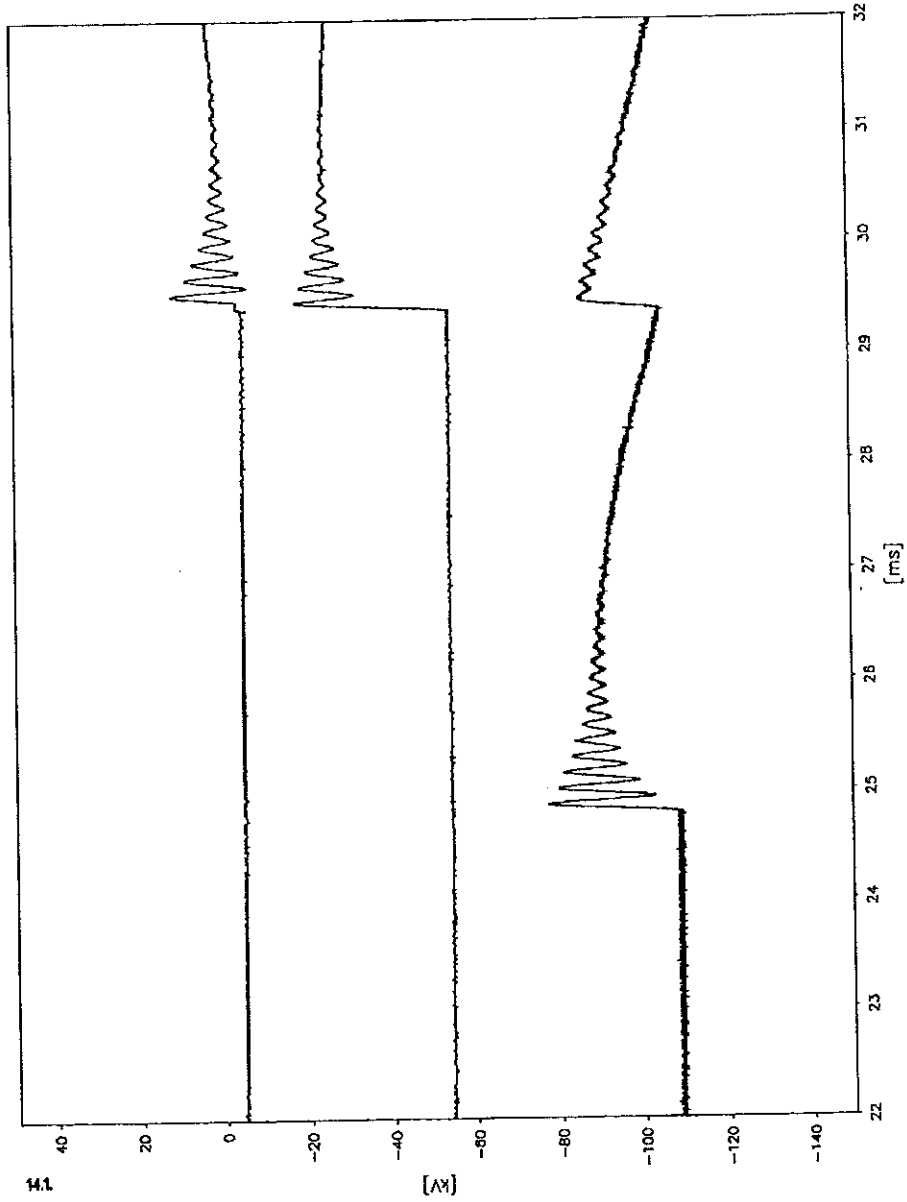
Test no.
PEHLA 0231Ra / 23



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Test no.
PEHLA 0231Ra / 23
Transient Recovery Voltage





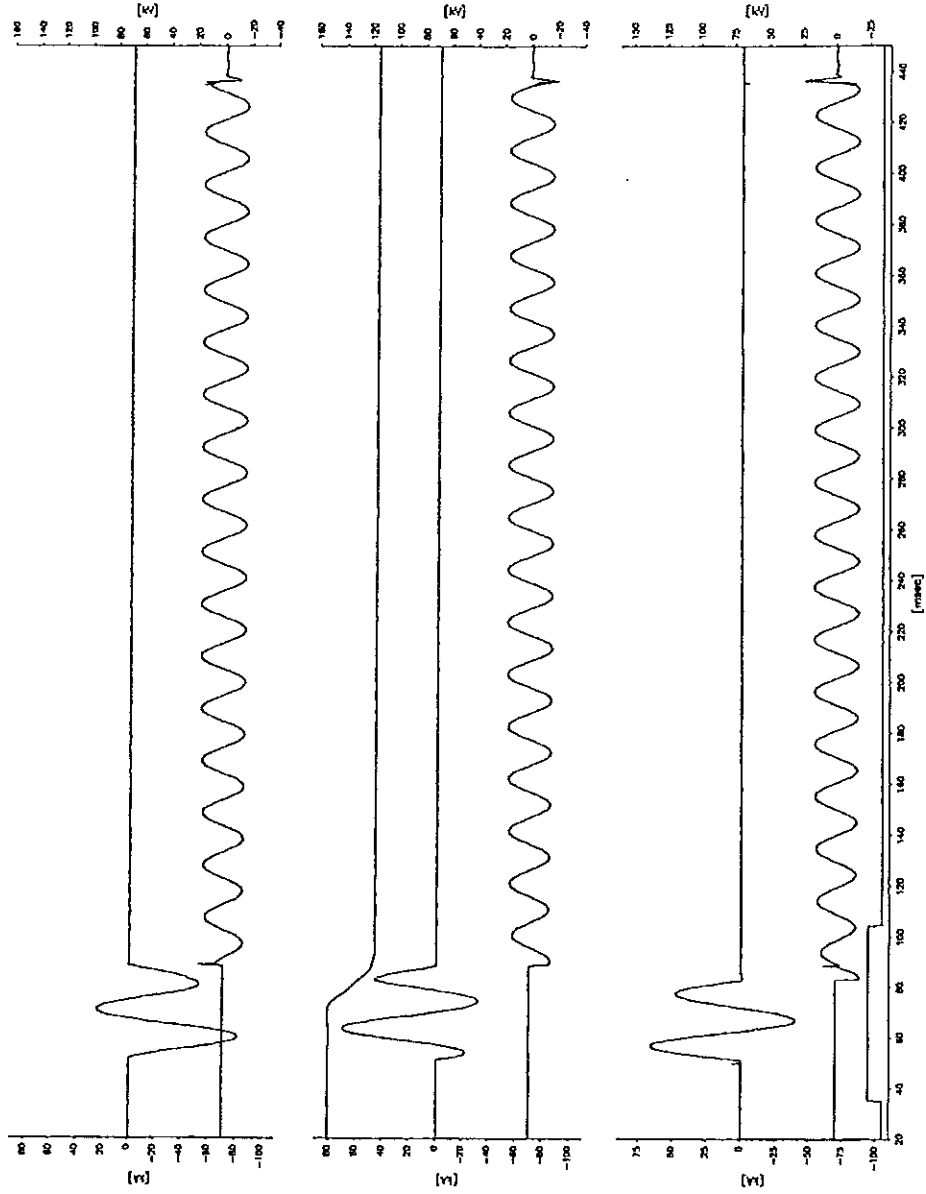
PEHLA

GESELLSCHAFT FÜR ELEKTRISCHE HOCHLEISTUNGSPRÜFUNGEN

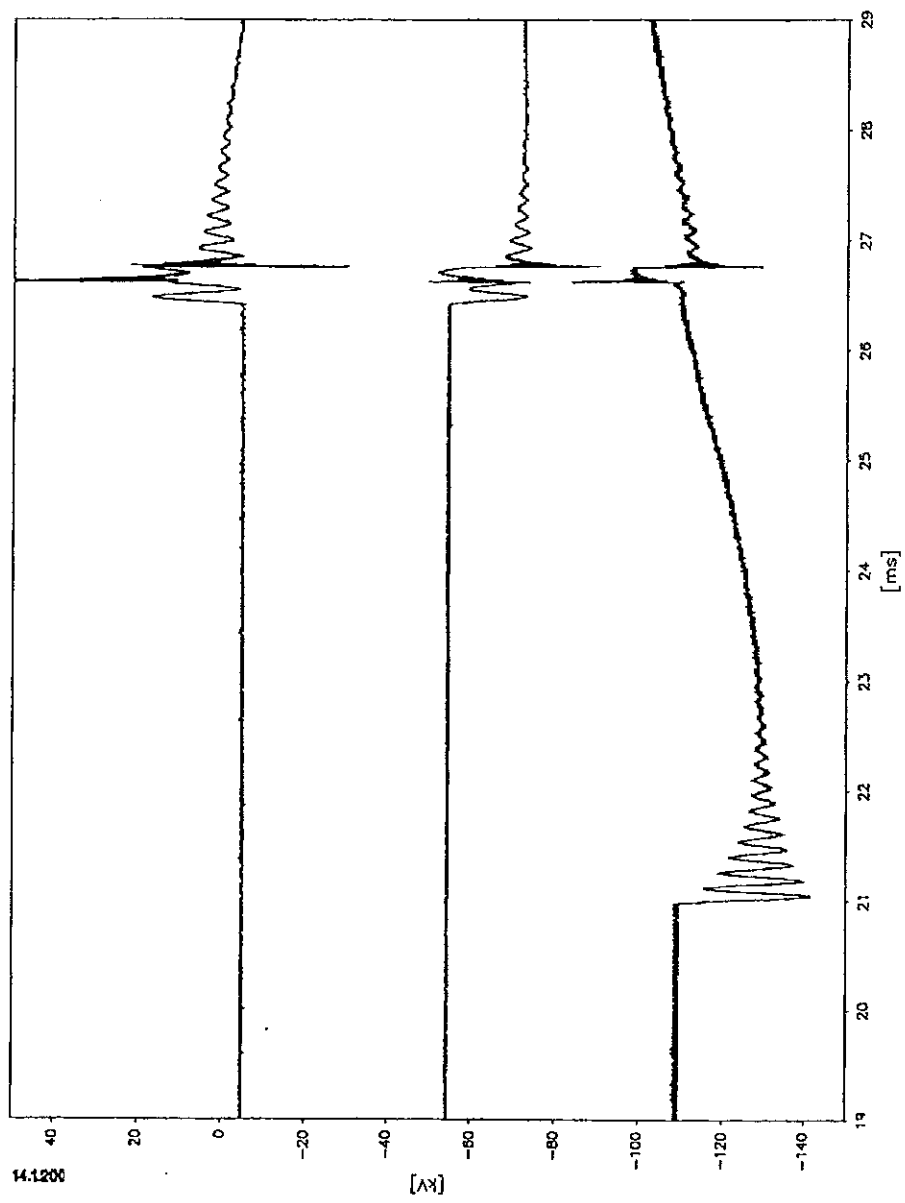
Report No.: 0231Ra

Sheet: 37

Test no.
PEHLA 0231Ra / 24



Test no.
PEHLA 0231Ra / 24
Transient Recovery Voltage



Short-Circuit Making and Breaking Tests

Circuit-breaker

Test duty: T10
Date of test: 19th December 2002
Condition of test object before test: As after test no. PEHLA 0231Ra / 24.
Connections to test object: By means of copper bars to the upper terminals of the circuit-breaker. Lower terminals of the circuit-breaker short-circuited and earthed.
Arc extinguishing medium: Vacuum

Test No. PEHLA 0231Ra		25		26	27
Operating sequence		O - 0.3s - CO - 3min - CO - 5min - CO			
Applied voltage	kV	-	18.6	17.0	17.7
Short-circuit making current	L1	-	8.50	7.20	6.60
	kA L2	-	6.80	5.50	6.90
	L3	-	6.20	8.10	8.40
Short-circuit breaking current	Short-circuit current	kA L1	3.42	3.47	3.48
		L2	3.35	3.46	3.40
		L3	3.40	3.46	3.37
	Average value	kA	3.39	3.46	3.41
d.c. component	%	L1	< 20	< 20	< 20
		L2	< 20	< 20	< 20
		L3	< 20	< 20	< 20
Recovery voltage	kV	L1	10.8	9.92	10.9
		L2	10.7	9.80	10.7
		L3	10.8	10.6	10.8
Average value (phase-to-phase)	kV	18.7	17.5	18.7	17.8
Transient Recovery Voltage (TRV), first-pole-to-clear	kV	-	-	-	-
Arcing time	ms	L1	3.2	6.0	7.4
		L2	7.4	2.0	7.0
		L3	8.2	6.0	2.6
Closing time	ms	-	66.9	66.8	66.0
Opening time	ms	60.5	63.5	63.5	62.6
Result		P	P	P	P

Legend: P: Positive, breaker cleared or breaker closed and cleared N: Negative, breaker failed

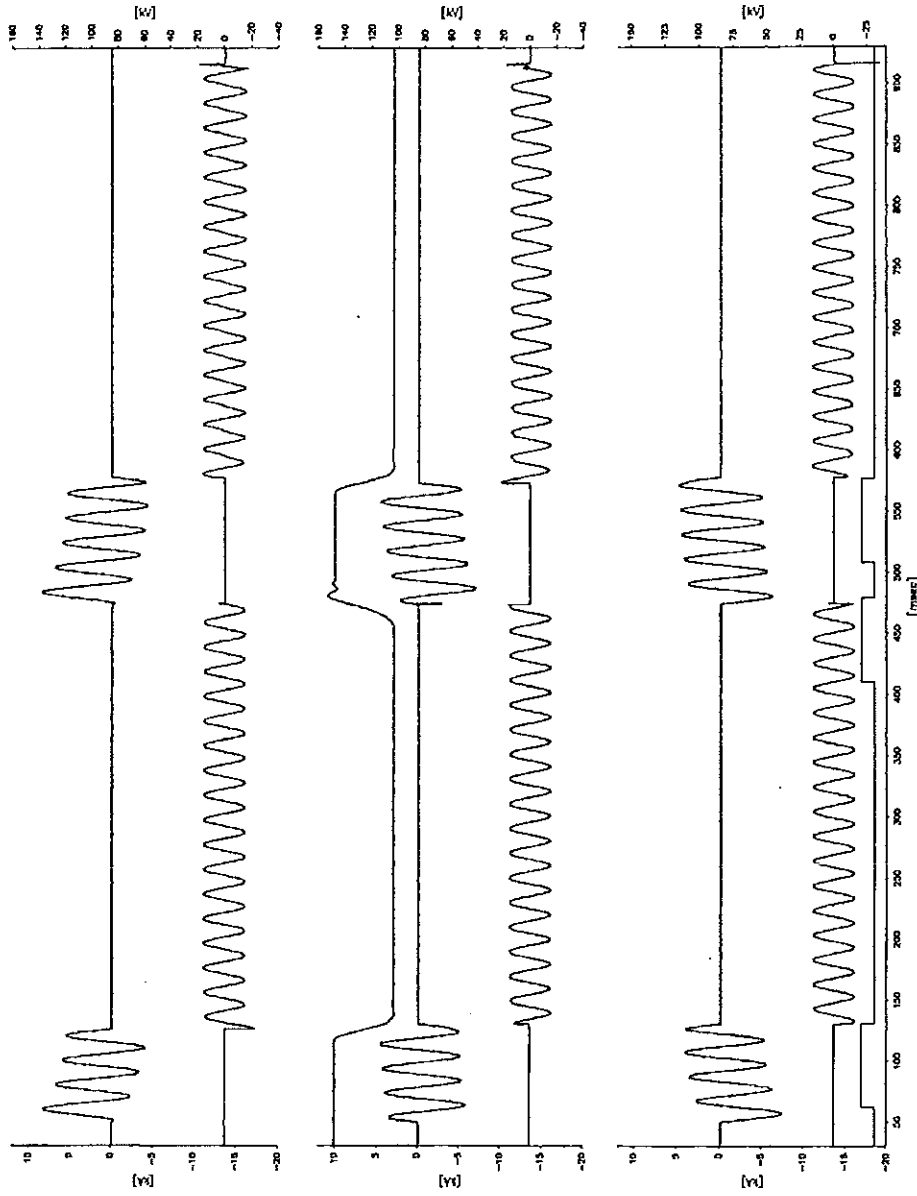
Remarks:

PEHLA 0231Ra / 25 to 27: The operating devices are supplied at their minimum voltage

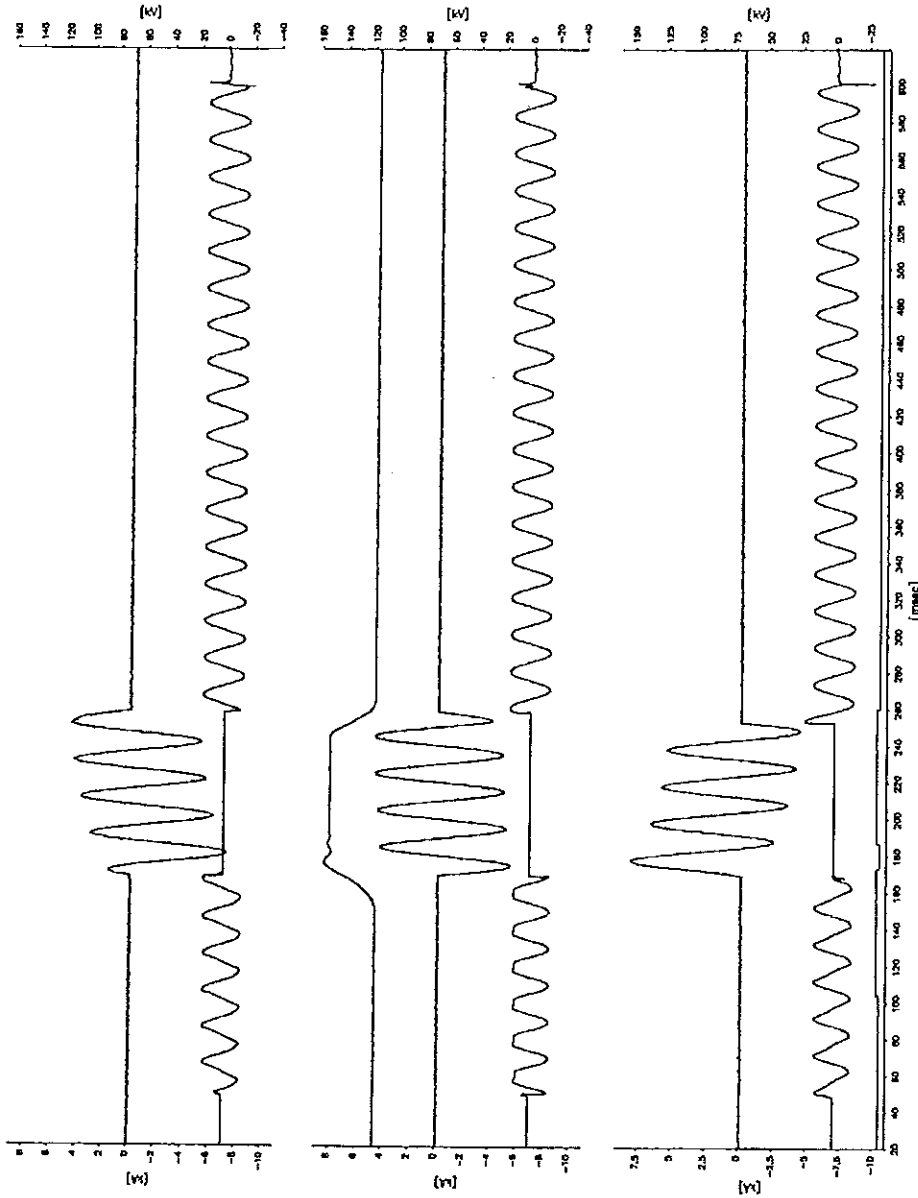
* n.e. = Due to a failure of the recorder the TRV could not be evaluated.

Condition of test object after test: Circuit-breaker and without functional or visible change.

Test no.
PEHLA 0231Ra / 25



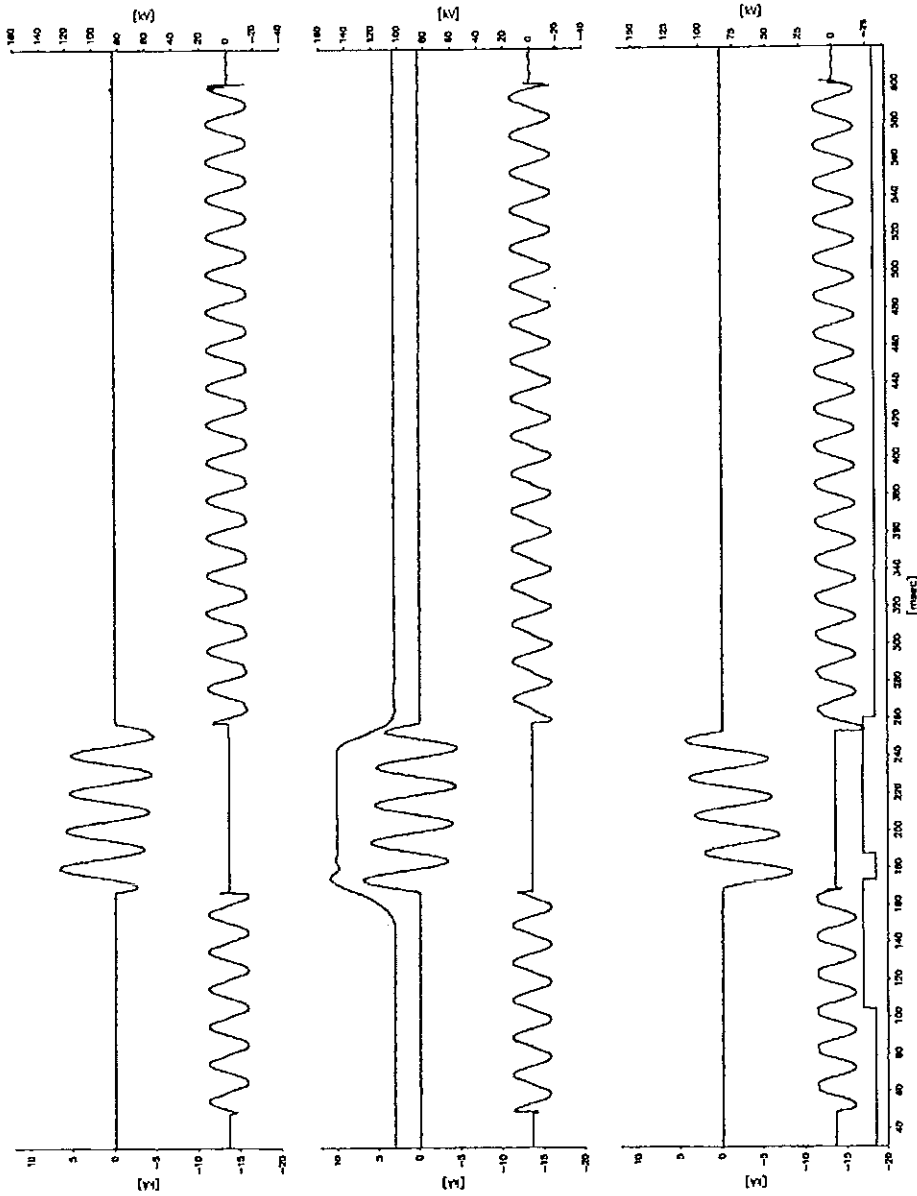
Test no.
PEHLA 0231Ra / 26



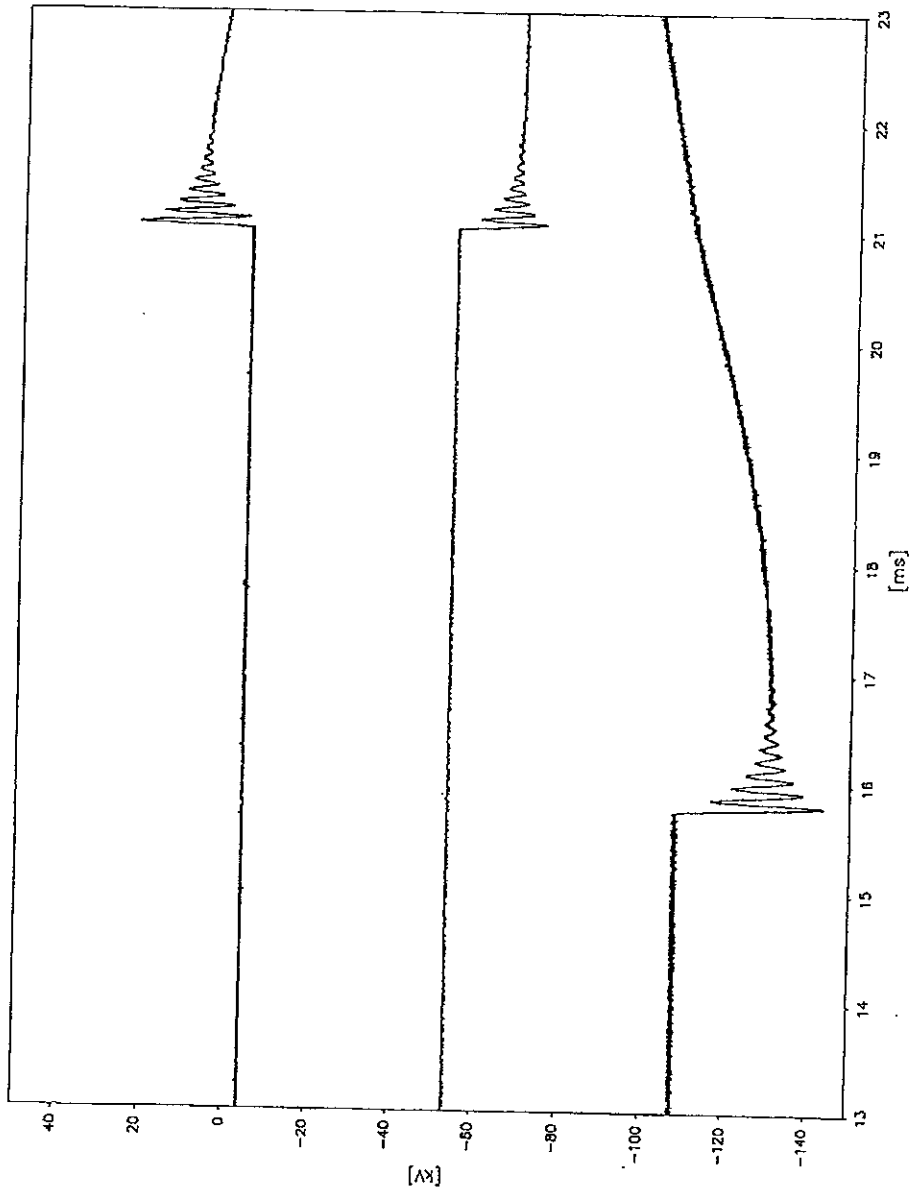
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Test no.
PEHLA 0231Ra / 27



Test no.
PEHLA 0231Ra / 27
Transient Recovery Voltage



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Short-Circuit Making and Breaking Tests

Circuit-breaker

Test duty: T30

Date of test: 19th December 2002

Condition of test object before test: As after test PEHLA 0231Ra / 27.

Connections to test object: By means of copper bars to the upper terminals of the circuit-breaker. Lower terminals of the circuit-breaker short-circuited and earthed.

Arc extinguishing medium: Vacuum

Test No. PEHLA 0231Ra		30		31	
Operating sequence		O - 0.3s - CO - 3min - CO			
Applied voltage	kV	-	18.8	17.7	
Short-circuit making current	L1	-	24.2	19.4	
	kA L2	-	18.0	19.3	
	L3	-	20.7	25.6	
Short-circuit breaking current	Short-circuit current	kA L1	9.60	9.69	9.86
		L2	9.71	9.87	9.99
		L3	9.74	9.00	9.94
	Average value	kA	9.69	9.81	9.93
d.c. component	%	L1	< 20	< 20	< 20
		L2	< 20	< 20	< 20
		L3	< 20	< 20	< 20
Recovery voltage	kV	L1	10.9	11.0	11.1
		L2	10.9	10.6	11.0
		L3	10.8	10.9	11.0
Average value (phase-to-phase)	kV	-	18.8	18.7	19.1
Transient Recovery Voltage (TRV), first-pole-to-clear	kV	-	34.4	47.3	34.4
Arcing time	ms	L1	6.2	2.0	6.6
		L2	6.6	7.0	6.4
		L3	1.6	6.8	2.4
Closing time	ms	-	64.9	66.4	
Opening time	ms	58.8	60.4	64.4	
Result		P	P	P	

Legend: P: Positive, breaker cleared or breaker closed and cleared N: Negative, breaker failed

Remarks:
 PEHLA 0231Ra / 28 and 29: Tests with reduced values
 PEHLA 0231Ra / 30 and 31: The operating devices are supplied at their minimum voltage

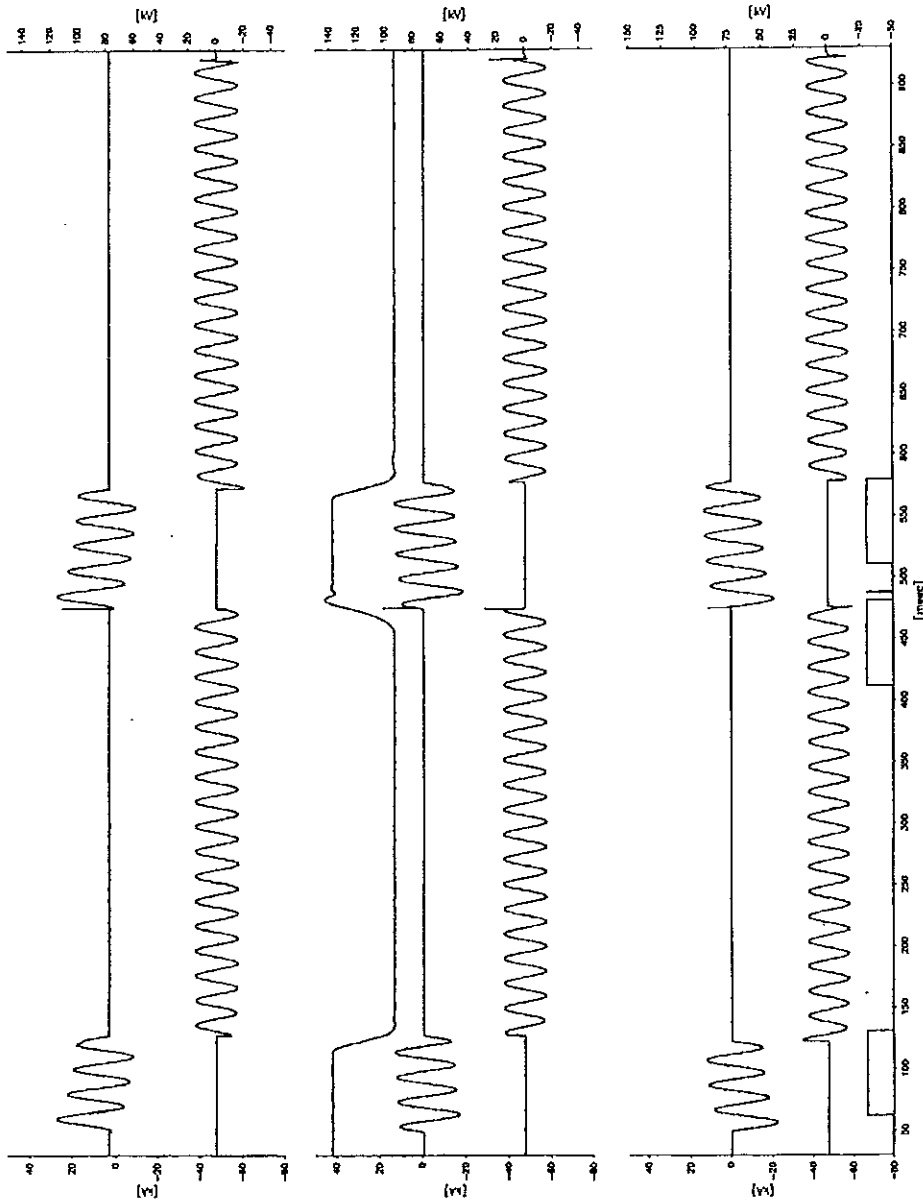
Condition of test object after test: Circuit-breaker without functional or visible change.



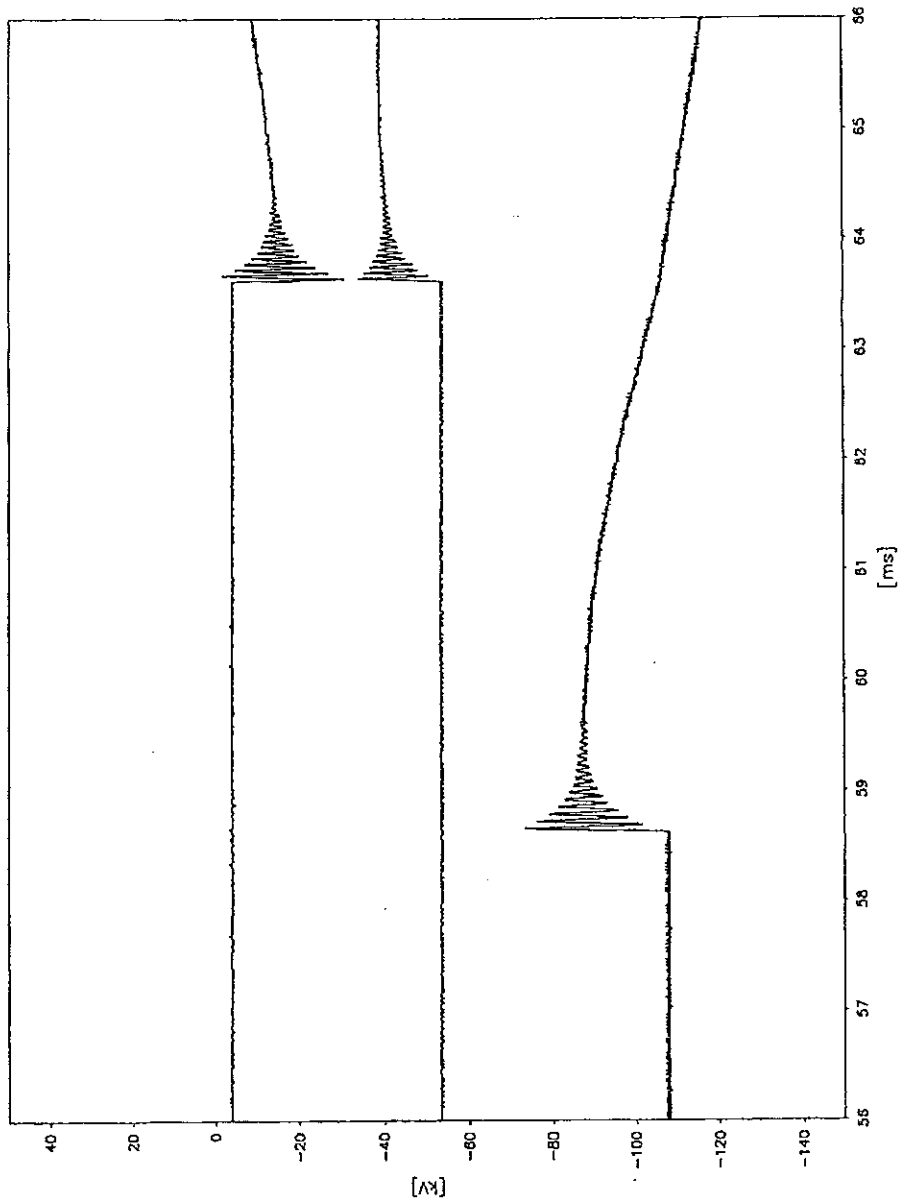

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Test no.
PEHLA 0231Ra / 30



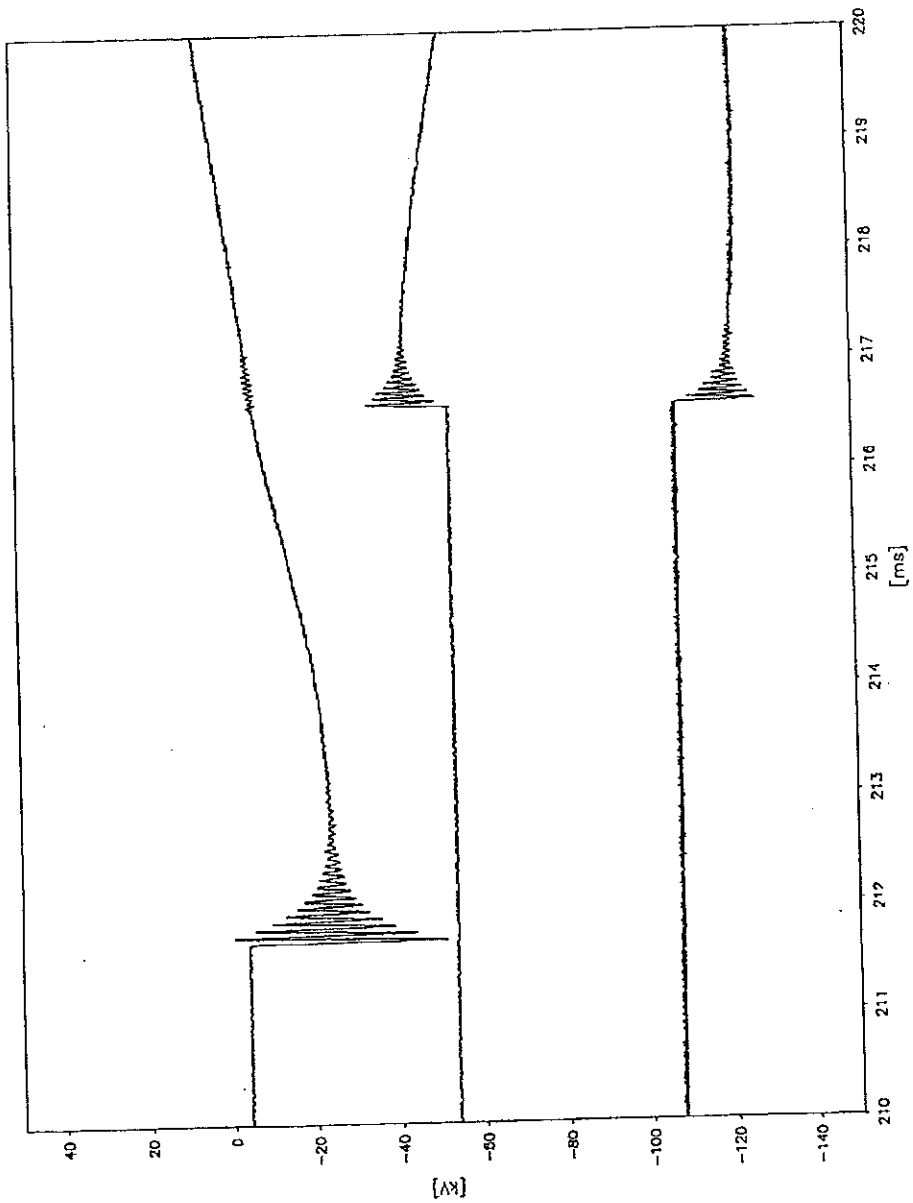
Test no.
PEHLA 0231Ra / 30
Transient Recovery Voltage, First O



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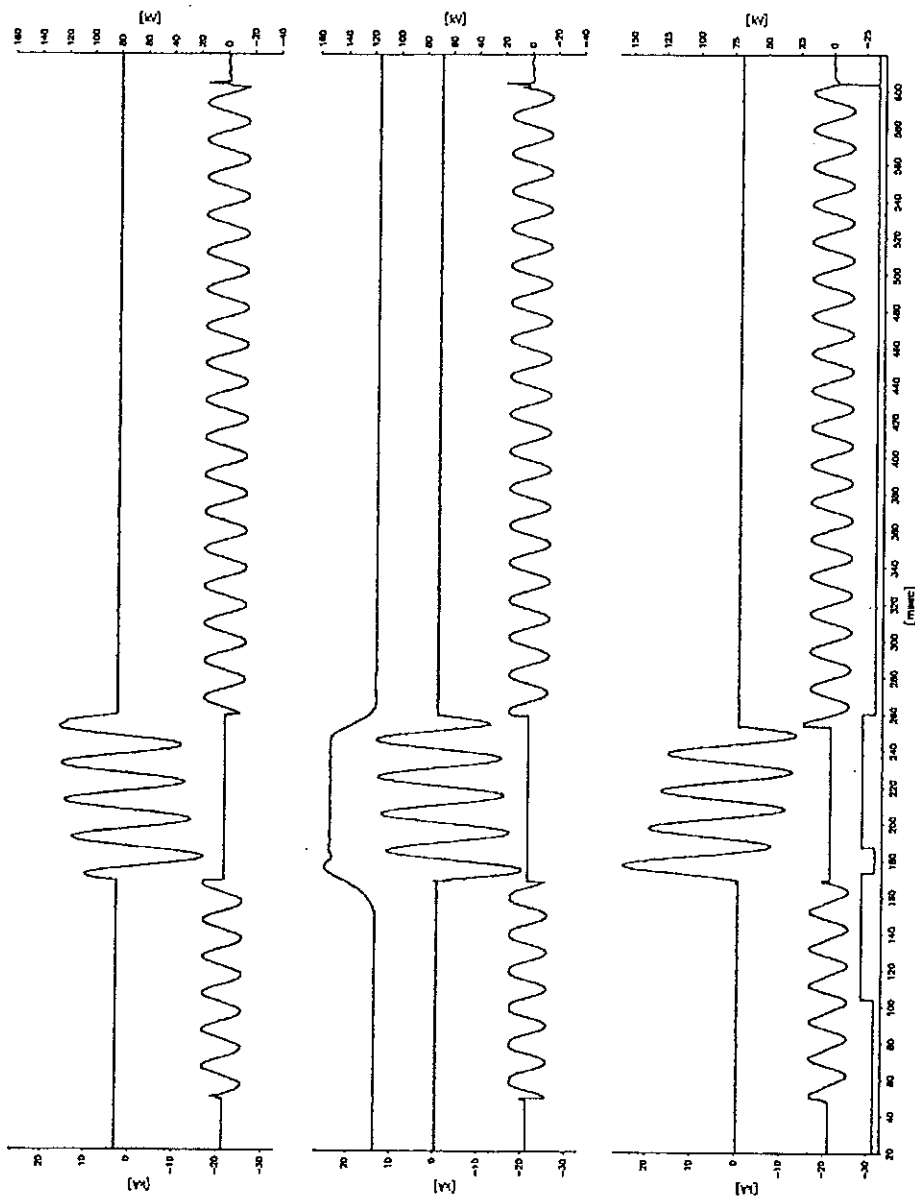
Test no.
PEHLA 0231Ra / 30
Transient Recovery Voltage, Second O

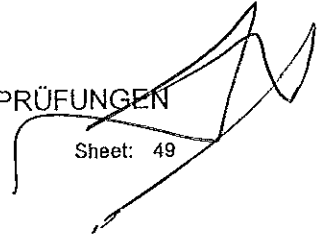


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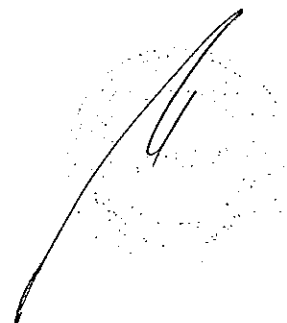
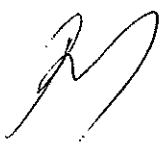
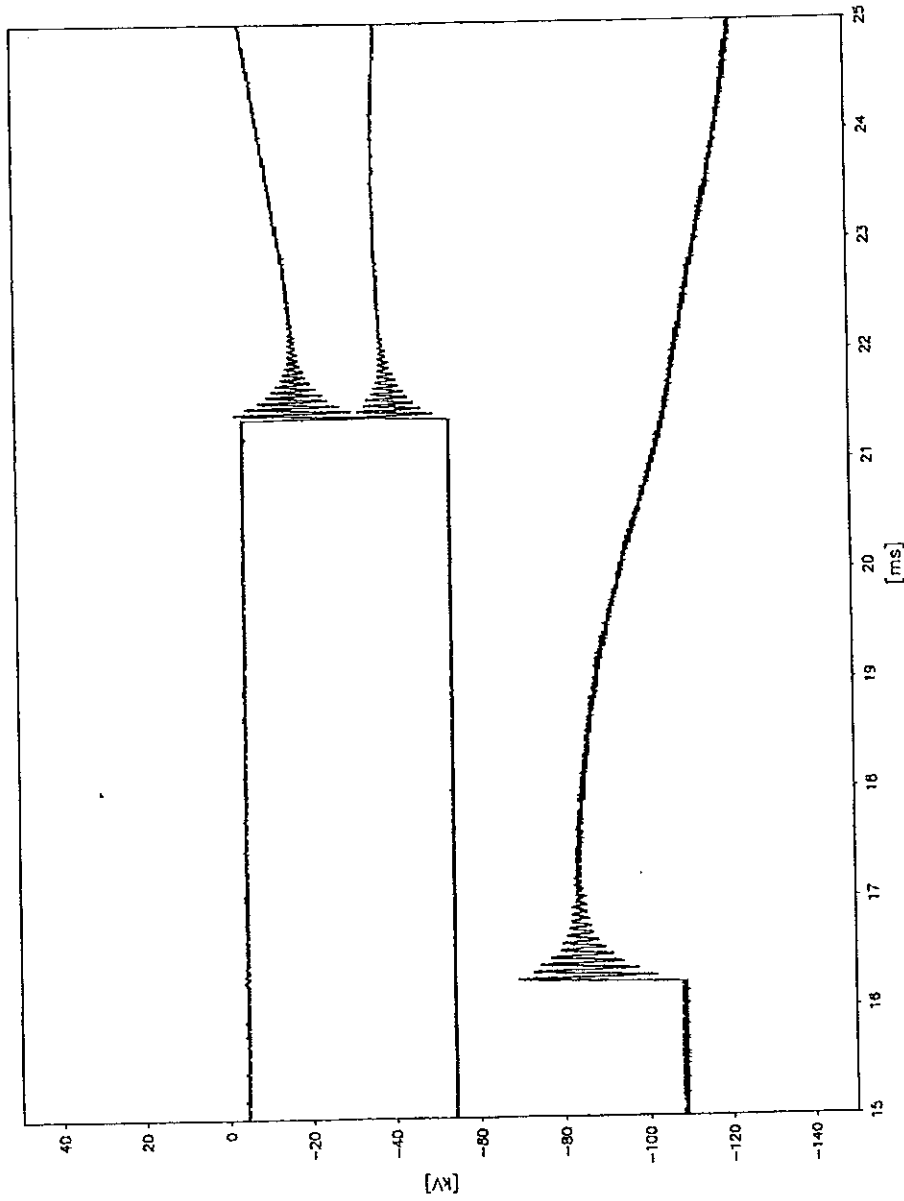
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Test no.
PEHLA 0231Ra / 31





Test no.
PEHLA 0231Ra / 31
Transient Recovery Voltage



Short-Circuit Making and Breaking Tests

Circuit-breaker

Test duty: Double earth fault test
Date of test: 19th December 2002
Condition of test object before test: As after test PEHLA 0231Ra / 31
Connections to test object: Phase L3 of the laboratory by means of a copper bar to the upper terminal of phase L3 of the circuit-breaker, lower terminal of phase L3 of the circuit-breaker connected to phase L1 of the laboratory.
Arc extinguishing medium: Vacuum

Test No. PEHLA 0231Ra		35	-	-
Operating sequence		0	-	-
Applied voltage	kV	-	-	-
Short-circuit making current	L1	-	-	-
	kA L2	-	-	-
	L3	-	-	-
Short-circuit breaking current	Short-circuit current	L1	-	-
		kA L2	-	-
		L3	28.8	-
	Average value	kA	-	-
d.c. component	%	L1	-	-
		L2	-	-
		L3	< 20	-
Recovery voltage	kV	L1	-	-
		L2	-	-
		L3	-	-
Average value (phase-to-phase)	kV	18.5	-	-
Transient Recovery Voltage (TRV), first-pole-to-clear	kV	32.9	-	-
Arcing time	L1	-	-	-
	ms L2	-	-	-
	L3	9.4	-	-
Opening time	ms	44.6	-	-
Result		P	-	-

Legend: P: Positive, breaker cleared or breaker closed and cleared N: Negative, breaker failed

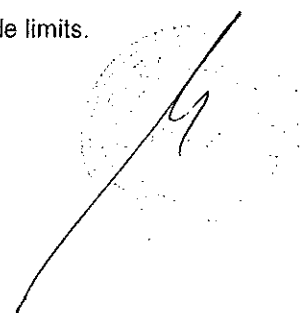
Remarks:

PEHLA 0231Ra / 32: No-load operations
 PEHLA 0231Ra / 33 and 34: Tests with reduced values
 PEHLA 0231Ra / 35: The operating devices are supplied at their maximum voltage
 PEHLA 0231Ra / 36: No-load operations

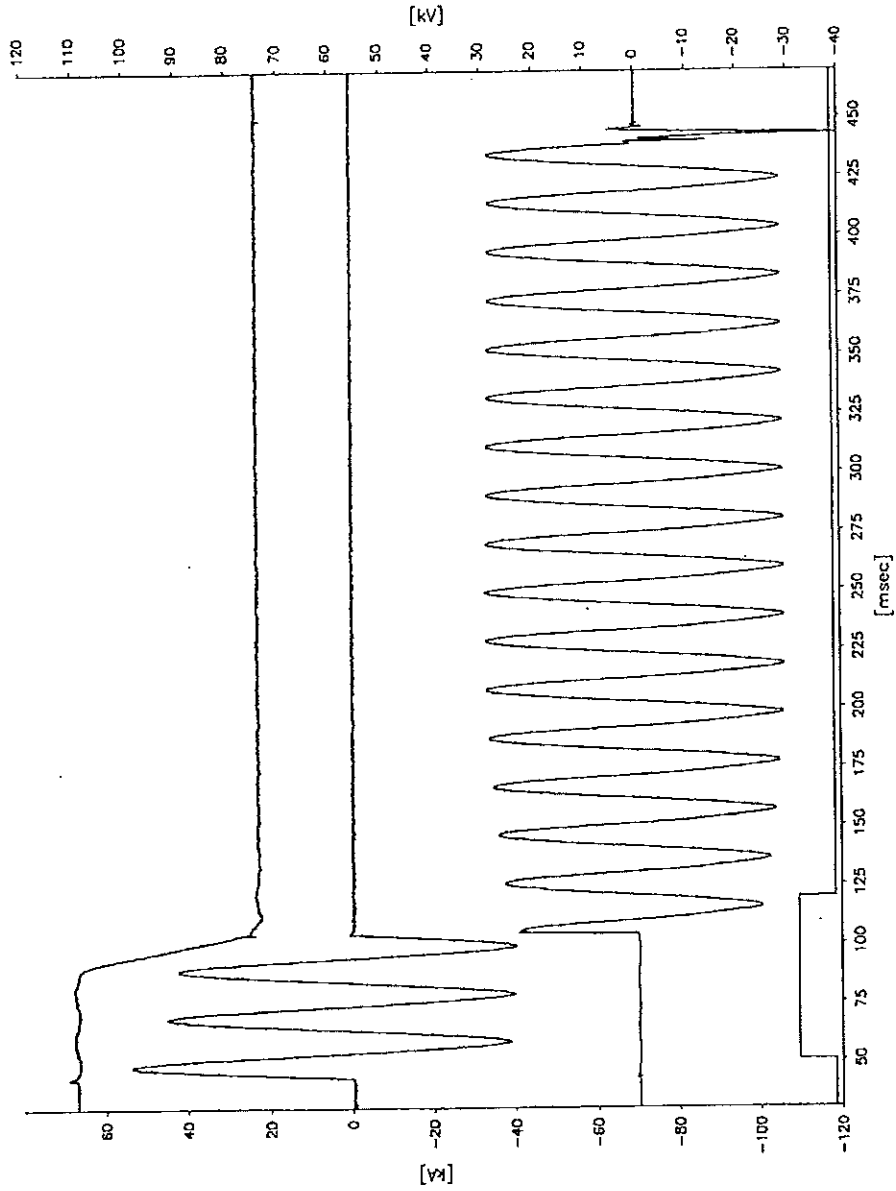
Condition of test object after test: Circuit-breaker without functional or visible change.

Power frequency withstand voltage test at 38 kV – 1 min passed.

The deviations from the reference mechanical travel characteristic are in the allowable limits.

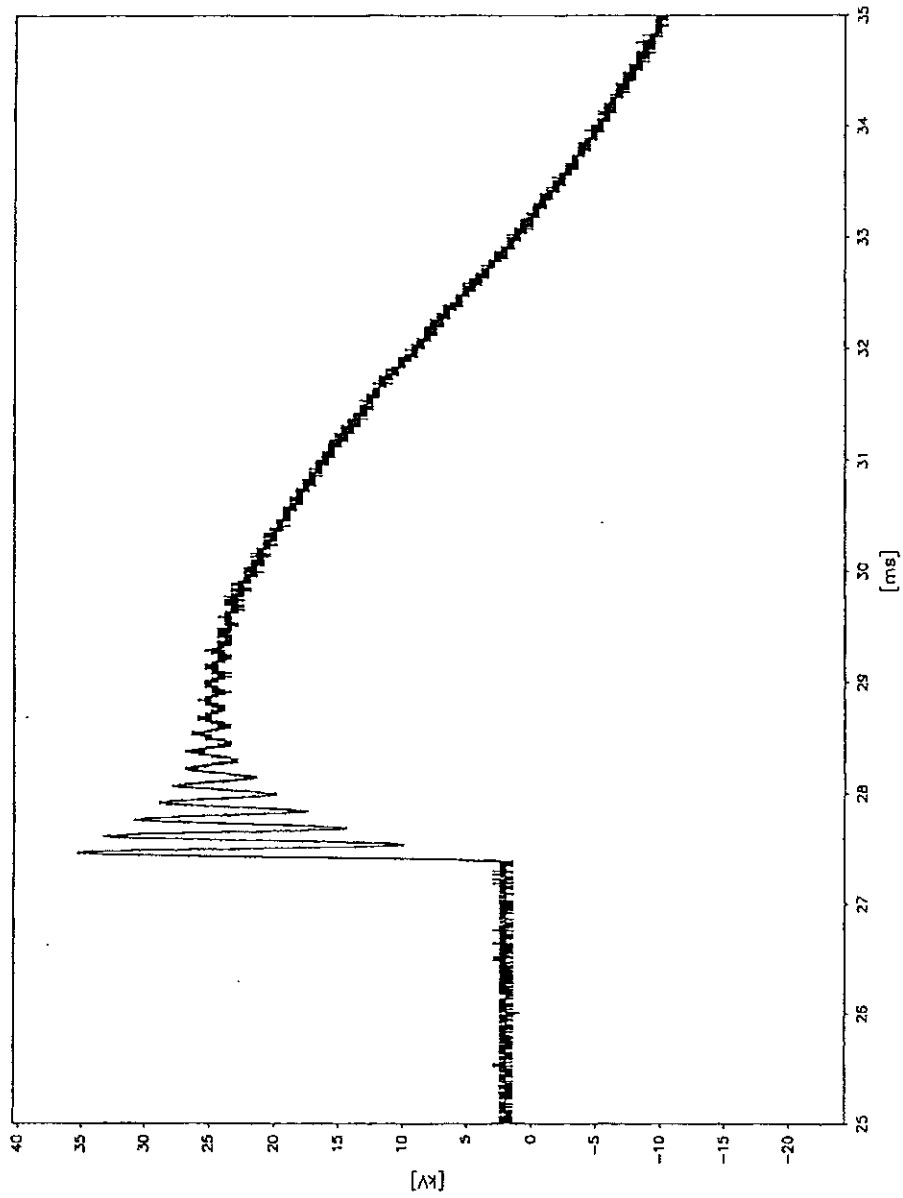
Test no.
PEHLA 0231Ra / 35



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Test no.
PEHLA 0231Ra / 35
Transient Recovery Voltage



Actual Values of No-load Operations

Rated supply voltage of closing coil 220 V DC
Rated supply voltage of opening coil 220 V DC

	Operation	Voltage closing coil V	Closing time ms	Voltage opening coil V	Opening time ms
Before basic short-circuit test duties					
Test 0231Ra / 002	O-	--	--	220	44.5
	CO	220	58.5	220	45.0
Test 0231Ra / 02A	O-	--	--	154	62.4
	CO	187	63.1	154	62.4
Test 0231Ra / 02B	O-	--	--	242	41.8
	CO	242	56.8	242	42.1
After double earth fault test					
Test 0231Ra / 036	O-	--	--	220	43.3
	CO	220	60.1	220	44.3
Test 0231Ra / 36A	O-	--	--	154	60.7
	CO	187	64.7	154	60.5
Test 0231Ra / 036	O-	--	--	242	41.9
	CO	242	57.7	242	42.1

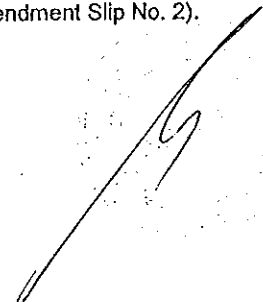
Measurement of the Resistance

Ambient air temperature: $\approx 18^\circ\text{C}$

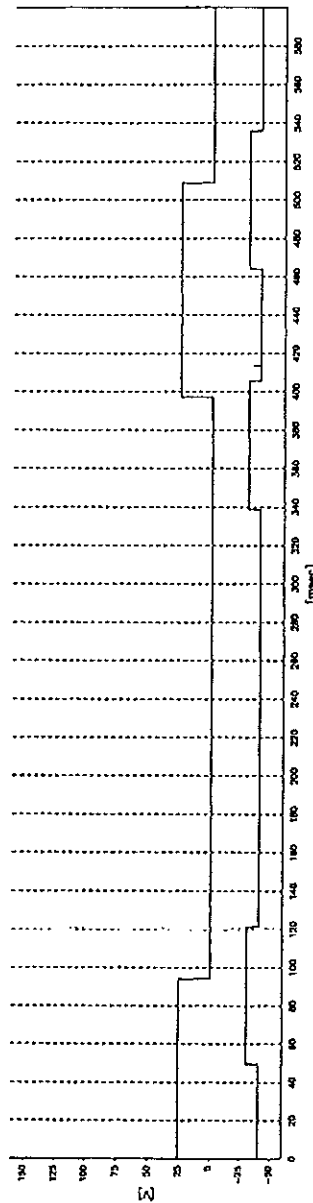
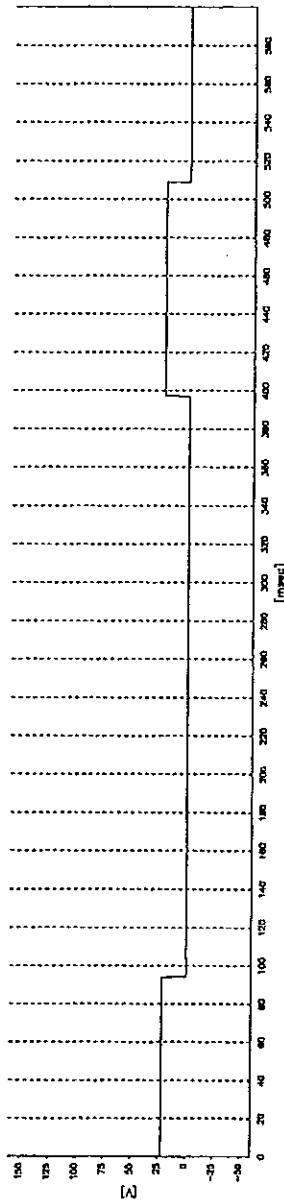
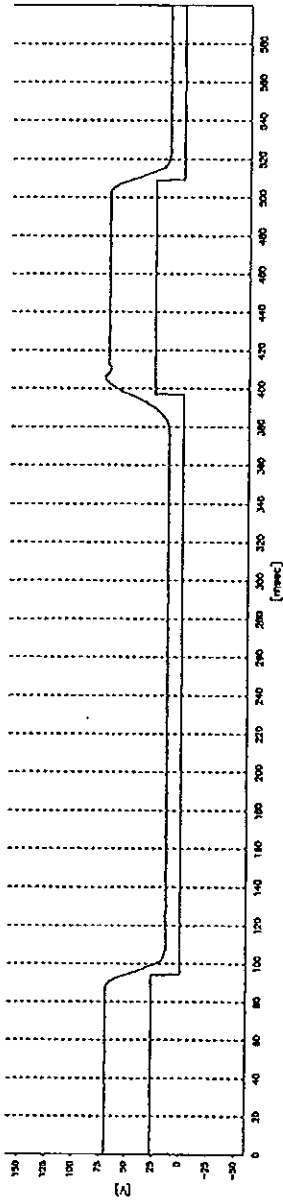
	Resistance of the pole parts $\mu\Omega$		
	L1	L2	L3
Before test 0231Ra / 002	14.9	15.0	15.7
After test 0231Ra / 036	19.6	21.4	22.9

(The resistance values fulfil the requirements of STL-Guide to IEC56: 4th Edition: 1987, Amendment Slip No. 2).

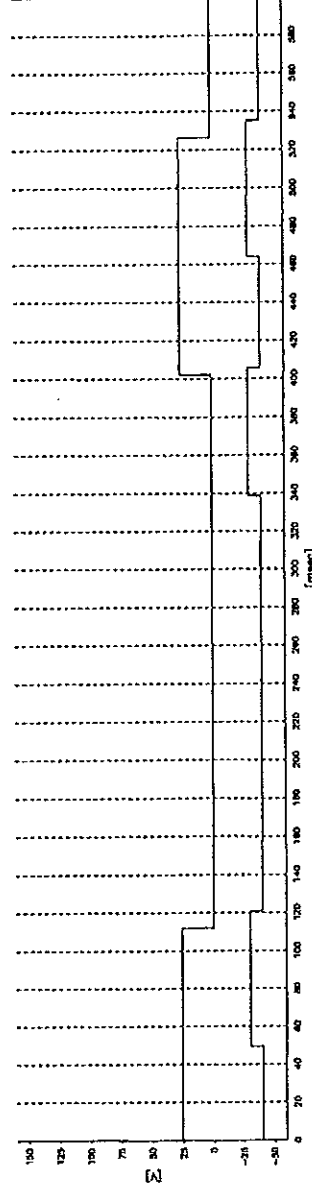
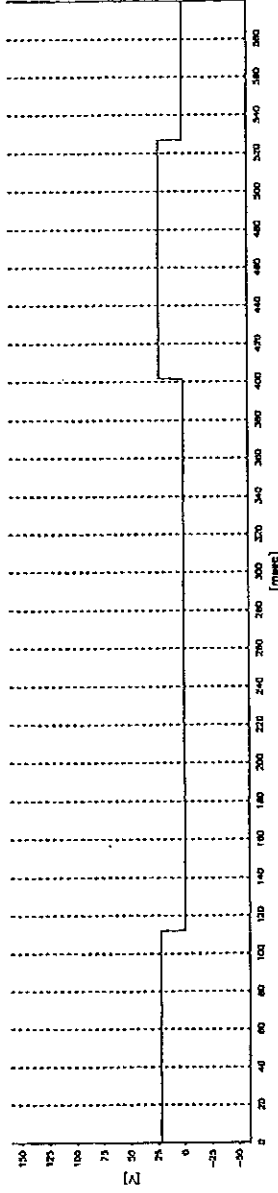
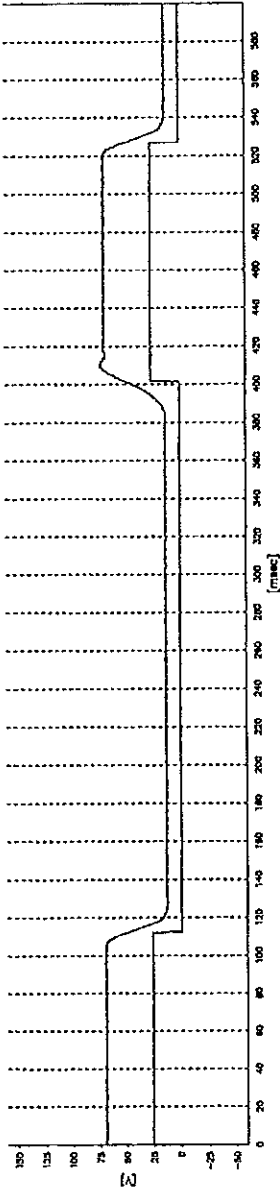
Remarks:
Resistance measurement at direct current of: 50 A

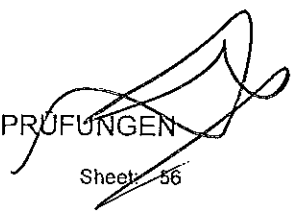



Test no.
PEHLA 0231Ra / 02

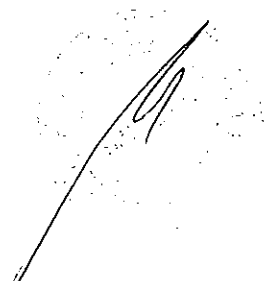
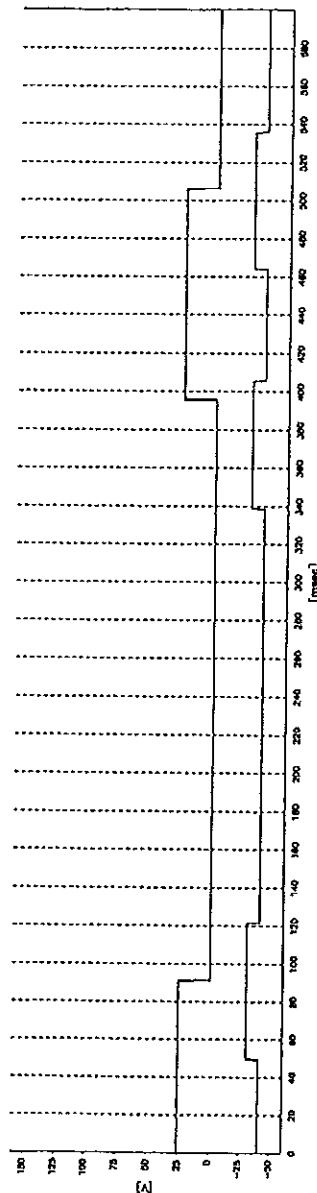
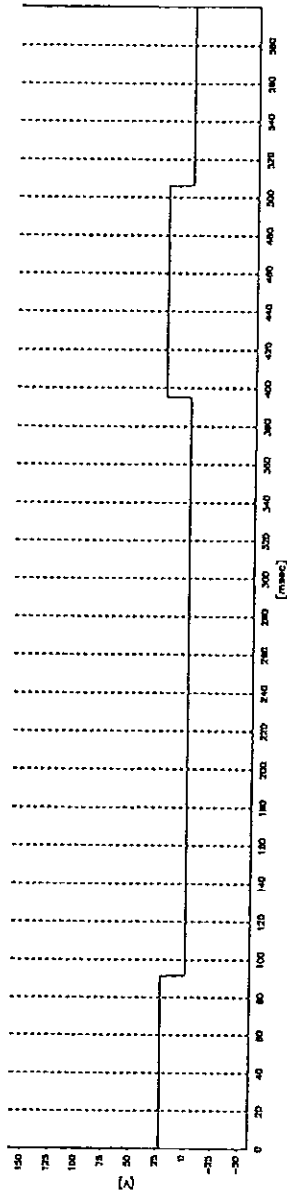
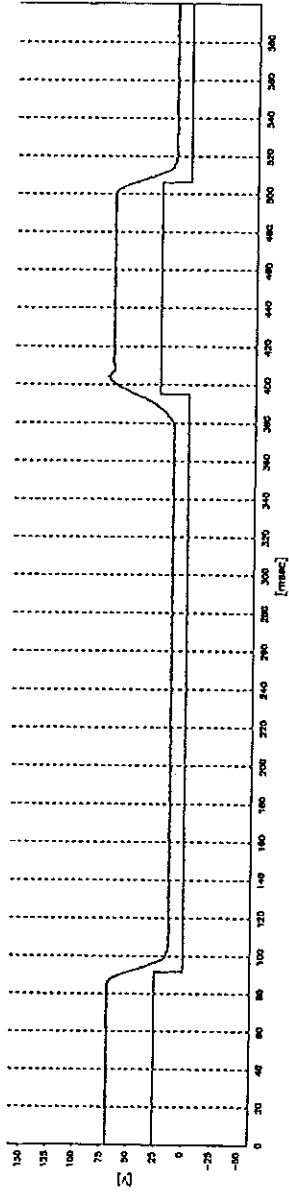


Test no.
PEHLA 0231Ra / 02A

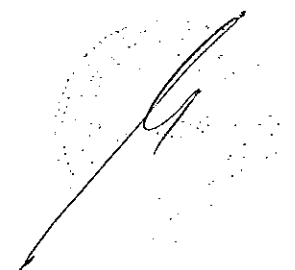
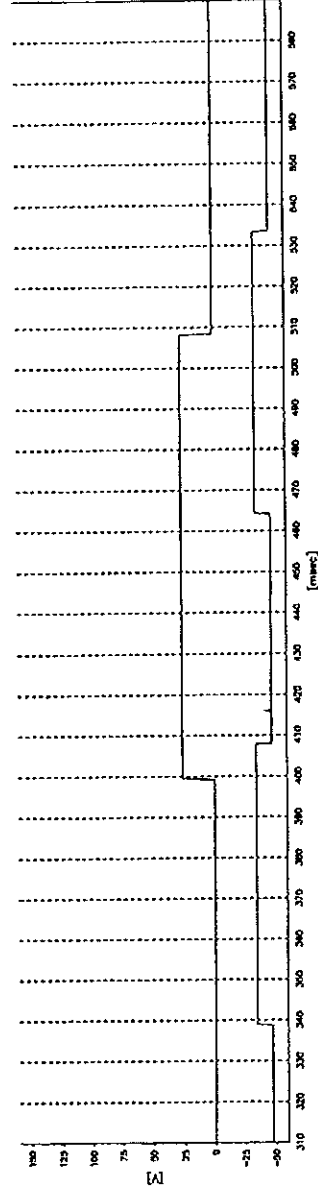
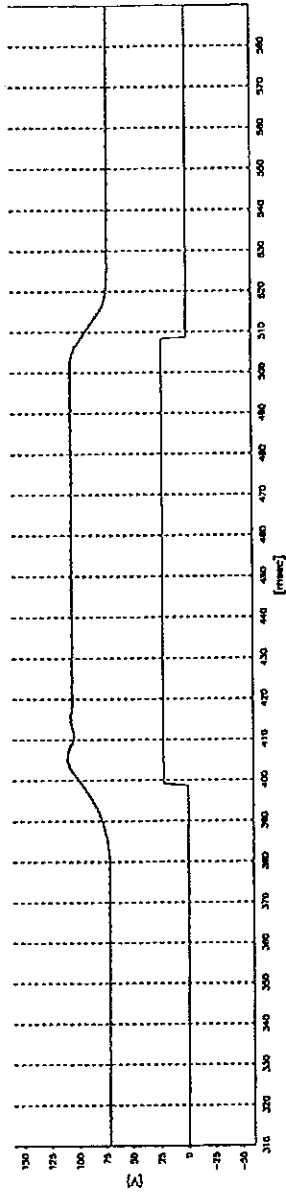
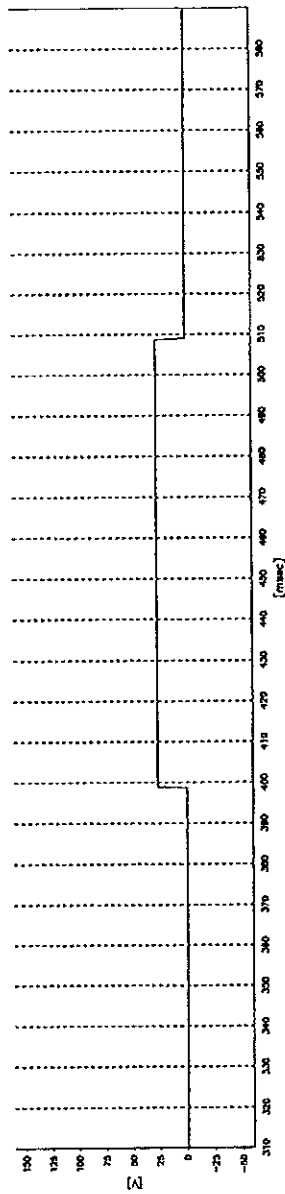




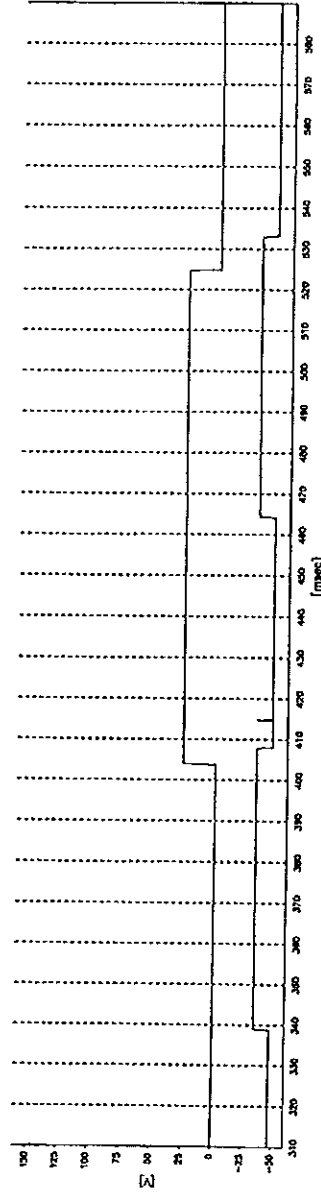
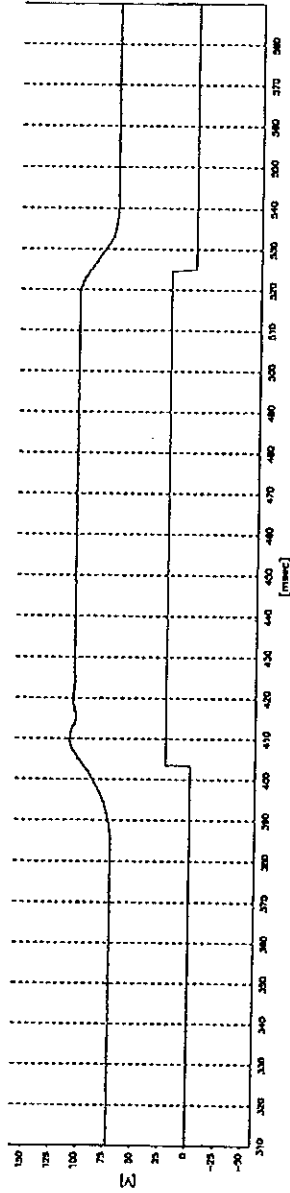
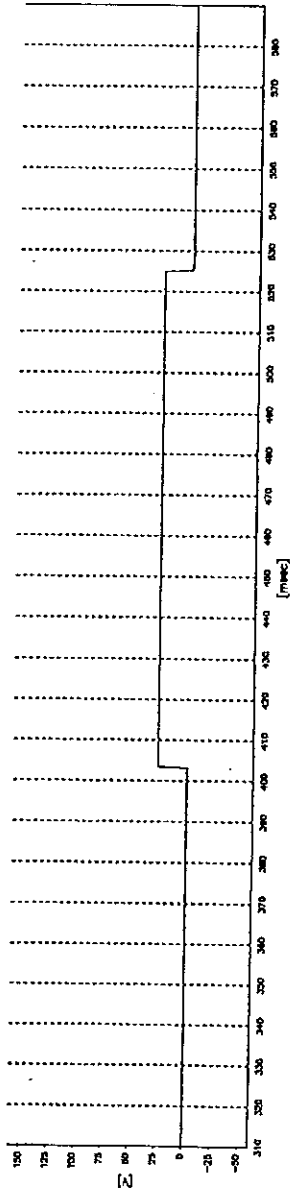
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PEHLA 0231Ra / 02B

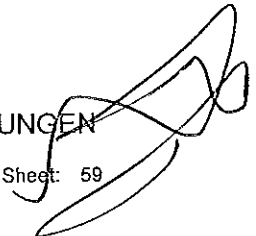


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PEHLA 0231Ra / 36

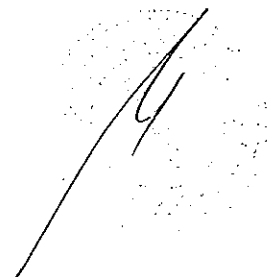
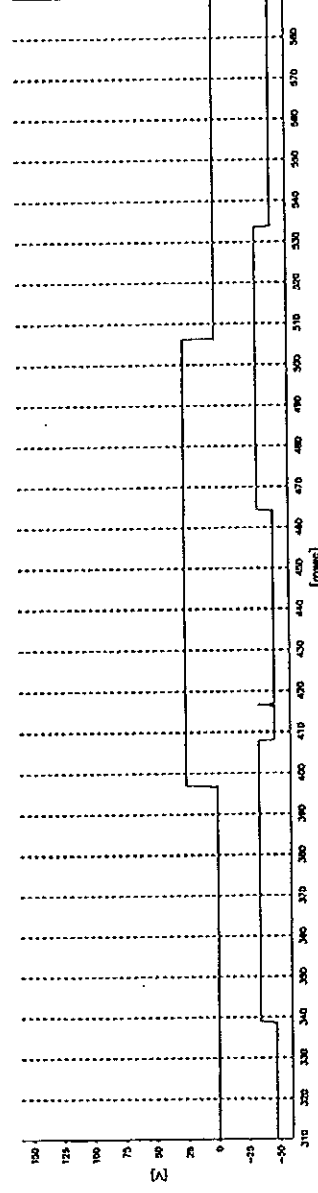
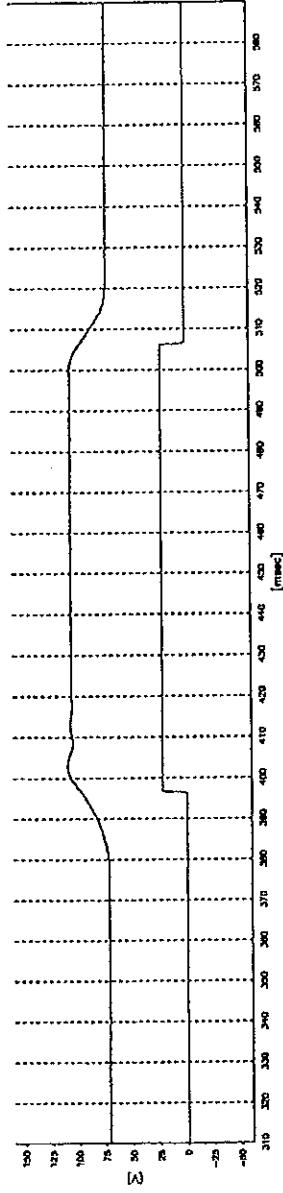
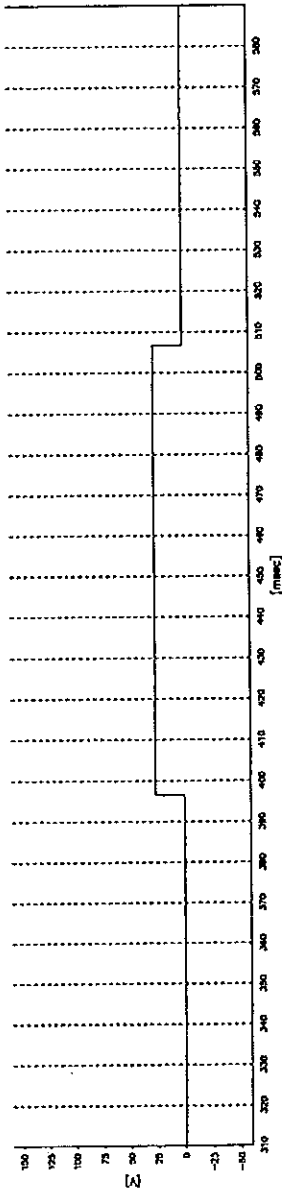


Test no.
PEHLA 0231Ra / 36A





Test no.
PEHLA 0231Ra / 36B



PEHLA

PEHLA

Report No.: 0231Ra

GESELLSCHAFT FÜR ELEKTRISCHE HOCHLEISTUNGSPRÜFUNGEN

PEHLA

Sheet: 60

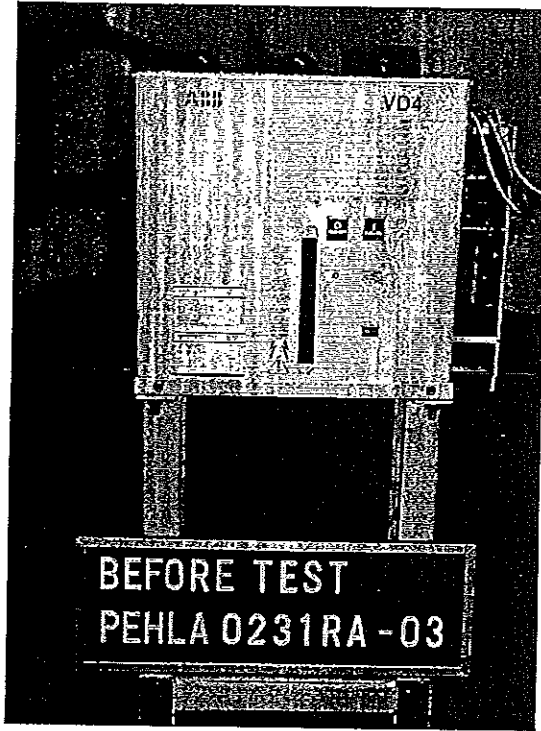


Photo No. 01
Before Test 0231Ra / 03

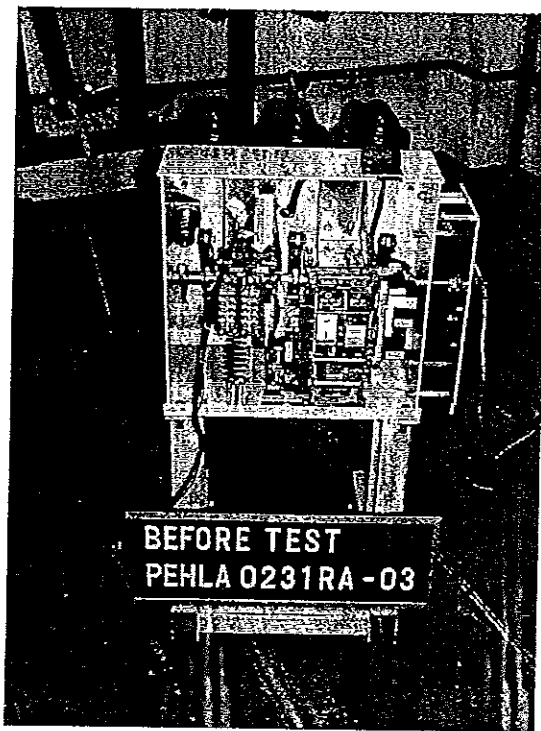


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Before Test 0231Ra / 03

PEHLA

PEHLA

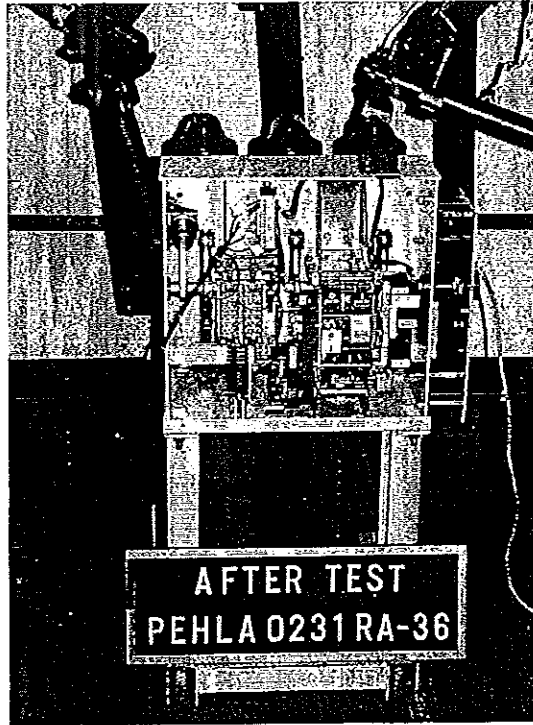


Photo No. 03
After Test 0231Ra / 36



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DAT-P-032/93

ABB Calor Emag Laboratories



TEST REPORT No. MZ ZS1 A 03

Issued by an Accredited Laboratory
corresponding to EN 45001

Sheet 1

Copy-No. 01e

Test Object

Metal-clad switchgear panel from a 12 kV switchgear type ZS1.2 (T = 650 mm), drawing-no. GCE 8010450 R0101, with withdrawable vacuum circuit-breaker type VD4P 1212-31 drawing-no. GCE 7373263 R1185 on a common truck drawing-no 549003Fig804 and with earthing switch type EK6-1208-150;

Rated voltage	U	12 kV
Rated normal current	I_n	1000 A
Rated frequency	f	50/60 Hz
Rated short-time withstand current	I_{th}	31,5 kA
Rated peak withstand current	I_p	80 kA
Rated duration of short-circuit current	t_{th}	3 s
Rated short-circuit breaking capacity at 12 kV	I_{sc}	31,5 kA

Manufacturer

Switchgear
Common truck

ABB Calor Emag Mittelspannung GmbH 40472 Ratingen / Germany
ABB EJV, A.S. VIDENSKA 117 Brno 658 67 Czech Republic

Tests performed

Mechanical operation test comprising 50 operations of the vacuum circuit-breaker, 50 operations of the earthing switch type EK6 and 25 manual insertions and withdrawals of the withdrawable part. The interlocks of the circuit-breaker, withdrawable part and the earthing switch were tested in the respective position. Test procedure and test parameters were based on IEC 60298/3rd. Ed./1990/Clause 6.102

Test Specification

IEC 60298/3rd. Ed./1990

Test Results

All switching devices and removable parts and the mechanical interlocks passed the mechanical operation test successfully. They were in proper working order and the effort to operate them was practically the same before and after the test.

Test Date

28th March 2000

Client

ABB Calor Emag Mittelspannung GmbH 40472 Ratingen / Germany

29th March 2000

Date of Issue



Laboratory Manager

Test Engineer

Total Number of Sheets: 11 Sheets

This test report refers exclusively to the object tested.
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Fax + 49 (0) 21 02 12 1713



Reg.-Nr.
DAT-P-032/93

ABB Calor Emag Laboratories



TEST REPORT No. MZ ZS1 A 03

Sheet 2

Issued by an Accredited Laboratory
corresponding to EN 45001

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EJF5490003Fig804 (common truck)	7
GCE 7373263 R1185 (Withdrawable vacuum circuit-breaker) ..	8
GCE 7169312 R0114 (Earthing switch)	9
2. Test Location and Set-up	10
3. Mechanical Operation Test	11



Reg.-Nr.
DAT-P-032/93

ABB Calor Emag Laboratories



TEST REPORT No. MZ ZS1 A 03

Sheet 3

Issued by an Accredited Laboratory
corresponding to EN 45001

1. Technical Data of Test Object

(Ratings assigned by the manufacturer)

Switchgear

Test Object: Metal-clad switchgear panel
Type: ZS1.2
Manufacturer: ABB Calor Emag Mittelspannung GmbH, 40472 Ratingen/ Germany
Serial-No.: 7550027/2001/00 **Year of manufacture:** 2000
Drawing Nos.: GCE 8010450 R0101

Rated voltage	12	kV
Rated lightning impulse withstand voltage	75	kV
Rated power frequency withstand voltage	28	kV

Rated frequency	50/60	Hz
Rated normal current busbar	1250	A
Rated normal current circuit	1000	A

Rated peak withstand current	80	kA
Rated short-time withstand current	31,5	kA
Rated duration of short-circuit	3	s

Prospected values under internal-arc conditions:

Peak withstand current	80	kA
Short-time withstand current	31,5	kA
Short-circuit duration	1	s

Date of receipt of test object: 27th March 2000



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DAT-P-032/93

ABB Calor Emag Laboratories



TEST REPORT No. MZ ZS1 A 03

Sheet 4

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corresponding to EN 45001

1. Technical Data of Test Object

(Ratings assigned by the manufacturer)

Switching Device

Test Object: Withdrawable vacuum circuit-breaker

Type: VD4P 1212-31

Vacuum interrupter: VG4S

Manufacturer: ABB Calor Emag Mittelspannung GmbH

Serial-No.: 7006579/4002/00 **Year of manufacture:** 2000

Drawing Nos.:

Breaker:	GCE 7373263 R1185
Operating mechanism:	GCE 7179610 R0101
Pole part:	GCE 7003979 R0104
Interrupters:	GCE 7005535 R0101
Pole Centres:	150 mm

Rated voltage	12	kV
Rated lightning impulse withstand voltage	75	kV
Rated power frequency withstand voltage	28	kV

Rated frequency	50/60	Hz
Rated normal current	1250	A
Rated short-circuit breaking current	31,5	kA
Rated short-circuit making current	80	kA
DC-component	--	--
Pole factor	--	--

Rated peak withstand current	80	kA
Rated short-time withstand current	31,5	kA
Rated duration of short-circuit	3	s
Rated operating sequence	O-0,3s-CO-3min-CO	

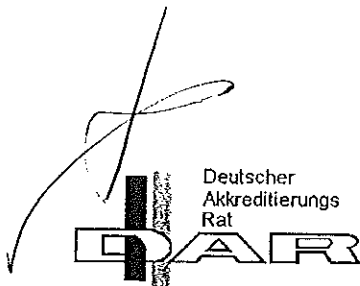
Rated times of circuit-breaker:

- opening time	--	ms
- closing time	--	ms

Number of poles	3
Number of units per pole	1

Date of receipt of test object: 27th March 2000

Remark: Common truck manufactured by ABB EJV, A.S. VIDENSKA 117 Brno 658 67 Czech Republic



Reg.-Nr.
DAT-P-032/93

ABB Calor Emag Laboratories



TEST REPORT No. MZ ZS1 A 03
Issued by an Accredited Laboratory
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Sheet 5

1. Technical Data of Test Object

(Ratings assigned by the manufacturer)

Switching Device

Test Object: Earthing switch

Type: EK6-1208-150

Manufacturer: ABB Calor Emag Mittelspannung GmbH

Serial-No.: 11/357/99 **Year of manufacture:** 1999

Drawing Nos.: Earthing switch: GCE 7169312 R 0114
Pole Centres: 150 mm

Rated voltage	12	kV
Rated lightning impulse withstand voltage	75	kV
Rated power frequency withstand voltage	28	kV
Rated short-circuit making current	80	kA
Rated peak withstand current	80	kA
Rated short-time withstand current	31,5	kA
Rated duration of short-circuit	3	s

Date of receipt of test object: 27th March 2000



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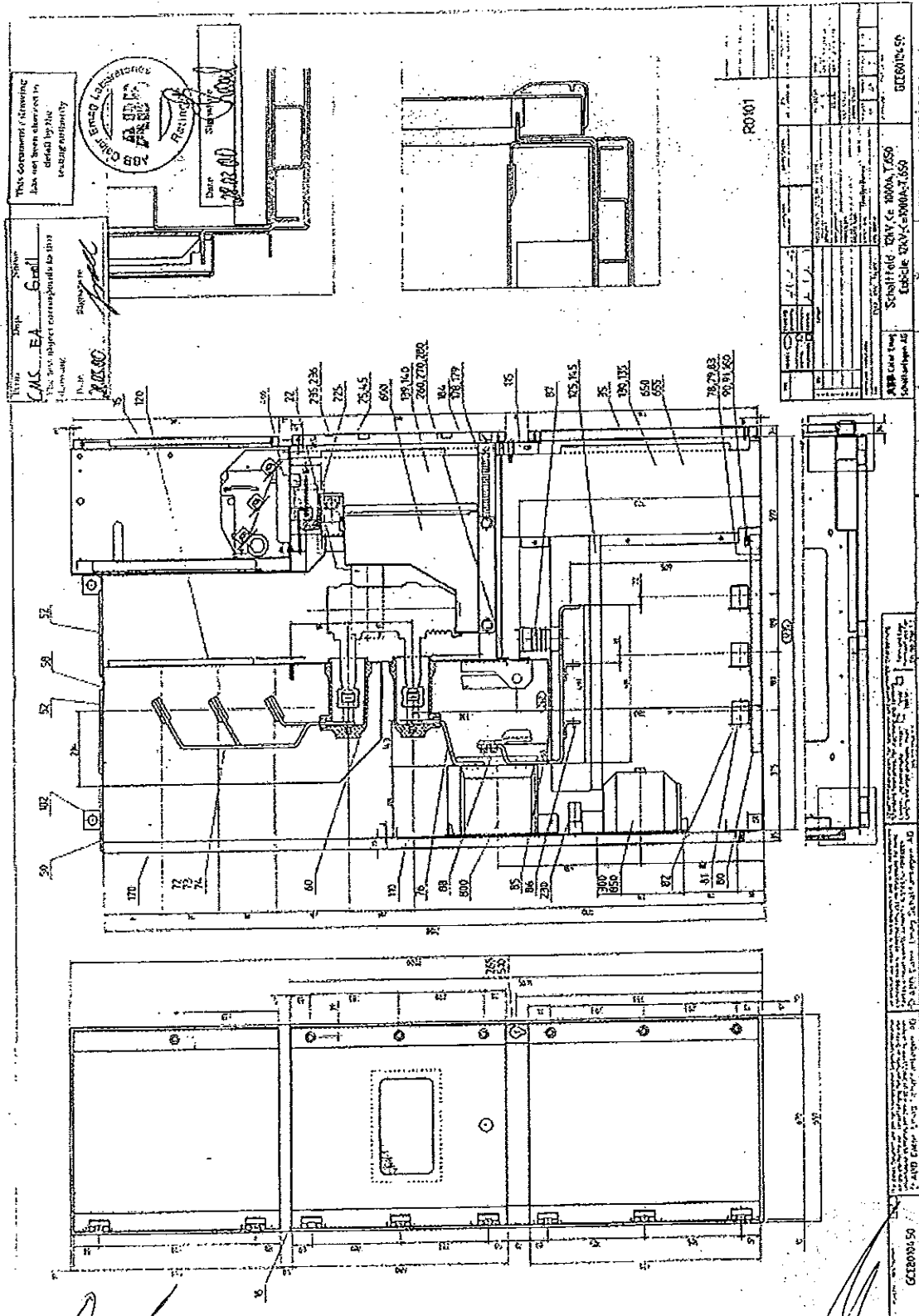


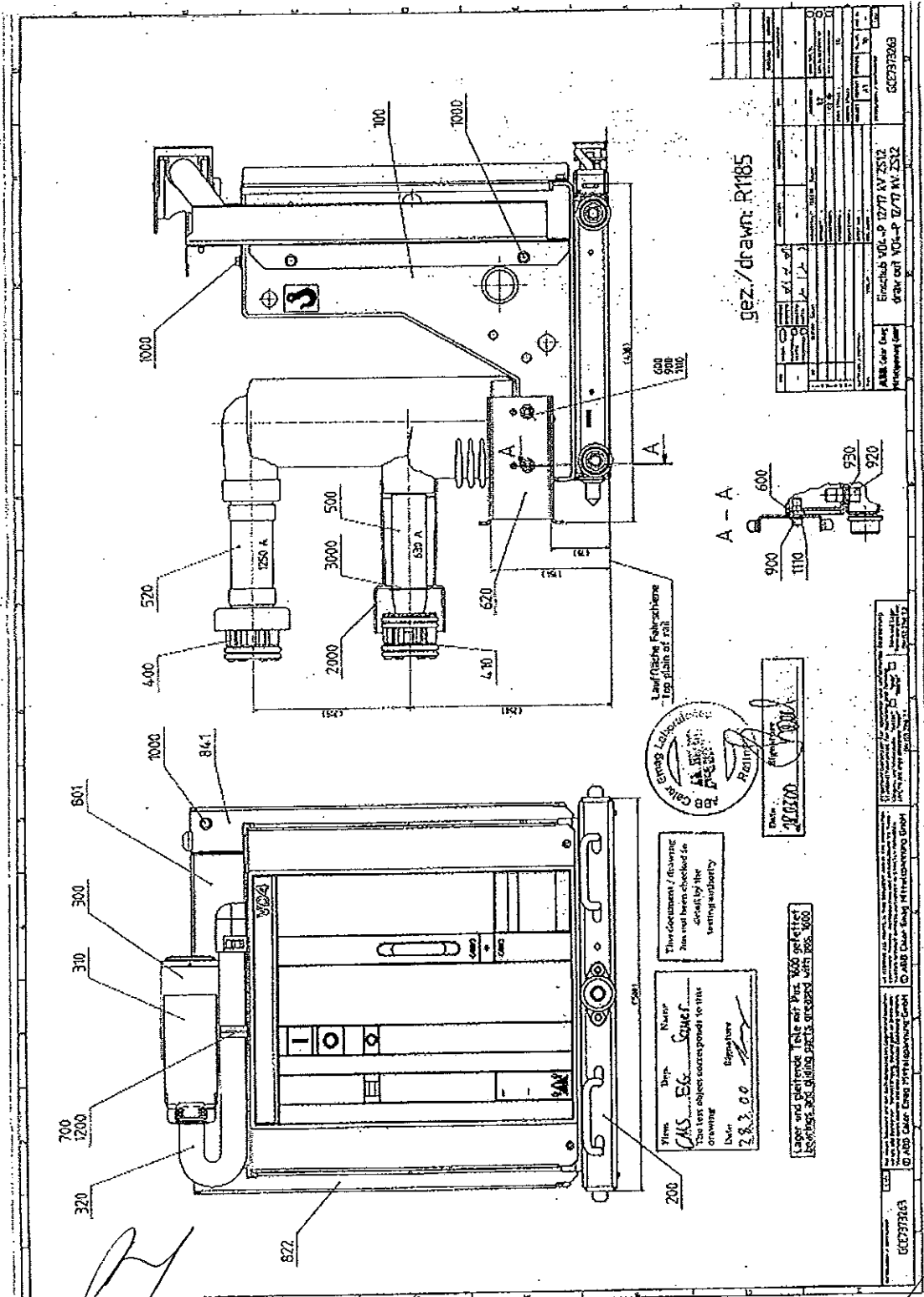
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TEST REPORT No. MZ ZS1 A 03

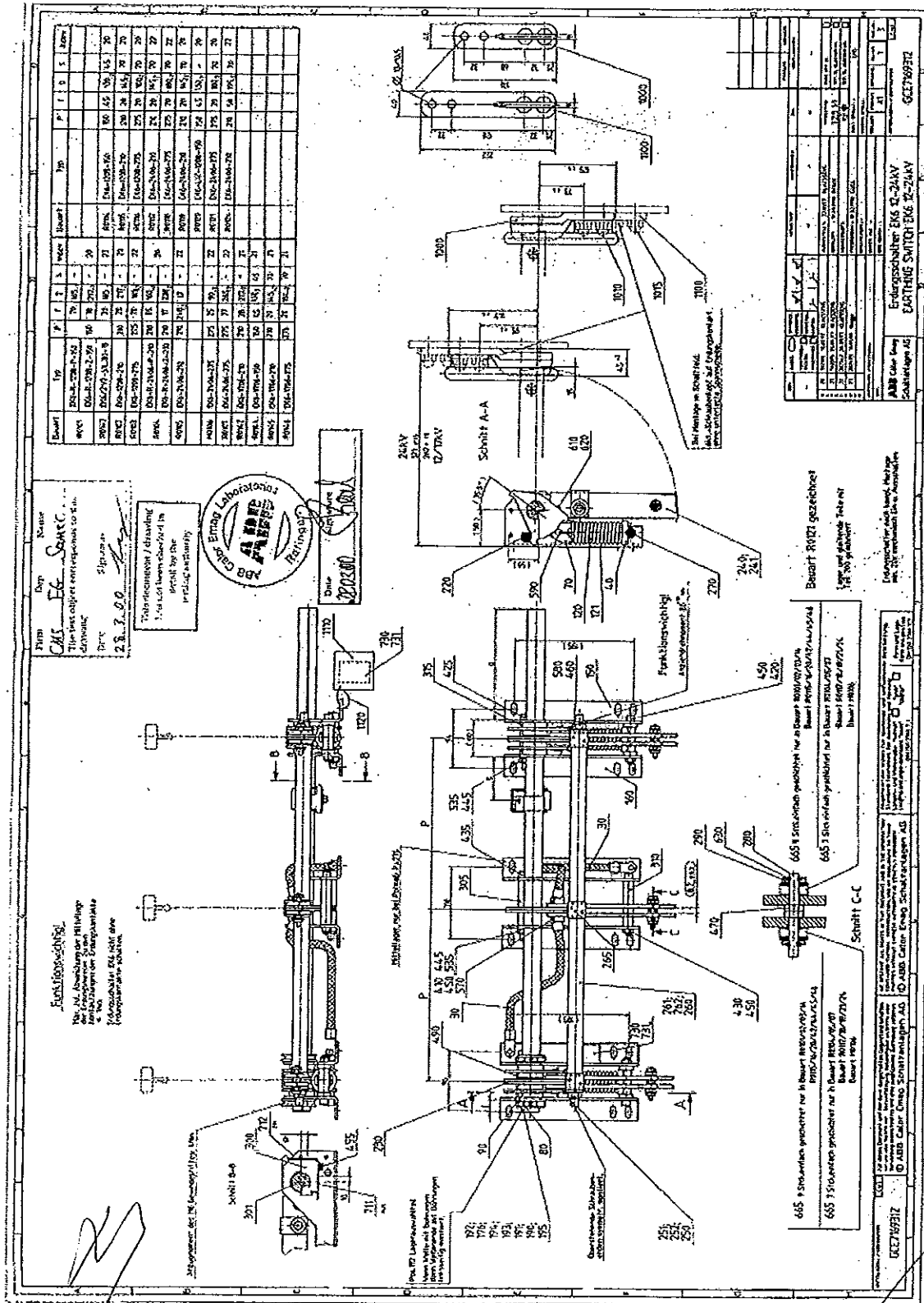
Sheet 6

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MZ ZS1 A 03



2. Test Locations and Set-up

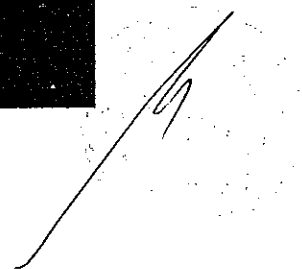
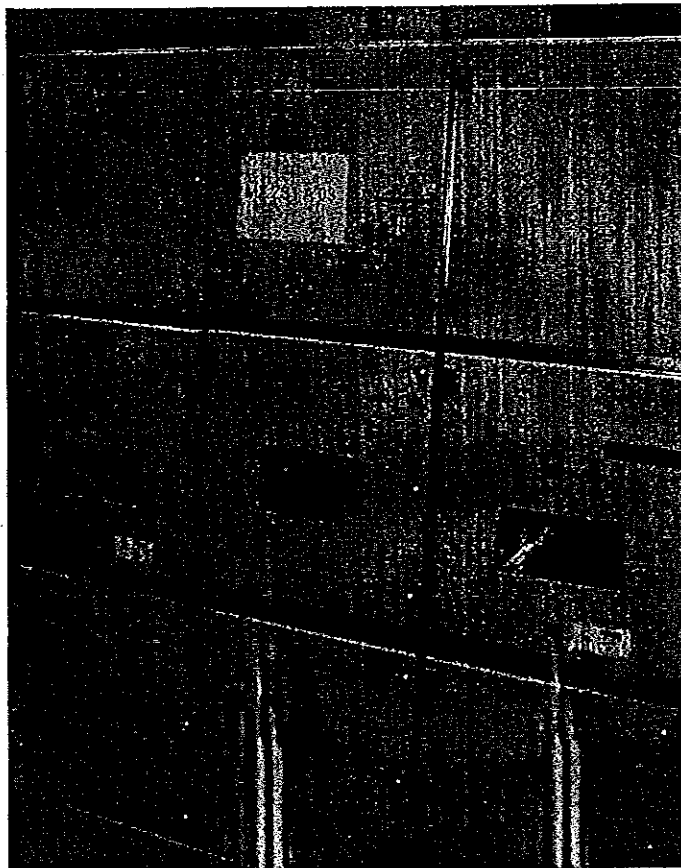
The test was performed in the Mechanical Testing Laboratory

of ABB Calor Emag Mittelspannung GmbH
Dept. LM in Ratingen

at an ambient temperature of approx. 20°C.

Test job no.: 7550030_012A

Test engineer: Koal





Reg.-Nr.
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ABB Calor Emag Laboratories

TEST REPORT No. MZ ZS1 A 03
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Sheet 11

3. Mechanical Operation Test

List of interlocks:

1. Withdrawable part in test-position
 - Circuit-breaker ON: prevented to move the withdrawable part in service-position
2. Withdrawable part in service-position
 - Circuit-breaker ON: prevented to move the withdrawable part in test-position
3. Withdrawable part between service and test position:
 - prevented to switch ON the circuit-breaker
4. Withdrawable part in test-position
 - Circuit-breaker OFF and earthing switch ON: prevented to move the withdrawable part in service-position
5. Withdrawable part in test-position
 - circuit-breaker ON and earthing switch ON: prevented to move the withdrawable part in service-position
6. Withdrawable part not in test-position
 - prevented to switch ON the earthing switch

All the above mentioned interlocks were checked, for this the circuit-breaker and the earthing switch were operated 50 times and the withdrawable part was inserted and withdrawn 25 times.



Reg. No.
DAT-P-032/93

ABB Calor Emag Laboratories



TEST REPORT No. HZ 146 L 02
Issued by an Accredited Laboratory
corresponding to EN 45001

Sheet 1
Copy-No. 1

Test Object Three-panel arrangement of metal-clad, air insulated switchgear type ZS1.2 (650 mm, 1000 mm, 800 mm width) equipped with bushing plates

Rated voltage	U_r	12 kV
Rated normal current	I_r	1000/1600/1600 A
Rated frequency	f_r	50/60 Hz
Rated short-time withstand current	I_k	31.5 kA
Rated peak withstand current	I_p	80 kA
Rated duration of short-circuit current	t_k	3 s

Manufacturer ABB Calor Emag Mittelspannung GmbH, Oberhausener Str. 33, 40472 Ratingen, Deutschland

Tests performed Testing of the behaviour of the metal-clad switchgear under conditions of arcing due to internal faults with 31.5 kA - 1.0 s in different compartments of the three panels. For further details see sheet-no. 2 to 5.

Test Specification The test has been carried out in accordance with the client's instructions. Test procedure and test parameters were based on IEC 60298/3rd Ed/1990-12, Clause 6.108, Annex AA in conjunction with PEHLA-Recommendation No. 4 / 3.1995.
(Accessibility Type A: Metal-enclosed switchgear and controlgear with accessibility restricted to authorized personnel only).

Test Results The assessment of the test was carried out in accordance with criteria 1 to 6 of the above mentioned test specifications.
For further details see sheet-no. 2 to 5 and 19 to 25.

Test Date 04th to 12th July 2000

Client ABB Calor Emag Mittelspannung GmbH, Oberhausener Str. 33, 40472 Ratingen, Deutschland



12th February 2002
Date of Issue

Stefan Göttlich
Dr. Stefan Göttlich
Laboratory Manager

A. Brandt
Andreas Brandt
Test Engineer

Total Number of Sheets: 34 Sheets

11 Oszillograms

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ABB Calor Emag Mittelspannung GmbH Ratingen
High-Power Testing Laboratory

Oberhausener Straße 33
40472 Ratingen, Deutschland

Phone + 49 (0) 21 02 12-1352
Fax + 49 (0) 21 02 12-1713

Comments on Test Arrangement and on the Test

The test object was a three-panel arrangement of a metal-clad, air insulated switchgear type ZS1.2 for 12 kV, consisting of a 650 mm width outgoing panel left-handed, of a 1000 mm width incoming panel in centre and a 800 mm width outgoing panel right-handed. The switchgear was installed in a room mock up with a ceiling height of approximately 3 m. The distance between the rear wall of the switchgear and the room mock up was approximately 0.2 m. The pressure relief took place by a top mounted pressure relief duct overcoming 1800 mm at the side wall of the left-handed panel.

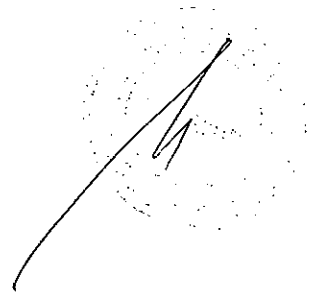
Each panel was equipped with a VD4 vacuum circuit-breaker dummy and a common earthing bar of copper 30 x 8 mm².

Infeed of current was made three-phase by means of a three core cable 1 x 3 x 240 mm² through the closed bottom of the centre panel.

For all tests black cretonne indicators (cotton fabric approximately 150 g/m²) were placed in front of and on both sides of the switchgear as stated in the relevant test regulations.

During the tests the pressure gauge in the compartment under test was measured and recorded. The tests were filmed with a high-speed video camera with a frequency of 500 frames/s.

The evaluation of the RMS-value of the short-circuit current was made according to the Simpson-Formula.





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ABB Calor Emag Laboratories



TEST REPORT No. HZ 146 L 02

Sheet 3

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Test Results:

Test-no.: HZ 146 L 02 / 03 Internal arcing test in the cable compartment of the left-handed panel (650 mm width), ignition of arc three-phase by means of a copper wire \varnothing 0.5 mm at the cable terminals.

Peak short-circuit current: 72.5 kA
Short-circuit current: 30.6 kA - 1.05 s equivalent to 31.5 kA - 1.02 s

Assessment of the test:

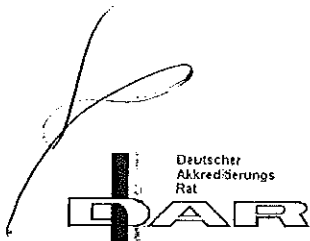
- Correctly secured doors, covers, etc. did not open (Criterion No. 1).
- Parts of the switchgear, which may cause injury to persons, did not fly off (Criterion No. 2).
- Arc did not cause holes to develop in the outer, freely accessible parts of the enclosure as a result of burning or other effects (Criterion No. 3).
- The indicators arranged vertically did not ignite (Criterion No. 4).
- The indicators arranged horizontally did not ignite (Criterion No. 5).
- All earthing connections were still effective (Criterion No. 6).

Test-no.: HZ 146 L 02 / 05 Internal arcing test in the cable compartment of the right-handed panel (800 mm width), ignition of arc three-phase by means of a copper wire \varnothing 0.5 mm at the cable terminals.

Peak short-circuit current: 77.3 kA
Short-circuit current: 31.5 kA - 1.05 s equivalent to 31.5 kA - 1.05 s

Assessment of the test:

- Correctly secured doors, covers, etc. did not open (Criterion No. 1).
- Parts of the switchgear, which may cause injury to persons, did not fly off (Criterion No. 2).
- Arc did not cause holes to develop in the outer, freely accessible parts of the enclosure as a result of burning or other effects (Criterion No. 3).
- The indicators arranged vertically did not ignite (Criterion No. 4).
- The indicators arranged horizontally did not ignite (Criterion No. 5).
- All earthing connections were still effective (Criterion No. 6).



Reg. No.
DAT-P-032/93

ABB Calor Emag Laboratories



TEST REPORT No. HZ 146 L 02

Sheet 4

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Test Results:

Test-no.: HZ 146 L 02 / 06 Internal arcing test in the circuit-breaker compartment of the left-handed panel (650 mm width), ignition of arc three-phase by means of a copper wire $\varnothing 0.5$ across the upper contact arms of the circuit-breaker.

Peak short-circuit current: 79.3 kA
Short-circuit current: 31.5 kA - 1.05 s equivalent to 31.5 kA - 1.05 s

Assessment of the test:

- Correctly secured doors, covers, etc. did not open (Criterion No. 1).
- Parts of the switchgear, which may cause injury to persons, did not fly off (Criterion No. 2).
- Arc did not cause holes to develop in the outer, freely accessible parts of the enclosure as a result of burning or other effects (Criterion No. 3).
- The indicators arranged vertically did not ignite (Criterion No. 4).
- The indicators arranged horizontally did not ignite (Criterion No. 5).
- All earthing connections were still effective (Criterion No. 6).

Test-no.: HZ 146 L 02 / 07 Internal arcing test in the busbar compartment of the right-handed panel (800 mm width), ignition of arc three-phase by means of a copper wire $\varnothing 0.5$ mm across the busbars.

Peak short-circuit current: 78.8 kA
Short-circuit current: 31.6 kA - 1.05 s equivalent to 31.5 kA - 1.05 s

Assessment of the test:

- Correctly secured doors, covers, etc. did not open (Criterion No. 1).
- Parts of the switchgear, which may cause injury to persons, did not fly off (Criterion No. 2).
- Arc did not cause holes to develop in the outer, freely accessible parts of the enclosure as a result of burning or other effects (Criterion No. 3).
- The indicators arranged vertically did not ignite (Criterion No. 4).
- The indicators arranged horizontally did not ignite (Criterion No. 5).
- All earthing connections were still effective (Criterion No. 6).

Test Results:

Test-no.: HZ 146 L 02 / 08 Internal arcing test in the busbar compartment of the centre panel (1000 mm width), ignition of arc three-phase by means of a copper wire \varnothing 0.5 across the busbars.

Peak short-circuit current: 77.3 kA
Short-circuit current: 31.5 kA - 1.05 s equivalent to 31.5 kA - 1.05 s

Assessment of the test:

- Correctly secured doors, covers, etc. did not open (Criterion No. 1).
- Parts of the switchgear, which may cause injury to persons, did not fly off (Criterion No. 2).
- Arc did not cause holes to develop in the outer, freely accessible parts of the enclosure as a result of burning or other effects (Criterion No. 3).
- The indicators arranged vertically did not ignite (Criterion No. 4).
- The indicators arranged horizontally did not ignite (Criterion No. 5).
- All earthing connections were still effective (Criterion No. 6).

Test-no.: HZ 146 L 02 / 09 Internal arcing test in the circuit-breaker compartment of the centre panel (1000 mm width), ignition of arc three-phase by means of a copper wire \varnothing 0.5 mm across the lower contact arms of the circuit-breaker.

Peak short-circuit current: 77.2 kA
Short-circuit current: 31.3 kA - 1.05 s equivalent to 31.5 kA - 1.04 s

Assessment of the test:

- Correctly secured doors, covers, etc. did not open (Criterion No. 1).
- Parts of the switchgear, which may cause injury to persons, did not fly off (Criterion No. 2).
- Arc did not cause holes to develop in the outer, freely accessible parts of the enclosure as a result of burning or other effects (Criterion No. 3).
- The indicators arranged vertically did not ignite (Criterion No. 4).
- The indicators arranged horizontally did not ignite (Criterion No. 5).
- All earthing connections were still effective (Criterion No. 6).





Reg. No.

DAT-P-032/93

ABB Calor Emag Laboratories



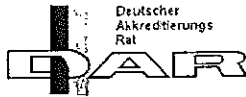
TEST REPORT No. HZ 146 L 02

Sheet 6

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Reg. No.

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**ABB Calor Emag
Laboratories**



TEST REPORT No. HZ 146 L 02

Sheet 7

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Assessment of the Test

Extraction of IEC 60298/3rd Ed/1990-12, Annex AA

The following criteria allow for the arcing effects.
It is to be observed:

Criterion No. 1

Whether correctly secured doors, covers, etc., do not open.

Criterion No. 2

Whether parts (of the metal-enclosed switchgear and controlgear), which may cause a hazard, do not fly off. This includes large parts or those with sharp edges, for example, inspection windows, pressure relief flaps, cover plates, etc.

Criterion No. 3

Whether arcing does not cause holes to develop in the freely accessible parts of the enclosure as a result of burning or other effects.

Criterion No. 4

Whether the indicators arranged vertically do not ignite. Indicators ignited as a result of paint or stickers burning are excluded from this assessment.

Criterion No. 5

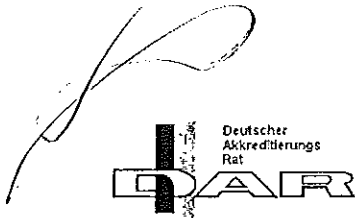
Whether the indicators arranged horizontally do not ignite. Should they start to burn during the test, the assessment criterion may be regarded as having been met, if proof is established of the fact that the ignition was caused by glowing particles rather than hot gases. Pictures taken by high-speed cameras should be produced in evidence.

Criterion No. 6

Whether all earthing connections are still effective.

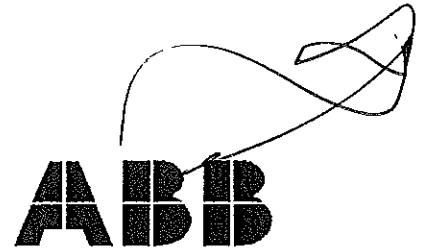
Remark:

When the PEHLA-Recommendation No. 4 is stated under *Test Specification* in the Test Report the results of each test were assessed by all six criteria.



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TEST REPORT No. HZ 146 L 02
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Sheet 8

Participants of the Tests

Client: ABB Calor Emag Mittelspannung GmbH, 40472 Ratingen, Deutschland

Representatives of the client:

Mr. Aufermann ABB Calor Emag Mittelspannung GmbH, 40472 Ratingen, Deutschland
Dept. EA

Mr. Groll ABB Calor Emag Mittelspannung GmbH, 40472 Ratingen, Deutschland
Dept. EA

Mr. Martschat ABB Calor Emag Mittelspannung GmbH, 40472 Ratingen, Deutschland
Dept. EA

Representatives of the laboratory:

Mr. Dr. Göttlich ABB Calor Emag Mittelspannung GmbH, 40472 Ratingen, Deutschland
Dept. LL

Test Engineer:

Mr. Strathmann ABB Calor Emag Mittelspannung GmbH, 40472 Ratingen, Deutschland
Dept. LL



Reg. No.
DAT-P-032/93

ABB Calor Emag Laboratories



TEST REPORT No. HZ 146 L 02
Issued by an Accredited Laboratory
corresponding to EN 45001

Sheet 9

Technical Data of Test Object (Ratings assigned by the manufacturer) Switchgear (left-handed)

Test Object: Metal-clad, air insulated switchgear

Type: ZS1.2, 650 mm width

Manufacturer: ABB Calor Emag Mittelspannung GmbH, 40472 Ratingen, Deutschland

Serial-No.: 7550027/2001/00

Year of manufacture: 2000

Drawing Nos.: See sheet-no. 12

Rated voltage	12	kV
Rated lightning impulse withstand voltage	75	kV
Rated power frequency withstand voltage	28	kV

Rated frequency	50/60	Hz
Rated current (busbar)	2000	A
Rated current (tee-off)	1000	A

Rated short-circuit peak withstand current	80	kA
Rated short-time withstand current	31.5	kA
Rated short-circuit duration	3	s

Insulating medium	air	
Rated filling pressure (abs., 20 ° C)	-	kPa

Prospective values under internal-arc conditions:

Peak withstand current	80	kA
Short-time withstand current	31.5	kA
Short-circuit duration	1	s

Additional specifications and data:

- busbars 2 x 80 mm x 10 mm / R 5 mm, Cu, bare
- tee-off bars 1 x 60 mm x 10 mm / R 5 mm, Cu, bare

Date of receipt of test object: 3rd July 2000



Reg. No.
DAT-P-032/93

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Sheet 10

Technical Data of Test Object

(Ratings assigned by the manufacturer)

Switchgear (centre)

Test Object: Metal-clad, air insulated switchgear

Type: ZS1.2, 1000 mm width

Manufacturer: ABB Calor Emag Mittelspannung GmbH, 40472 Ratingen, Deutschland

Serial-No.: 7550027/2009/00

Year of manufacture: 2000

Drawing Nos.: See sheet-no. 12

Rated voltage	12	kV
Rated lightning impulse withstand voltage	75	kV
Rated power frequency withstand voltage	28	kV

Rated frequency	50/60	Hz
Rated current (busbar)	2000	A
Rated current (tee-off)	1600	A

Rated short-circuit peak withstand current	80	kA
Rated short-time withstand current	31.5	kA
Rated short-circuit duration	3	s

Insulating medium	air	
Rated filling pressure (abs., 20 ° C)	-	kPa

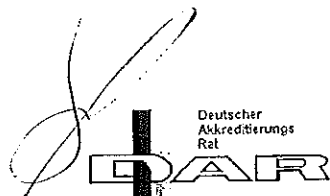
Prospective values under internal-arc conditions:

Peak withstand current	80	kA
Short-time withstand current	31.5	kA
Short-circuit duration	1	s

Additional specifications and data:

- busbars 2 x 80 mm x 10 mm / R 5 mm, Cu, bare
- tee-off bars 2 x 100 mm x 10 mm / R 5 mm, Cu, bare

Date of receipt of test object: 3rd July 2000



Reg. No.
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ABB Calor Emag Laboratories



TEST REPORT No. HZ 146 L 02
Issued by an Accredited Laboratory
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Sheet 11

Technical Data of Test Object (Ratings assigned by the manufacturer) Switchgear (right-handed)

Test Object: Metal-clad, air insulated switchgear

Type: ZS1.2, 800 mm width

Manufacturer: ABB Calor Emag Mittelspannung GmbH, 40472 Ratingen, Deutschland

Serial-No.: 7550027/2005/00

Year of manufacture: 2000

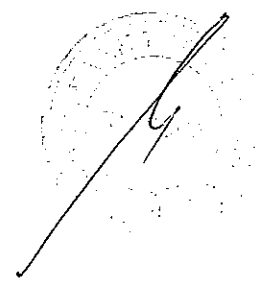
Drawing Nos.: See sheet-no. 12

Rated voltage	12	kV
Rated lightning impulse withstand voltage	75	kV
Rated power frequency withstand voltage	28	kV
Rated frequency	50/60	Hz
Rated current (busbar)	2000	A
Rated current (tee-off)	1600	A
Rated short-circuit peak withstand current	80	kA
Rated short-time withstand current	31.5	kA
Rated short-circuit duration	3	s
Insulating medium	air	
Rated filling pressure (abs., 20 ° C)	-	kPa
Prospective values under internal-arc conditions:		
Peak withstand current	80	kA
Short-time withstand current	31.5	kA
Short-circuit duration	1	s

Additional specifications and data:

- busbars 2 x 80 mm x 10 mm / R 5 mm, Cu, bare
- tee-off bars 2 x 80 mm x 10 mm / R 5 mm, Cu, bare

Date of receipt of test object: 3rd July 2000





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Reg. No.

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TEST REPORT No. HZ 146 L 02

Sheet 12

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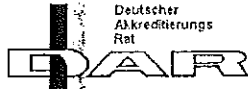
Table of Drawings of Test Objects

The drawings submitted for identification of the test object were stamped and signed by the test engineer.

The manufacturer/client has guaranteed by signature on the drawings that the equipment submitted for tests has been manufactured in accordance with the given drawings.

A copy of the following drawing is part of this Test Report:

ZS 1.2, feeder panel 12 kV, PW.650	GCE8010450R0101, sheet 1, index 00,
ZS 1.2, feeder panel 12 kV, PW.1000	GCE8010452R0110, sheet 19, index 00,
ZS 1.2, feeder panel 12 kV, PW.800	GCE8010451R0103, sheet 3, index 00,
Type Test Arrangement (internal fault) ZS1.2 - Panel	GCEP800241 sheet 1, index 00



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Sheet 16

Issued by an Accredited Laboratory corresponding to EN 45001

Panel 1
GCE8010450R0101
630mm / 1000A

Panel 2
GCE8010452R0110
1000mm / 2000A

Panel 3
GCE8010451R0103
800mm / 1600A

① cable terminal 31,5KA 1S
② cable terminal 31,5KA 1S
③ circuit breaker VD4 31,5KA 1S upper contact
④ busbar system 31,5KA 1S
⑤ busbar system 31,5KA 1S
⑥ circuit breaker VD4 31,5KA 1S lower contact

ABB
Emag Laboratories Rating

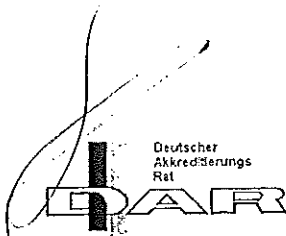
Date: 03.07.02
Signature: R. Schmitt

This document / drawing has not been checked in detail by the testing authority

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Type Test Arrangement (internal fault)
ZS1.2 - Panel: 12kV

GCEP800241



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ABB Calor Emag Laboratories



TEST REPORT No. HZ 146 L 02
Issued by an Accredited Laboratory
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Sheet 17

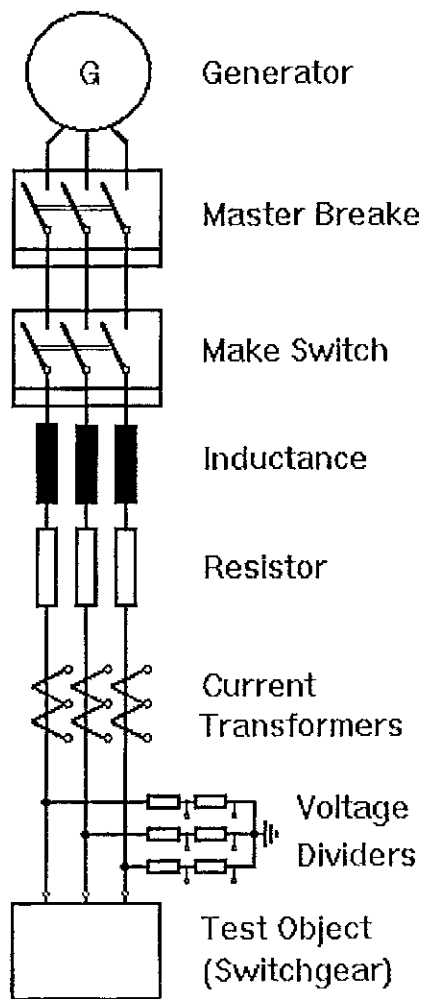
Technical Data of Test Circuit

Test	Internal fault	-	-	-
Oscillogram-No. HZ 146 L 02	02 - 09	-	-	-
Number of phases (circuit)	3	-	-	-
Number of poles/phases (test object)	3	-	-	-
Power frequency	Hz	50	-	-
Power factor	cos φ	≤ 0.15	-	-
Earthing	Generator	earthed via 5 kΩ	-	-
	Transformer	not earthed	-	-
	Short-circuit point	not earthed	-	-
Circuit diagram	Sheet no.:	18	-	-
Circuit impedance	mΩ	≈ 120	-	-
			-	-
TRV control elements		-	-	-
Capacitance in parallel	μF	-	-	-
Resistance in series	Ω	-	-	-
			-	-
			-	-
Prospective TRV		-	-	-
TRV peak value u_c	kV	-	-	-
Time co-ordinate t_3	μs	-	-	-
Time delay t_d	μs	-	-	-
Based on	kV	-	-	-
Rate-of-rise	kV/μs	-	-	-
			-	-
			-	-
Voltage measurements	Divider 375 kΩ / 2 kΩ	-	-	-
Current measurements	Transformer 50 kA / 5 A	-	-	-

Remarks:

HZ 146 L 02 / 01: Current calibration
HZ 146 L 02 / 04: Pre-test

Principle Diagram of Test Circuit





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Sheet 19

Determination of the Prospective Short-Circuit Current

Condition of test object before test: -

Arrangement: See sheet-no. 2

Connection: Infeed of current was made three-phase by means of a three core cable
1 x 3 x 240 mm² through the closed bottom of the centre panel.

For the determination of the prospective short-circuit current the infeeding busbars of the test plant were short-circuited and earthed outside the switchgear under test.

Test-No.: HZ 146 L 02 / 02		Applied voltage (phase-to-phase) 6.5 kV		Duration of short-circuit current 1.05 s
	Peak short-circuit current kA	Short-circuit current:		Arithmetic mean value kA
		first cycle kA	last cycle kA	
L1	81.9	37.4	30.0	30.2
L2	27.7	36.4	30.5	30.7
L3	67.2	37.2	29.8	30.0
Average value		37.0	30.1	30.3
Equivalent duration of short-circuit current 1.01 s			corresponding to a short-circuit current of 31.5 kA	

Remarks: -



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Sheet 20

Internal Arcing Test

Condition of test object before test: Switchgear factory-new.

Arrangement: See sheet-no.: 2

Connection: Infeed of current was made three-phase by means of a three core cable 1 x 3 x 240 mm² through the closed bottom of the centre panel.

Ignition: Internal arcing test in the cable compartment of the left-handed panel (650 mm width), ignition of arc three-phase by means of a copper wire Ø 0.5 mm at the cable terminals.

Test-No.: HZ 146 L 02 / 03		Applied voltage (phase-to-phase) 6.5 kV		Duration of short-circuit current 1.05 s
	Peak short-circuit current kA	Short-circuit current: first cycle kA		Arithmetic mean value kA
L1	72.5	37.1	30.4	30.2
L2	27.0	36.0	30.9	31.0
L3	60.7	37.4	30.1	30.6
Average value		36.9	39.8	30.6
Equivalent duration of short-circuit current 1.02 s			corresponding to a short-circuit current of 31.5 kA	

Remarks and condition of test object after test:

The condition of the switchgear before and after test is shown on the photos on sheet-no. 26 to 34. The measured pressure gauge was about 75 kPa.

Assessment of the test:

- Correctly secured doors, covers, etc. did not open (Criterion No. 1).
- Parts of the switchgear, which may cause injury to persons, did not fly off (Criterion No. 2).
- Arc did not cause holes to develop in the outer, freely accessible parts of the enclosure as a result of burning or other effects (Criterion No. 3).
- The indicators arranged vertically did not ignite (Criterion No. 4).
- The indicators arranged horizontally did not ignite (Criterion No. 5).
- All earthing connections were still effective (Criterion No. 6).



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TEST REPORT No. HZ 146 L 02
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Sheet 21

Internal Arcing Test

Condition of test object before test: as after test HZ 146 L 02 / 03.

Arrangement: See sheet-no.: 2

Connection: Infeed of current was made three-phase by means of a three core cable 1 x 3 x 240 mm² through the closed bottom of the centre panel.

Ignition: Internal arcing test in the cable compartment of the right-handed panel (800 mm width), ignition of arc three-phase by means of a copper wire \varnothing 0.5 mm at the cable terminals.

Test-No.: HZ 146 L 02 / 05		Applied voltage (phase-to-phase) 6.65 kV		Duration of short-circuit current 1.05 s
	Peak short-circuit current kA	Short-circuit current: first cycle last cycle kA kA		Arithmetic mean value kA
L1	77.3	38.3	30.9	31.4
L2	25.7	36.7	31.2	31.3
L3	60.9	37.7	31.7	31.7
Average value		37.6	31.3	31.5
Equivalent duration of short-circuit current 1.05 s			corresponding to a short-circuit current of 31.5 kA	

Remarks and condition of test object after test:

The condition of the switchgear before and after test is shown on the photos on sheet-no. 26 to 34. The measured pressure gauge was about 57 kPa.

Assessment of the test:

- Correctly secured doors, covers, etc. did not open (Criterion No. 1).
- Parts of the switchgear, which may cause injury to persons, did not fly off (Criterion No. 2).
- Arc did not cause holes to develop in the outer, freely accessible parts of the enclosure as a result of burning or other effects (Criterion No. 3).
- The indicators arranged vertically did not ignite (Criterion No. 4).
- The indicators arranged horizontally did not ignite (Criterion No. 5).
- All earthing connections were still effective (Criterion No. 6).

Internal Arcing Test

Condition of test object before test: as after test HZ 146 L 02 / 05.

Arrangement: See sheet-no.: 2

Connection: Infeed of current was made three-phase by means of a three core cable 1 x 3 x 240 mm² through the closed bottom of the centre panel.

Ignition: Internal arcing test in the circuit-breaker compartment of the left-handed panel (650 mm width), ignition of arc three-phase by means of a copper wire Ø 0.5 across the upper contact arms of the circuit-breaker

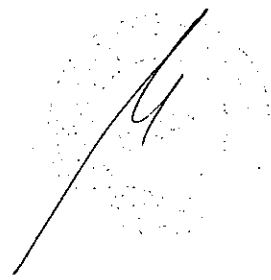
Test-No.: HZ 146 L 02 / 06		Applied voltage (phase-to-phase) 6.65 kV		Duration of short-circuit current 1.05 s
	Peak short-circuit current kA	Short-circuit current: first cycle kA		Arithmetic mean value kA
L1	79.3	38.7	30.3	31.0
L2	26.1	37.1	32.3	31.8
L3	62.6	38.3	32.0	31.6
Average value		38.0	31.5	31.5
Equivalent duration of short-circuit current 1.05 s			corresponding to a short-circuit current of 31.5 kA	

Remarks and condition of test object after test:

The condition of the switchgear before and after test is shown on the photos on sheet-no. 26 to 34. The measured pressure gauge was about 48 kPa.

Assessment of the test:

- Correctly secured doors, covers, etc. did not open (Criterion No. 1).
- Parts of the switchgear, which may cause injury to persons, did not fly off (Criterion No. 2).
- Arc did not cause holes to develop in the outer, freely accessible parts of the enclosure as a result of burning or other effects (Criterion No. 3).
- The indicators arranged vertically did not ignite (Criterion No. 4).
- The indicators arranged horizontally did not ignite (Criterion No. 5).
- All earthing connections were still effective (Criterion No. 6).




Internal Arcing Test

Condition of test object before test: as after test HZ 146 L 02 / 06.

Arrangement: See sheet-no.: 2

Connection: Infeed of current was made three-phase by means of a three core cable 1 x 3 x 240 mm² through the closed bottom of the centre panel.

Ignition: Internal arcing test in the busbar compartment of the right-handed panel (800 mm width), ignition of arc three-phase by means of a copper wire \varnothing 0.5 mm across the busbars.

Test-No.: HZ 146 L 02 / 07		Applied voltage (phase-to-phase) 6.65 kV		Duration of short-circuit current 1.05 s
	Peak short-circuit current kA	Short-circuit current: first cycle last cycle kA kA		Arithmetic mean value kA
L1	78.8	39.0	32.0	31.8
L2	23.3	36.6	31.4	31.3
L3	60.3	38.4	31.6	31.6
Average value		38.0	31.7	31.6
Equivalent duration of short-circuit current 1.05 s			corresponding to a short-circuit current of 31.5 kA	

Remarks and condition of test object after test:

The condition of the switchgear before and after test is shown on the photos on sheet-no. 26 to 34. The measured pressure gauge was about 27 kPa.

Assessment of the test:

- Correctly secured doors, covers, etc. did not open (Criterion No. 1).
- Parts of the switchgear, which may cause injury to persons, did not fly off (Criterion No. 2).
- Arc did not cause holes to develop in the outer, freely accessible parts of the enclosure as a result of burning or other effects (Criterion No. 3).
- The indicators arranged vertically did not ignite (Criterion No. 4).
- The indicators arranged horizontally did not ignite (Criterion No. 5).
- All earthing connections were still effective (Criterion No. 6).

Internal Arcing Test

Condition of test object before test: as after test HZ 146 L 02 / 07.

Arrangement: See sheet-no.: 2

Connection: Infeed of current was made three-phase by means of a three core cable 1 x 3 x 240 mm² through the closed bottom of the centre panel.

Ignition: Internal arcing test in the busbar compartment of the centre panel (1000 mm width), ignition of arc three-phase by means of a copper wire \varnothing 0.5 across the busbars.

Test-No.: HZ 146 L 02 / 08		Applied voltage (phase-to-phase) 6.65 kV		Duration of short-circuit current 1.05 s
	Peak short-circuit current kA	Short-circuit current: first cycle kA		Arithmetic mean value kA
		last cycle kA		
L1	77.3	38.5	30.8	31.2
L2	25.4	37.4	32.1	32.2
L3	61.4	38.4	31.4	31.2
Average value		38.1	31.4	31.5
Equivalent duration of short-circuit current 1.05 s			corresponding to a short-circuit current of 31.5 kA	

Remarks and condition of test object after test:

The condition of the switchgear before and after test is shown on the photos on sheet-no. 26 to 34. The measured pressure gauge was about 23 kPa.

Assessment of the test:

- Correctly secured doors, covers, etc. did not open (Criterion No. 1).
- Parts of the switchgear, which may cause injury to persons, did not fly off (Criterion No. 2).
- Arc did not cause holes to develop in the outer, freely accessible parts of the enclosure as a result of burning or other effects (Criterion No. 3).
- The indicators arranged vertically did not ignite (Criterion No. 4).
- The indicators arranged horizontally did not ignite (Criterion No. 5).
- All earthing connections were still effective (Criterion No. 6).

Internal Arcing Test

Condition of test object before test: as after test HZ 146 L 02 / 08.

Arrangement: See sheet-no.: 2

Connection: Infeed of current was made three-phase by means of a three core cable 1 x 3 x 240 mm² through the closed bottom of the centre panel.

Ignition: Internal arcing test in the circuit-breaker compartment of the centre panel (1000 mm width), ignition of arc three-phase by means of a copper wire \varnothing 0.5 mm across the lower contact arms of the circuit-breaker.

Test-No.: HZ 146 L 02 / 09		Applied voltage (phase-to-phase) 6.65 kV		Duration of short-circuit current 1.05 s
	Peak short-circuit current kA	Short-circuit current:		Arithmetic mean value kA
		first cycle kA	last cycle kA	
L1	77.2	38.0	31.4	31.2
L2	27.1	37.0	32.0	31.7
L3	62.1	38.0	30.5	31.0
Average value		37.7	31.3	31.3
Equivalent duration of short-circuit current 1.04 s			corresponding to a short-circuit current of 31.5 kA	

Remarks and condition of test object after test:

The condition of the switchgear before and after test is shown on the photos on sheet-no 26 to 34.
The measured pressure gauge was about 44 kPa.

Assessment of the test:

- Correctly secured doors, covers, etc. did not open (Criterion No. 1).
- Parts of the switchgear, which may cause injury to persons, did not fly off (Criterion No. 2).
- Arc did not cause holes to develop in the outer, freely accessible parts of the enclosure as a result of burning or other effects (Criterion No. 3).
- The indicators arranged vertically did not ignite (Criterion No. 4).
- The indicators arranged horizontally did not ignite (Criterion No. 5).
- All earthing connections were still effective (Criterion No. 6).

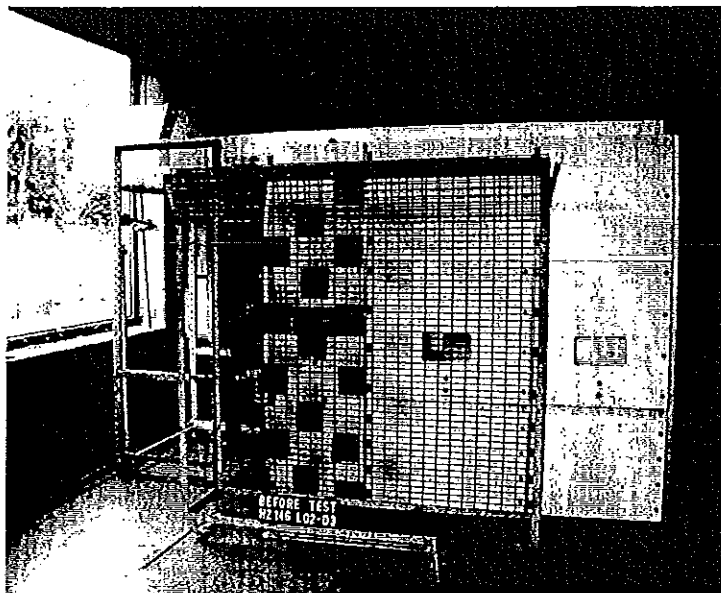


Photo No. 01
Before Test HZ 146 L 02 / 03

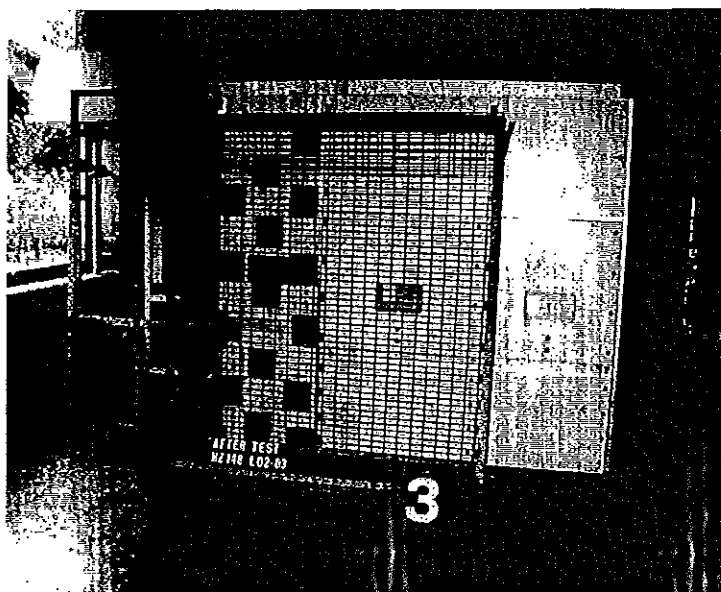


Photo No. 02
After Test HZ 146 L 02 / 03



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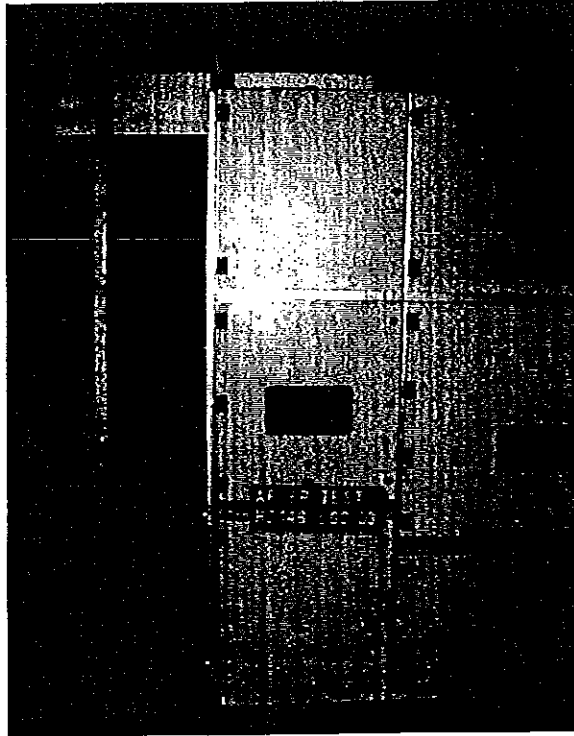


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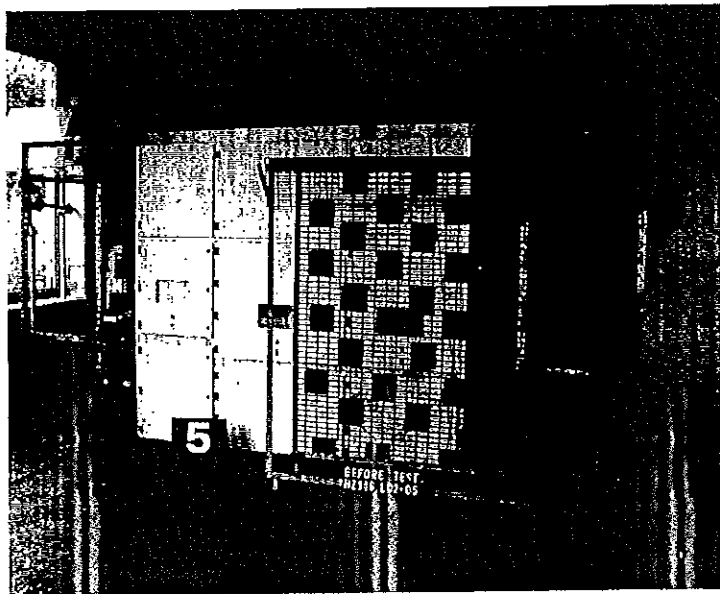


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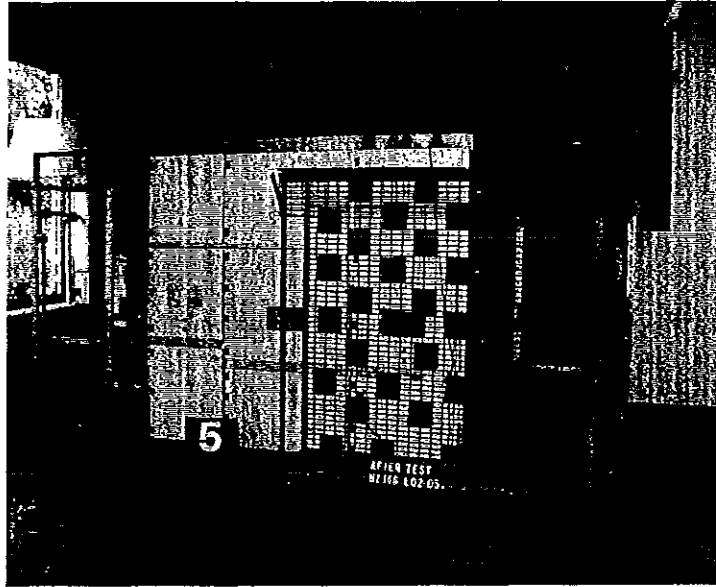


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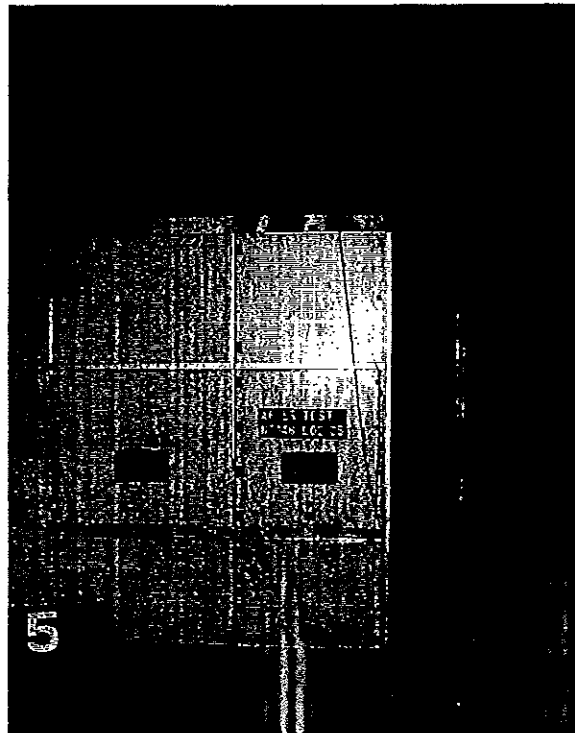


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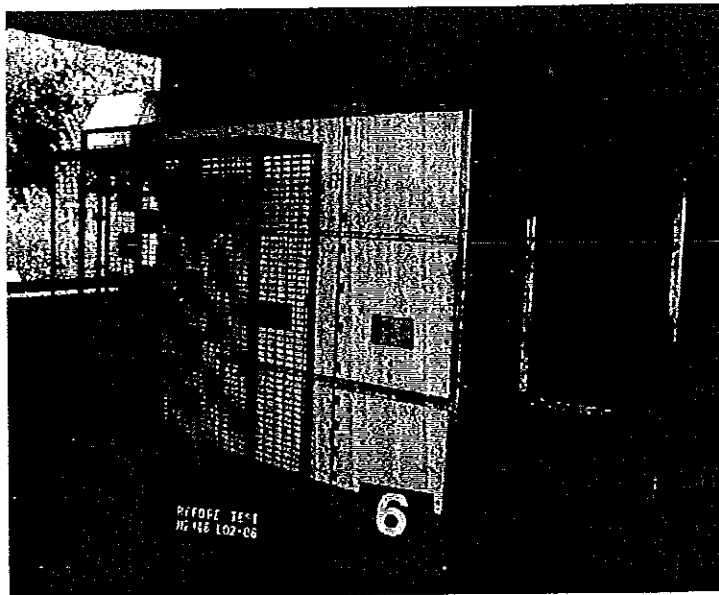


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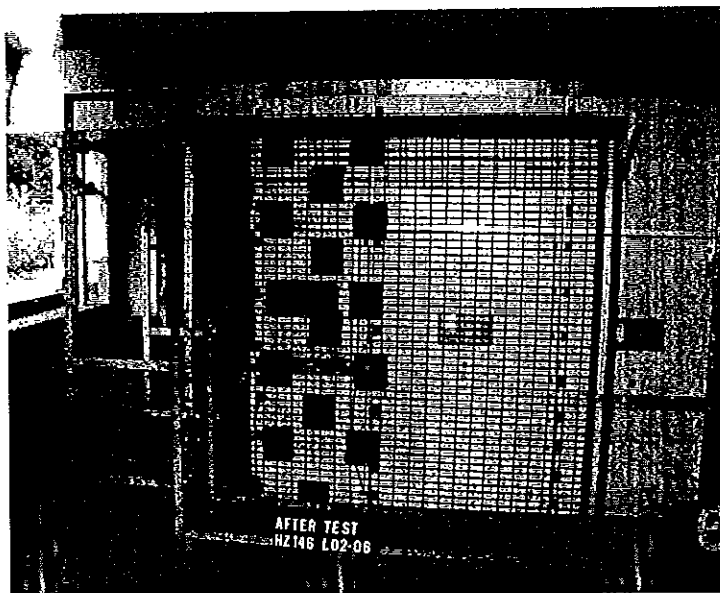
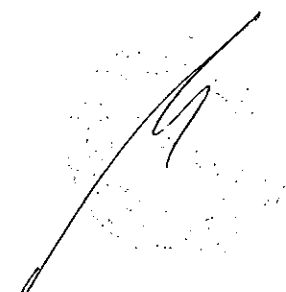


Photo No. 08
After Test HZ 146 L 02 / 06







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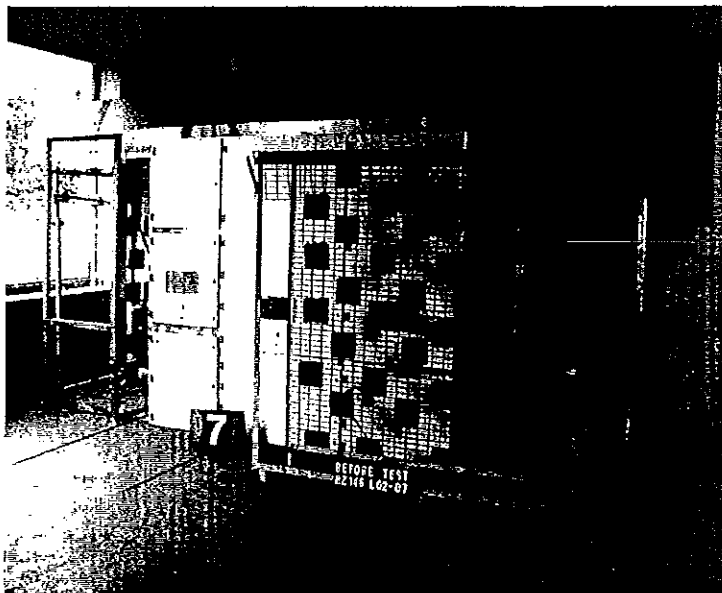


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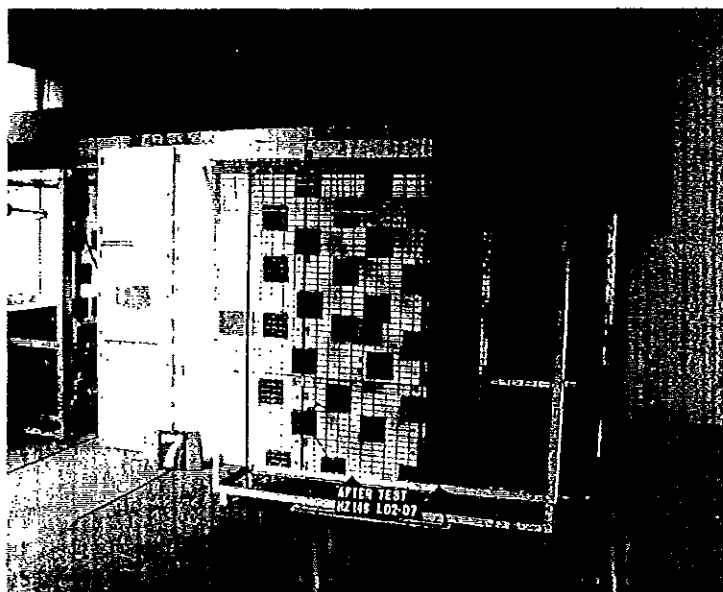


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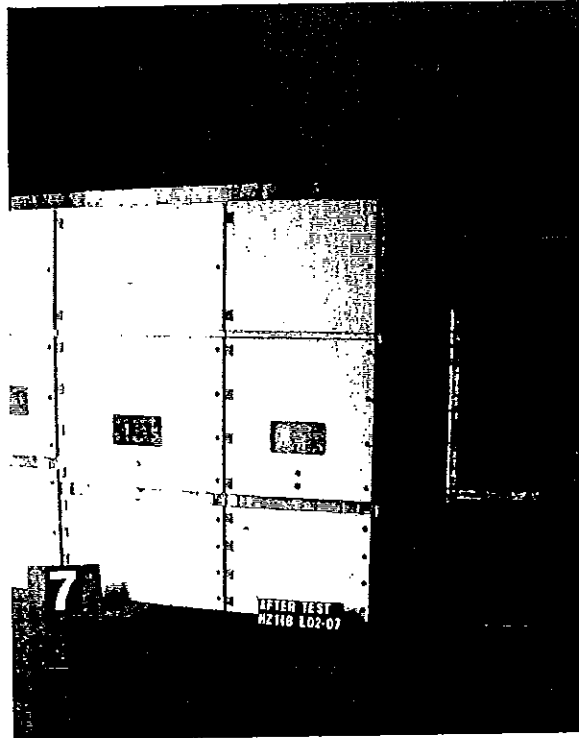


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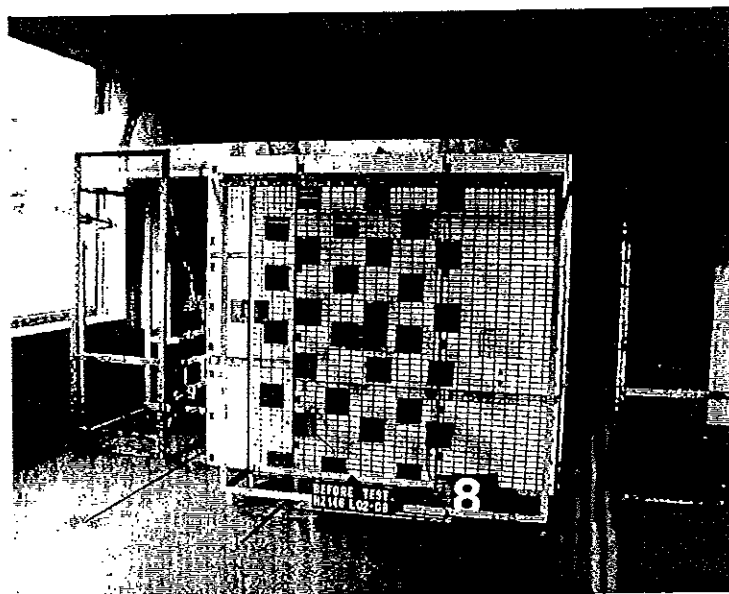
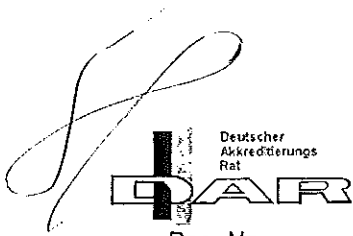


Photo No. 12
Before Test HZ 146 L 02 / 08



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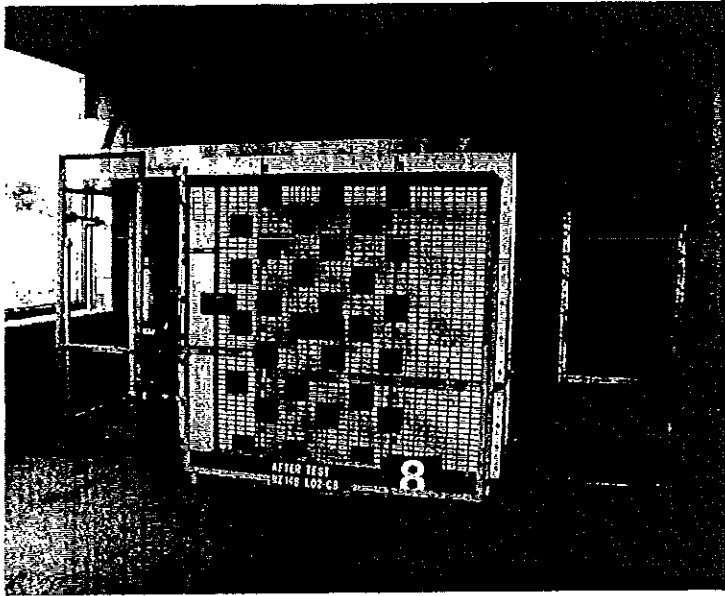


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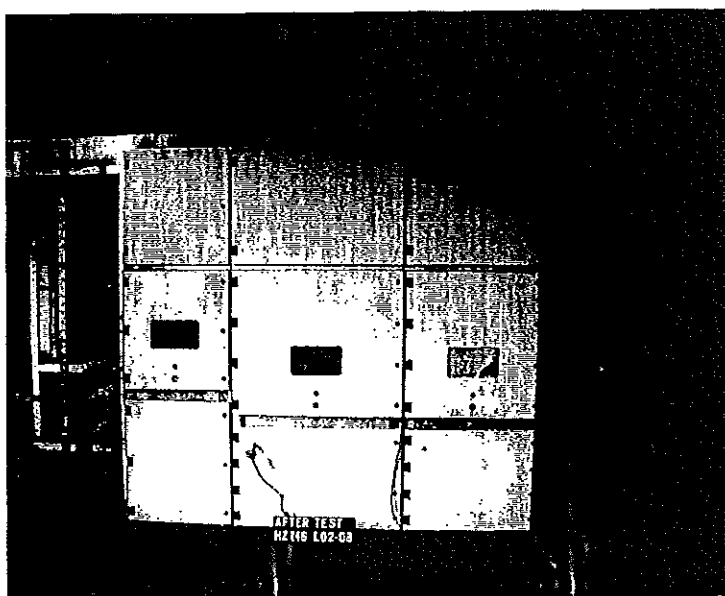


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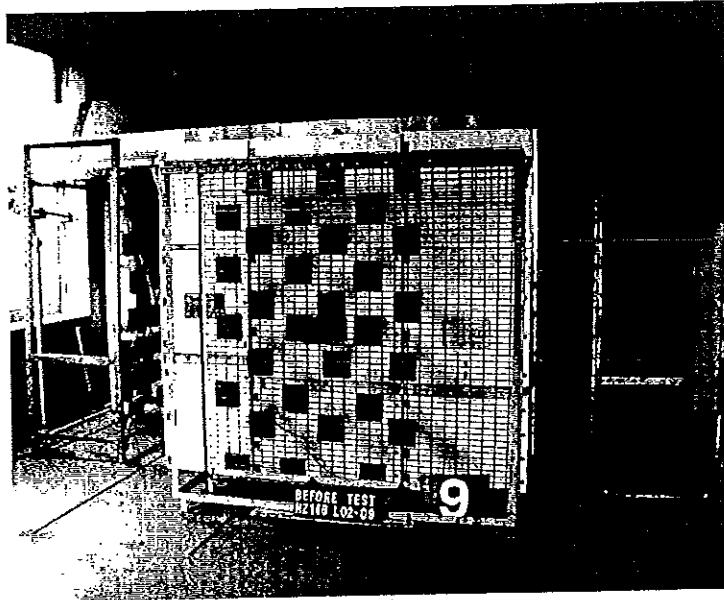


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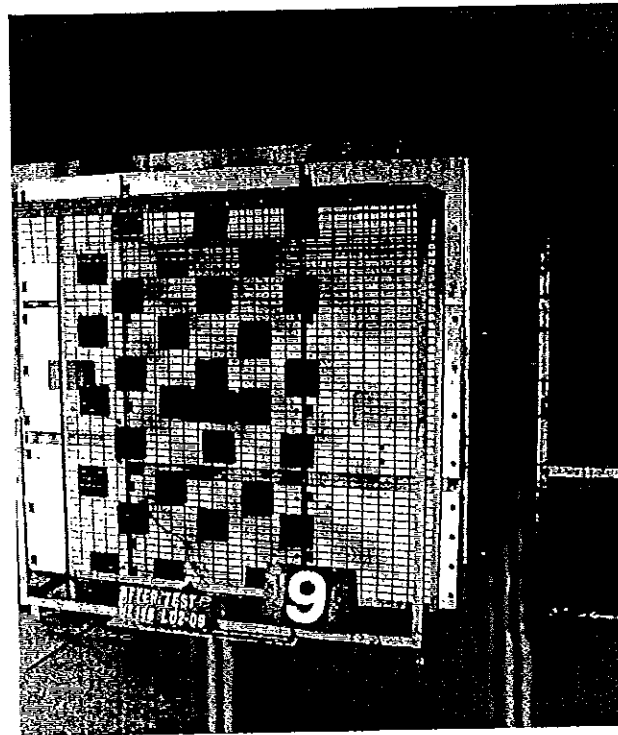


Photo No. 16
After Test HZ 146 L 02 / 09



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DAT-P-032/93

ABB Calor Emag Laboratories


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Issued by an Accredited Laboratory
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Sheet 34

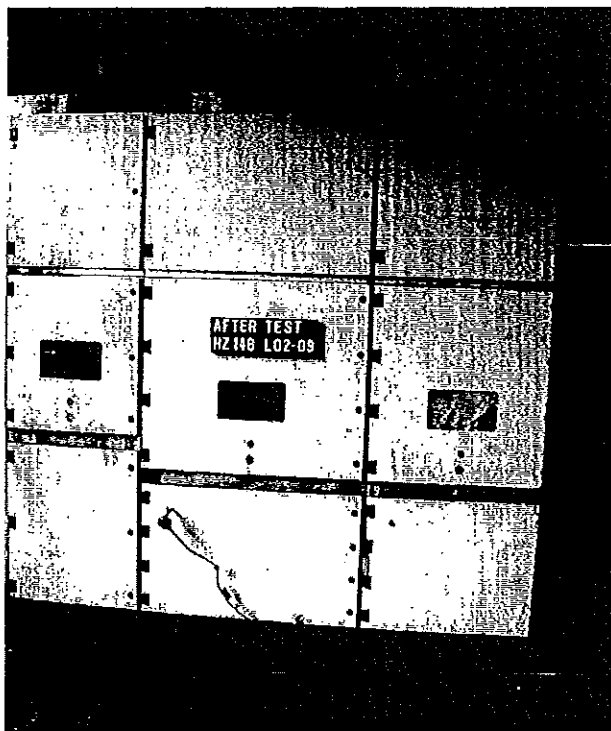
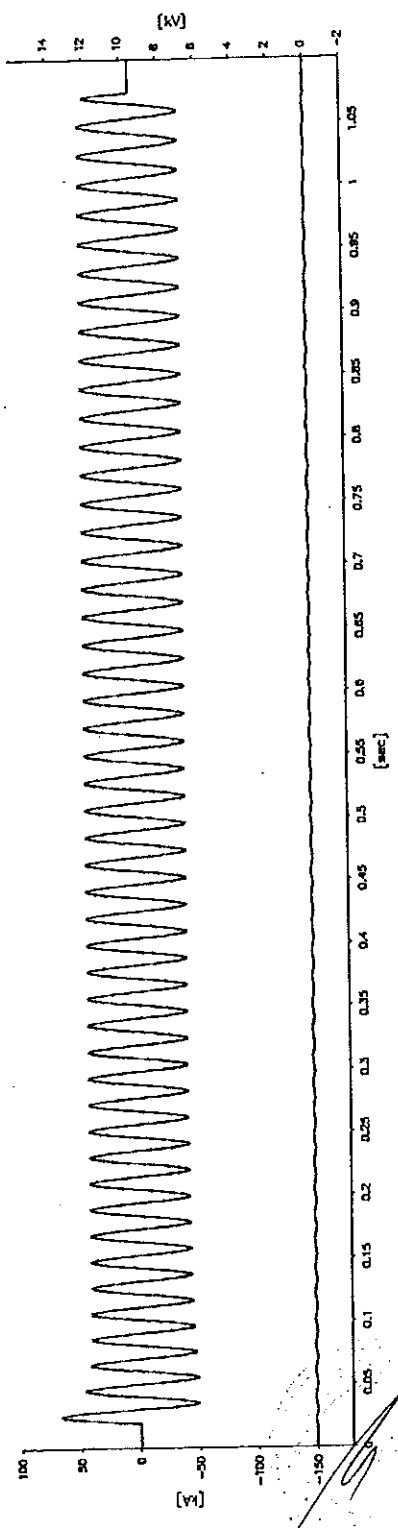
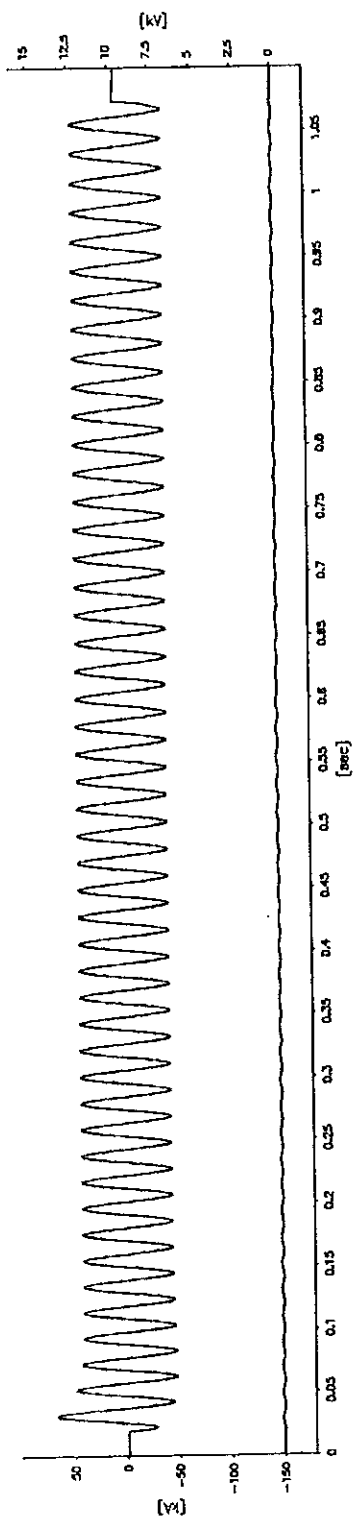
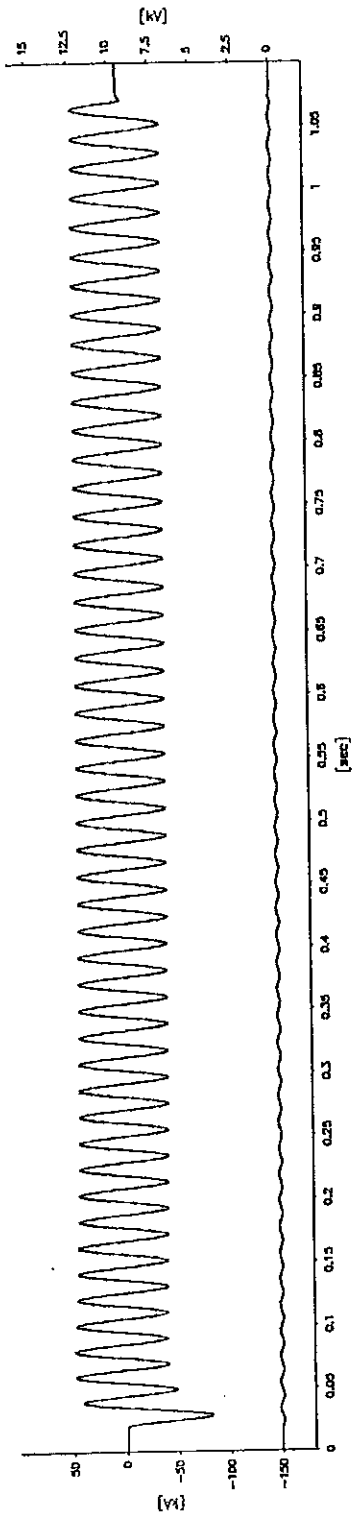


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After Test HZ 146 L 02 / 09



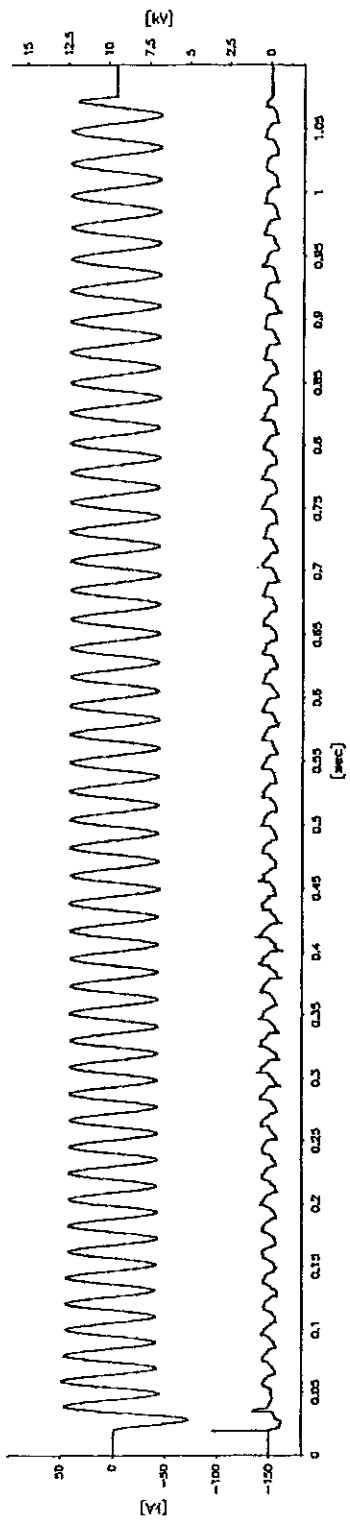


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HZ146L02.002

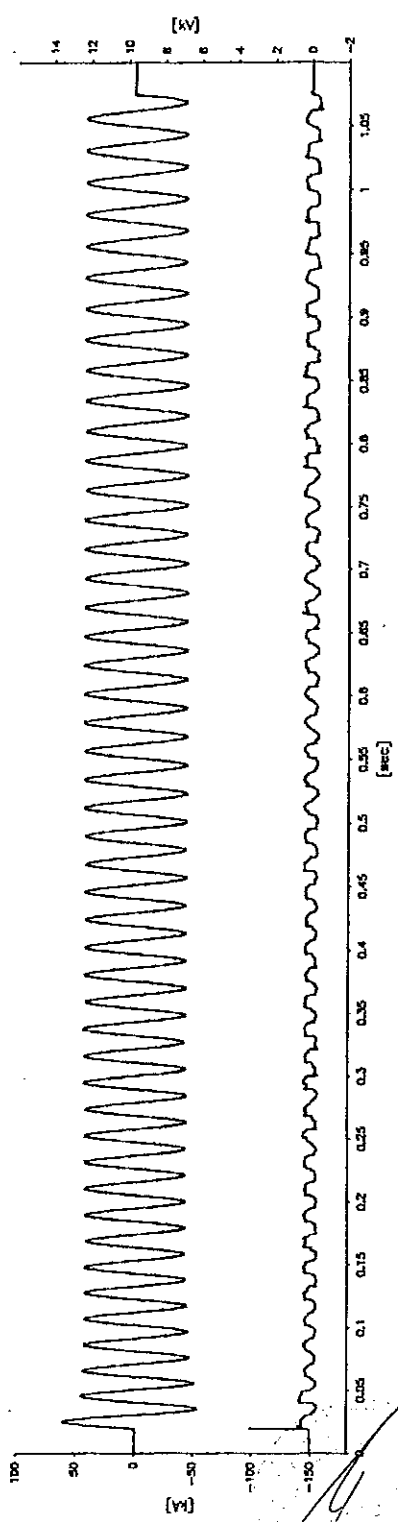
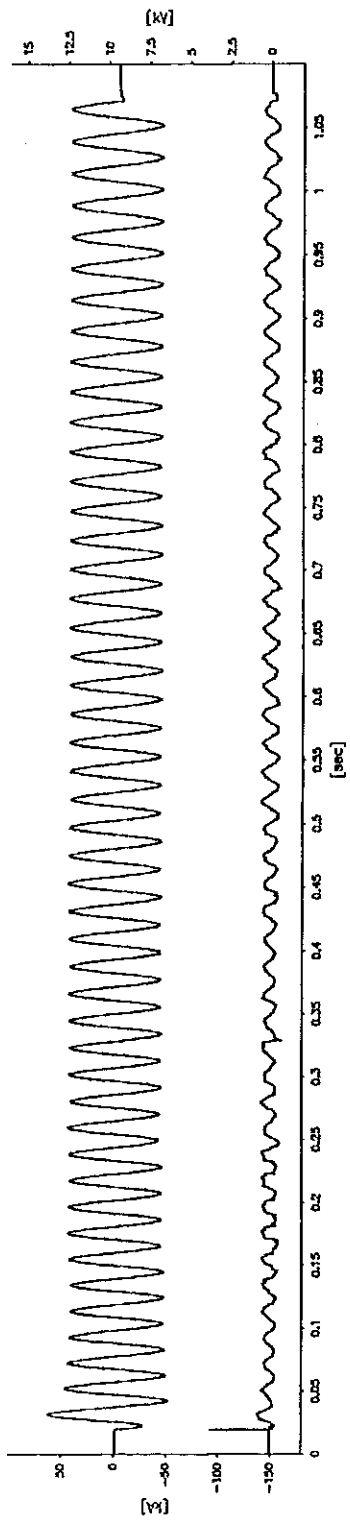
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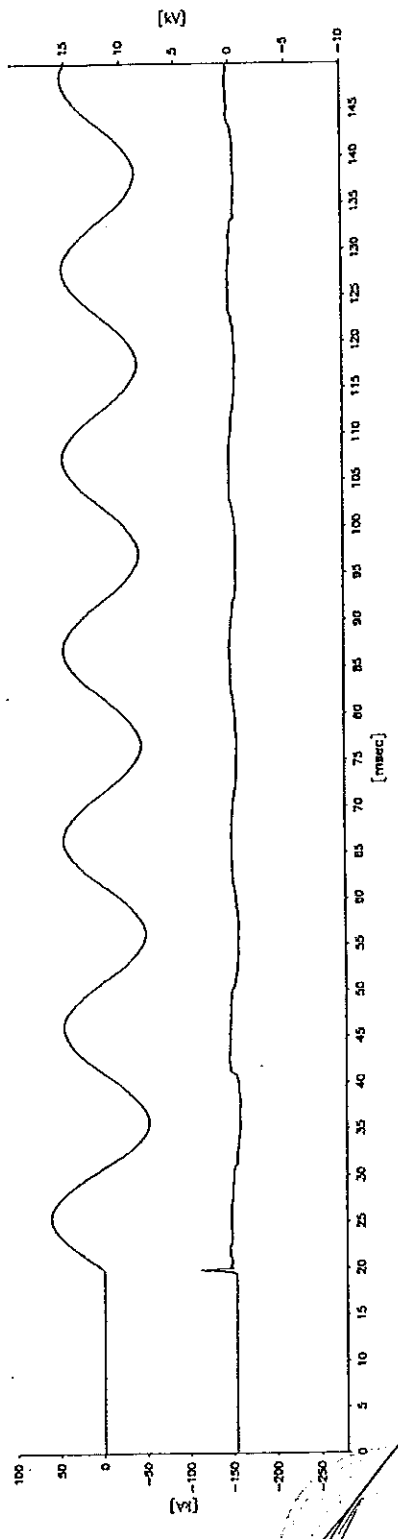
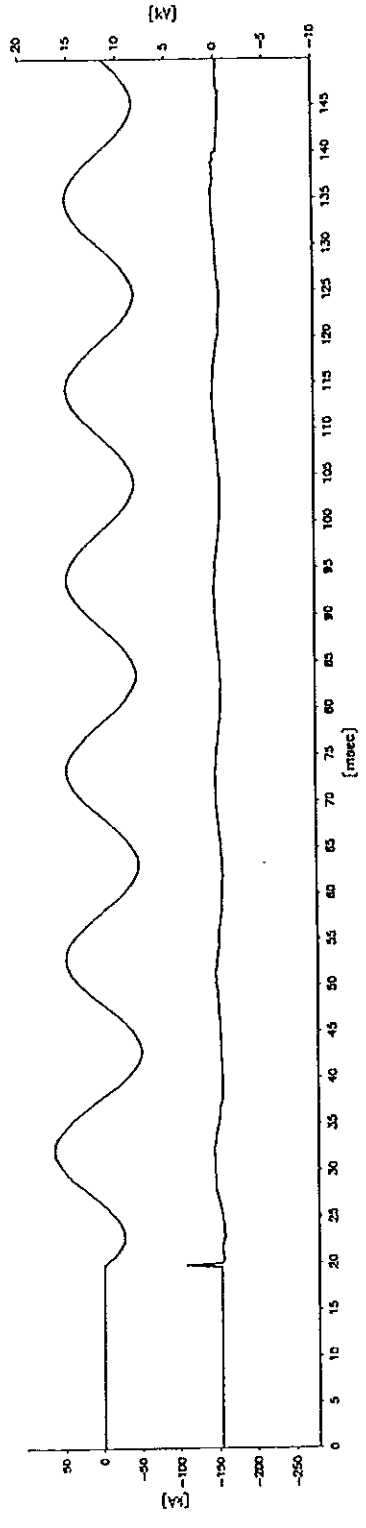
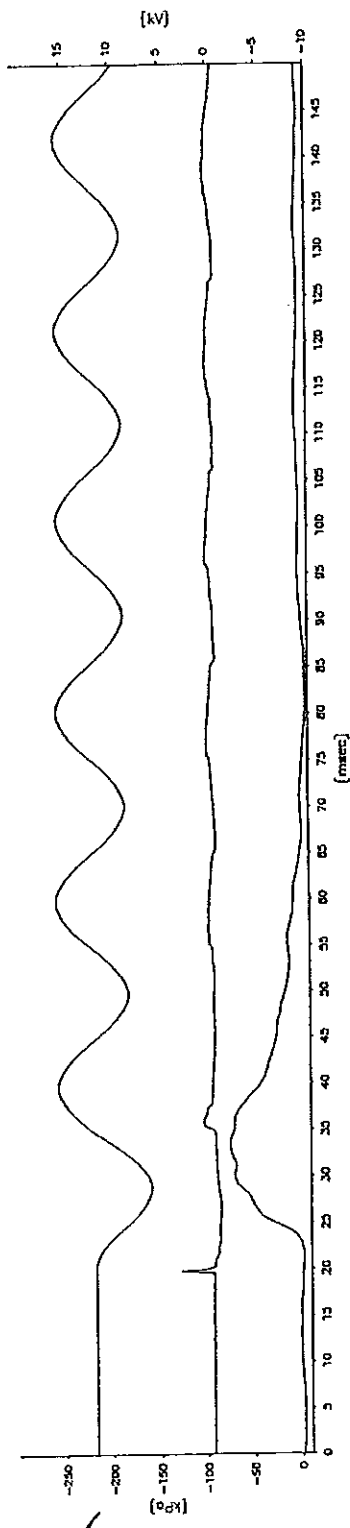
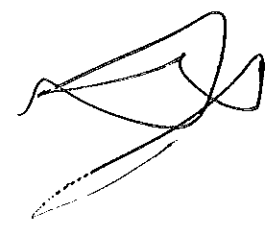


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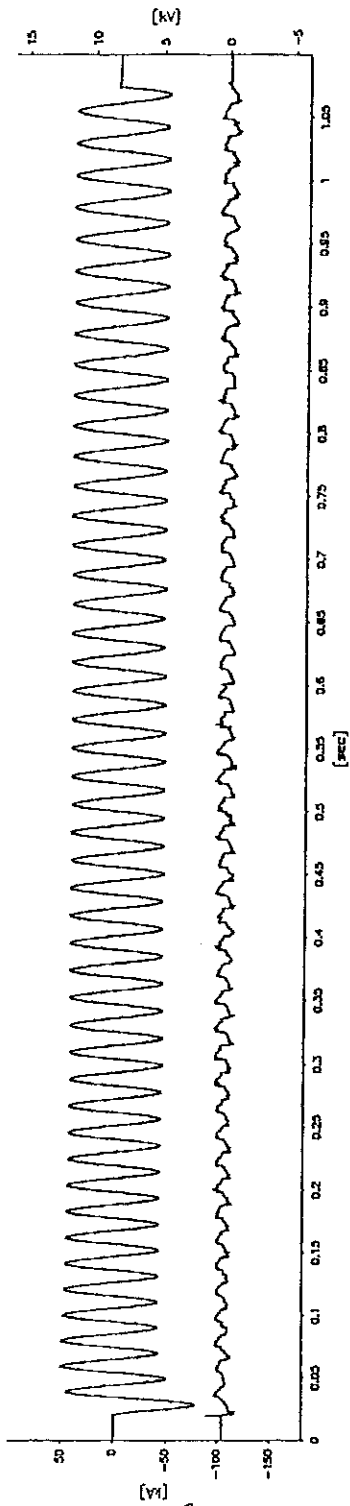


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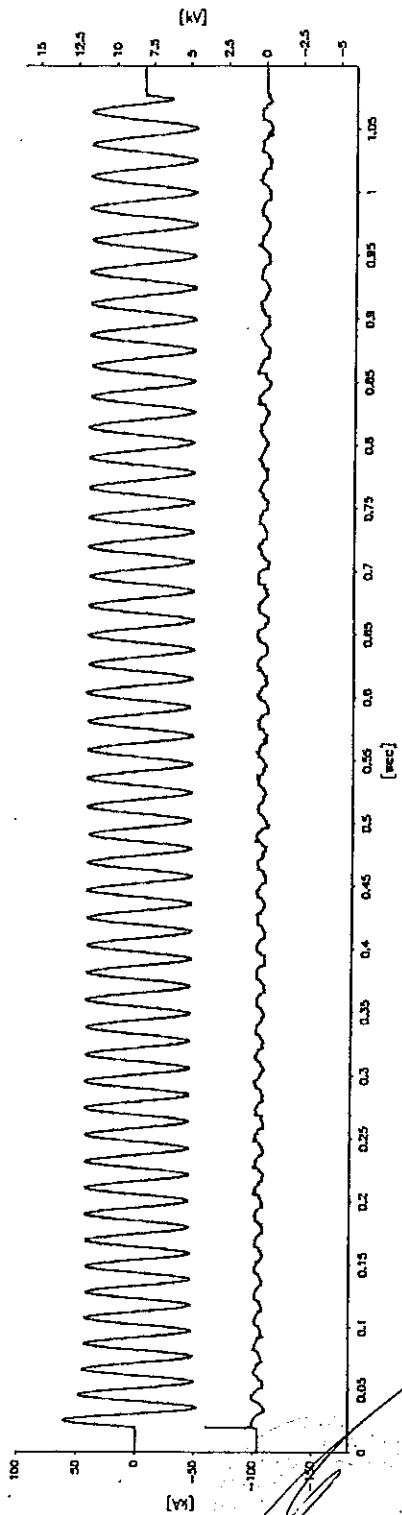
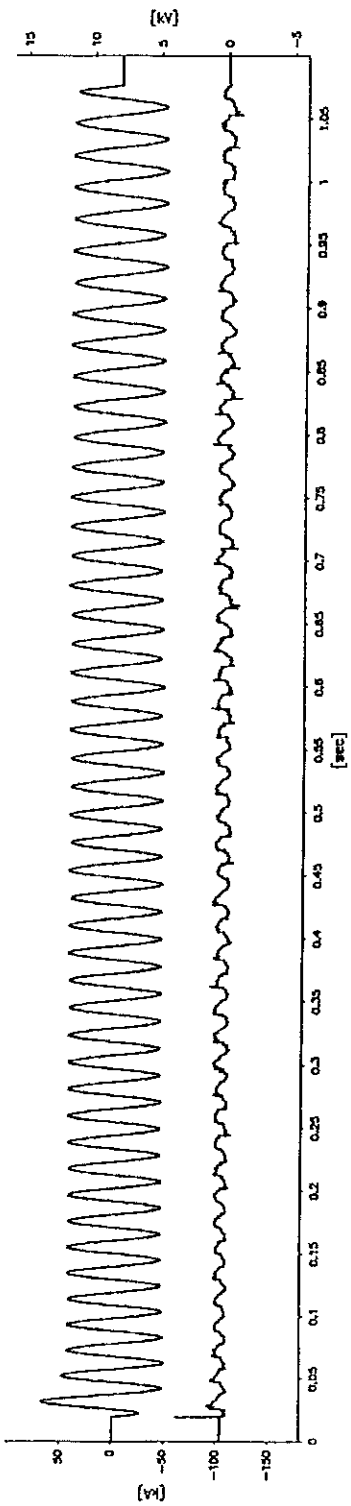
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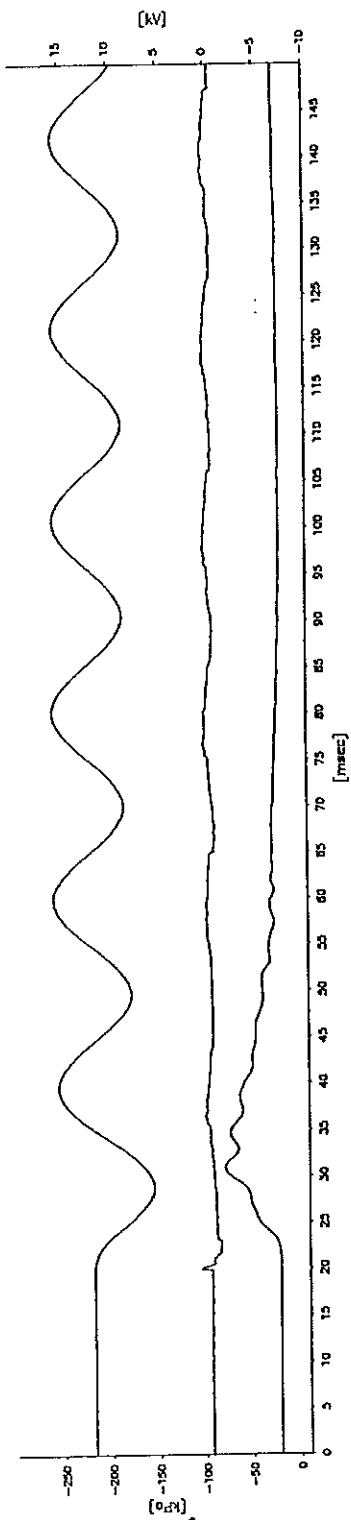


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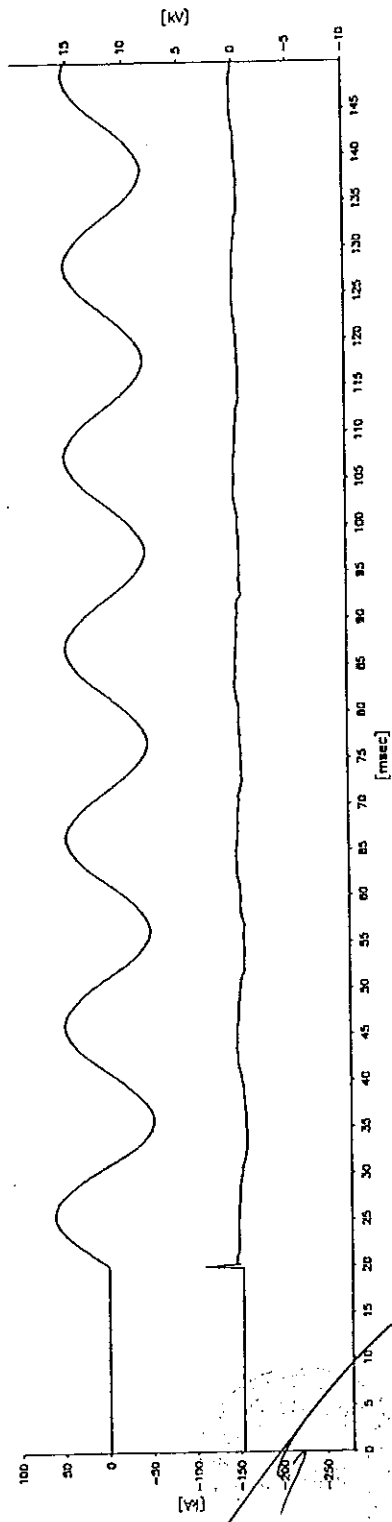
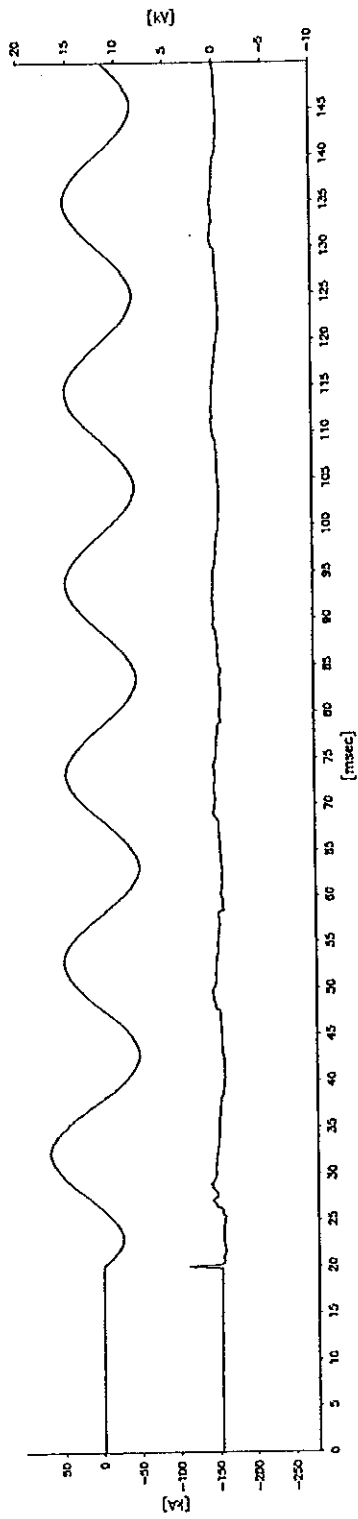
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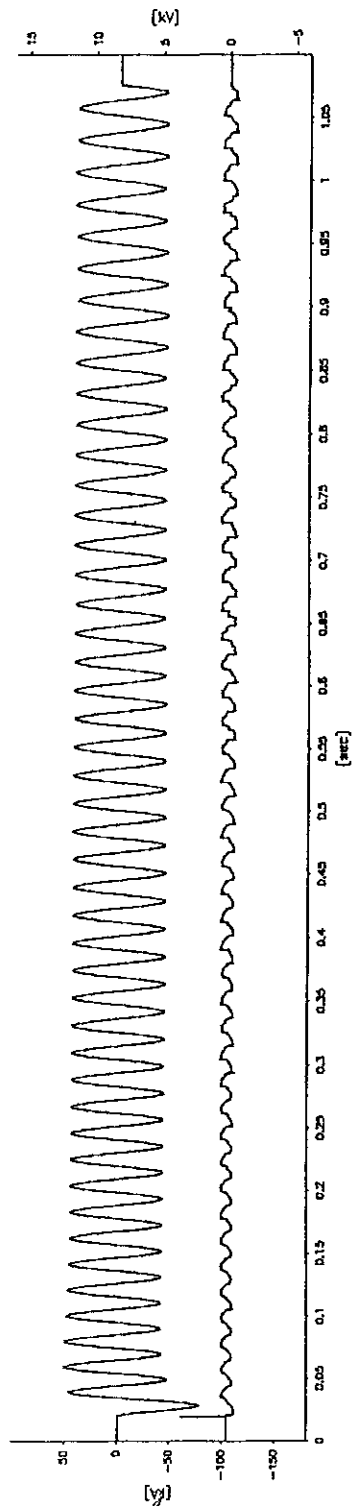
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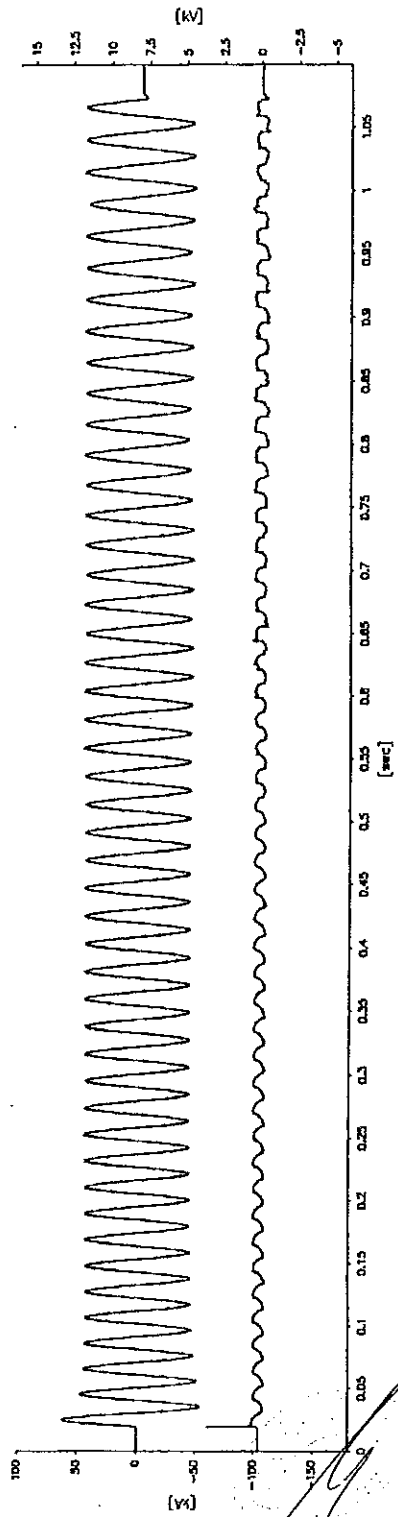
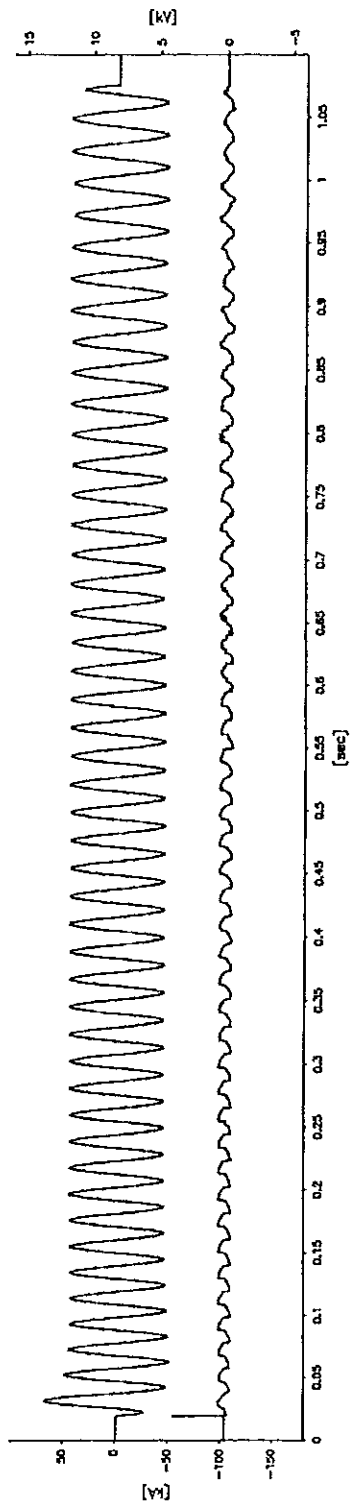


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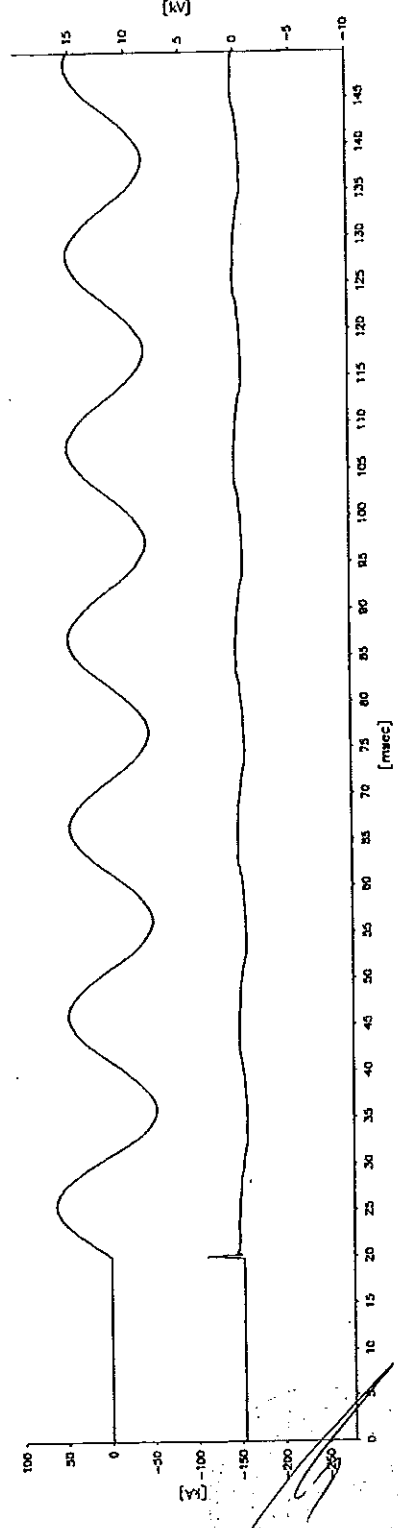
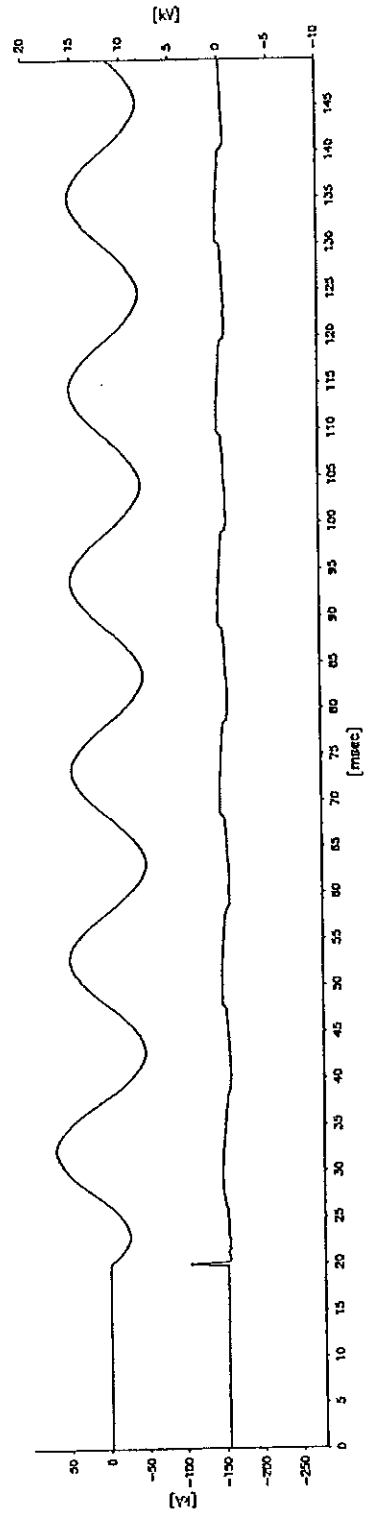
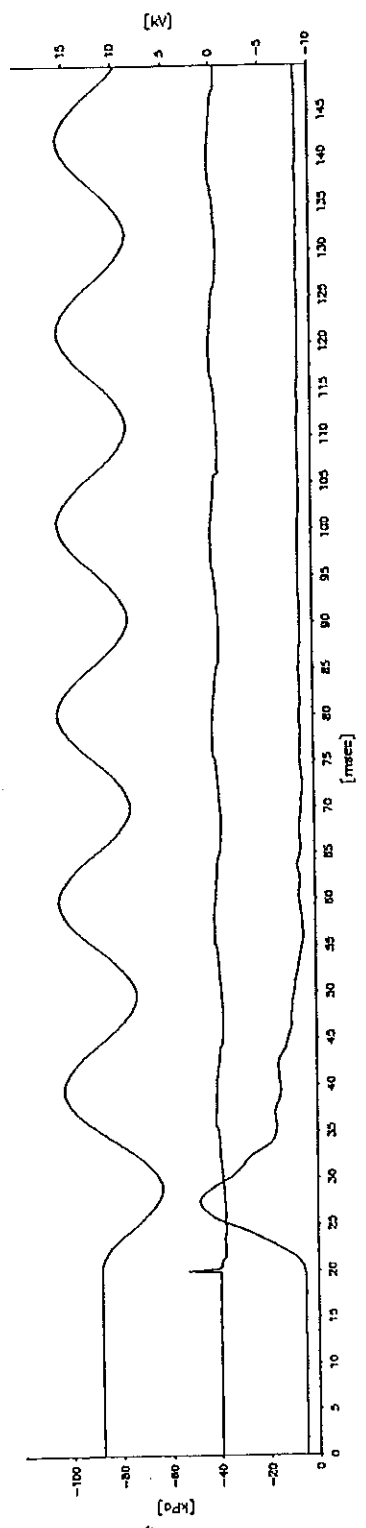
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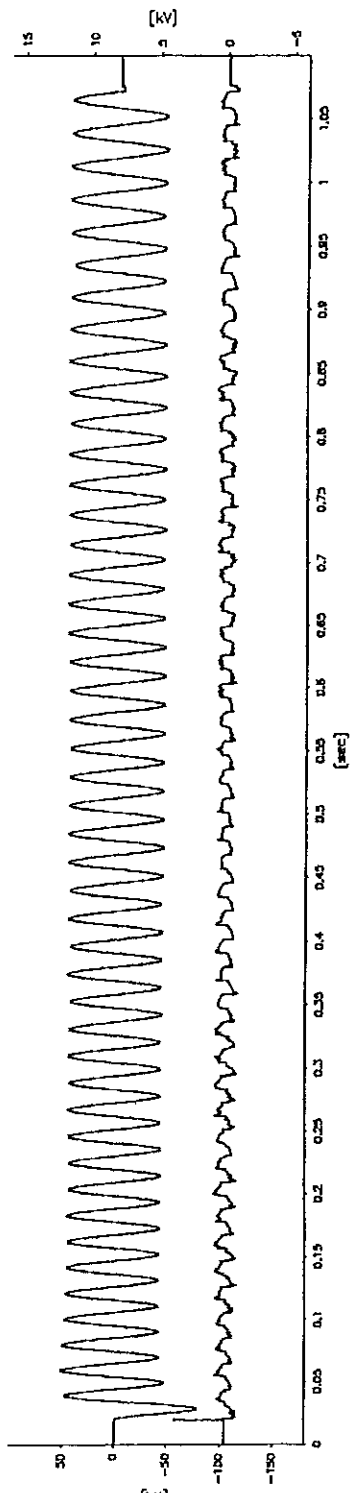
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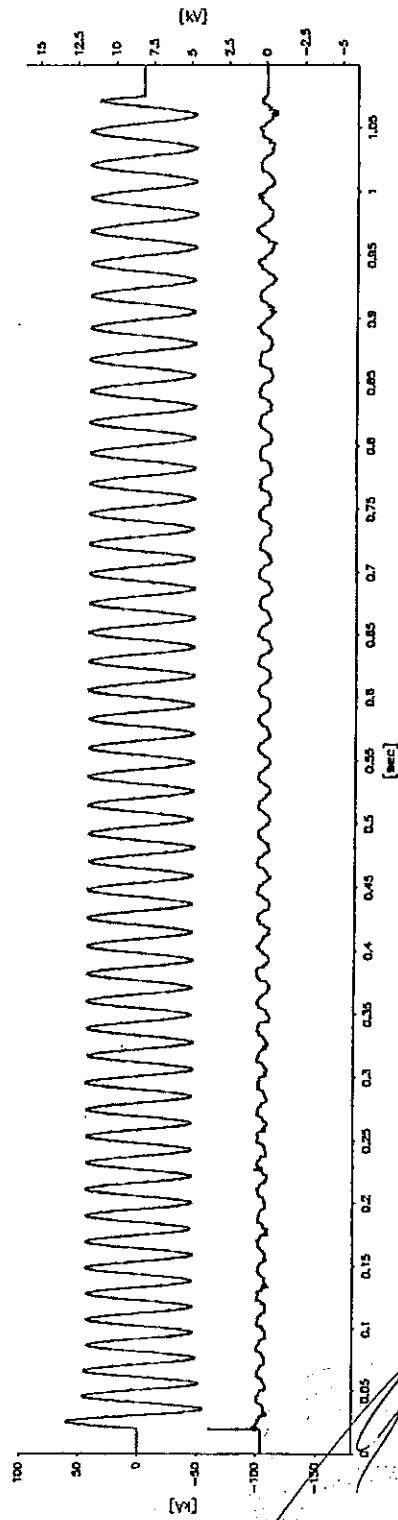
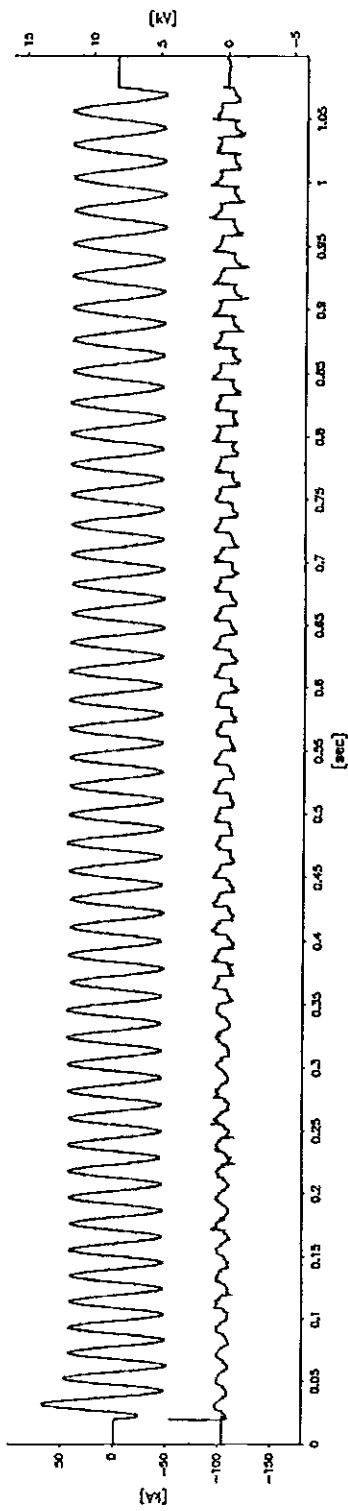
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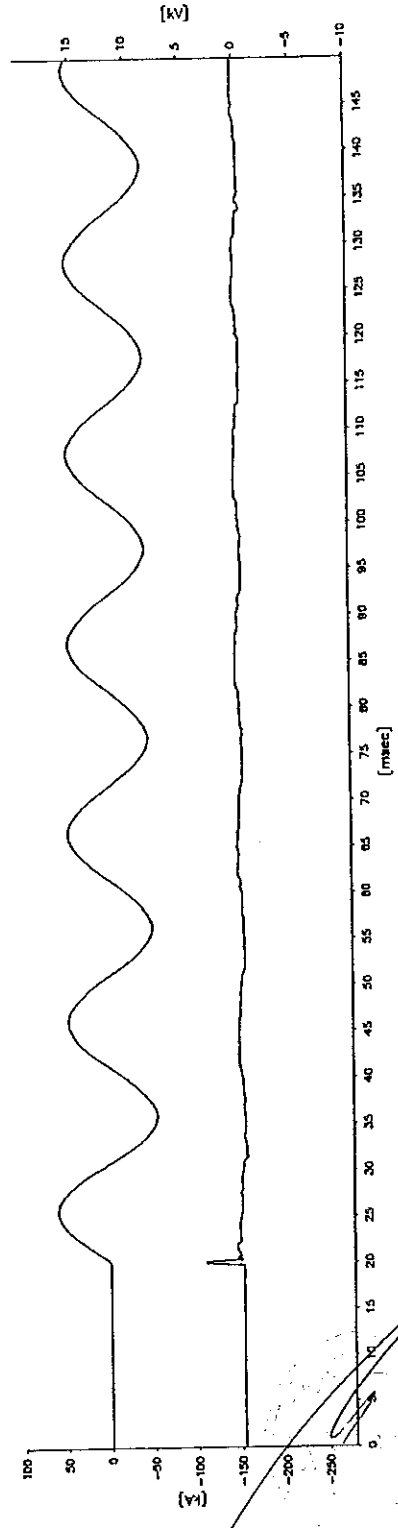
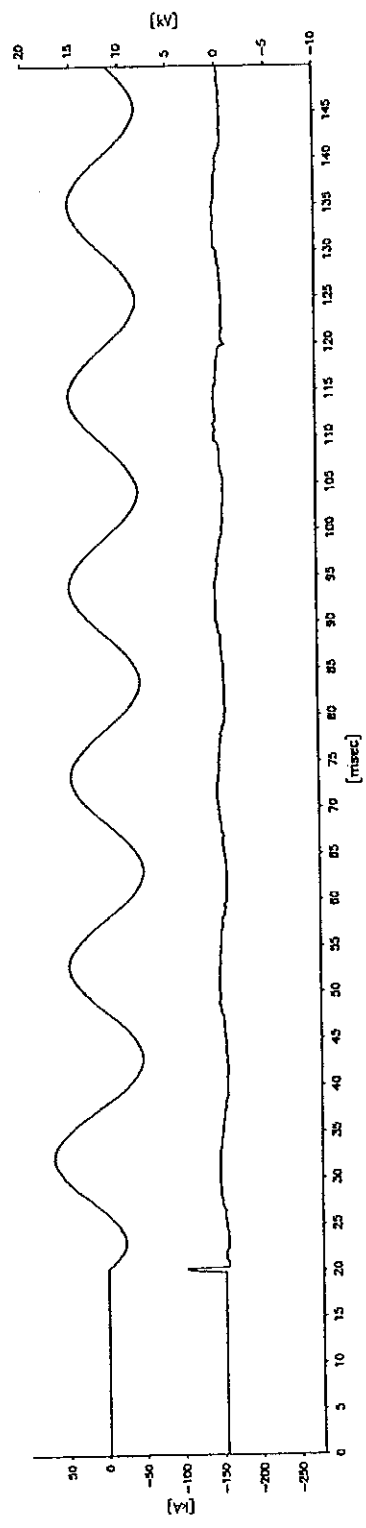
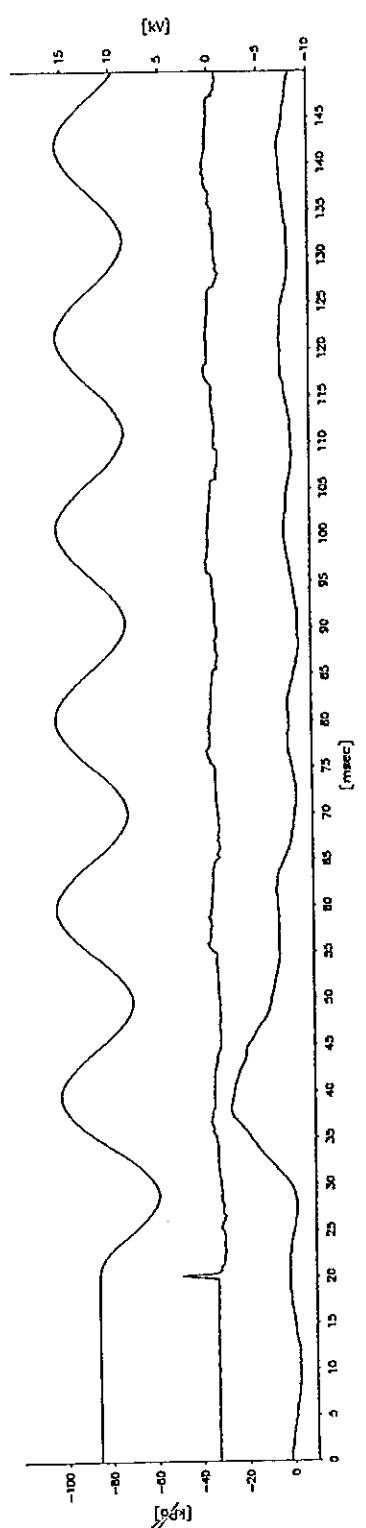
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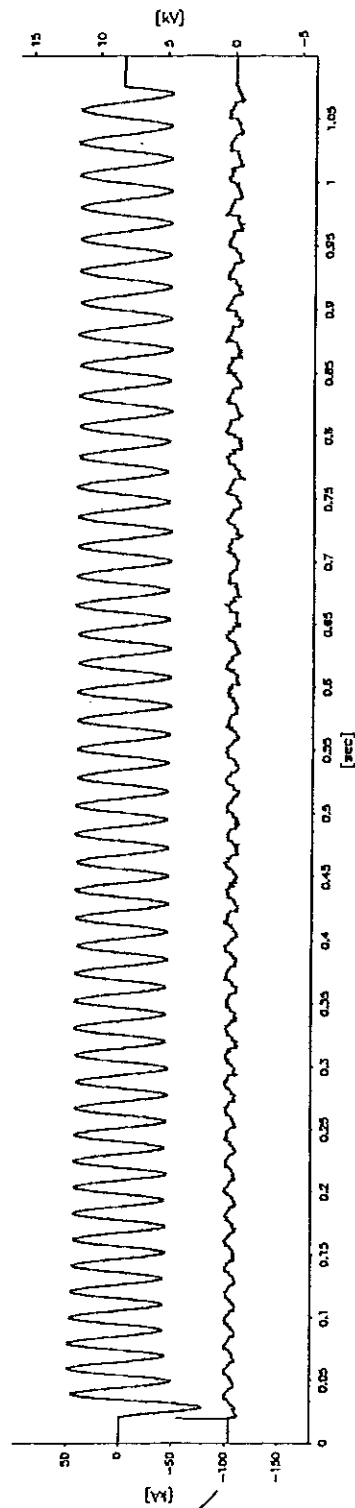
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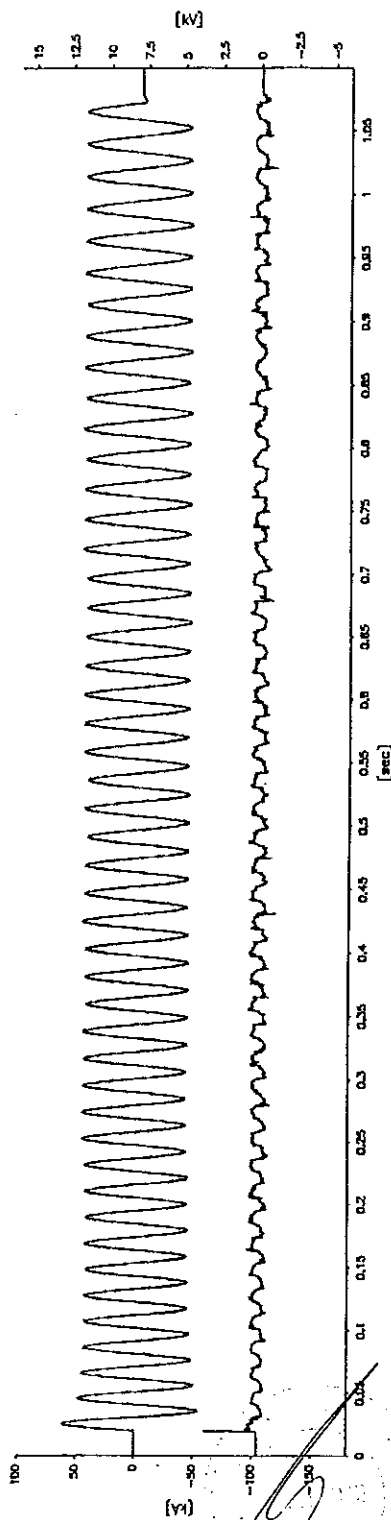
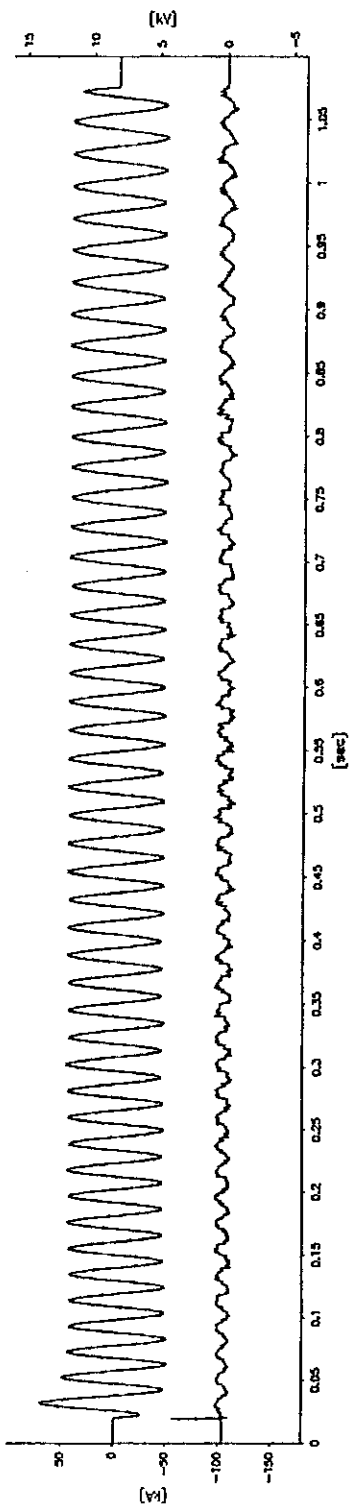
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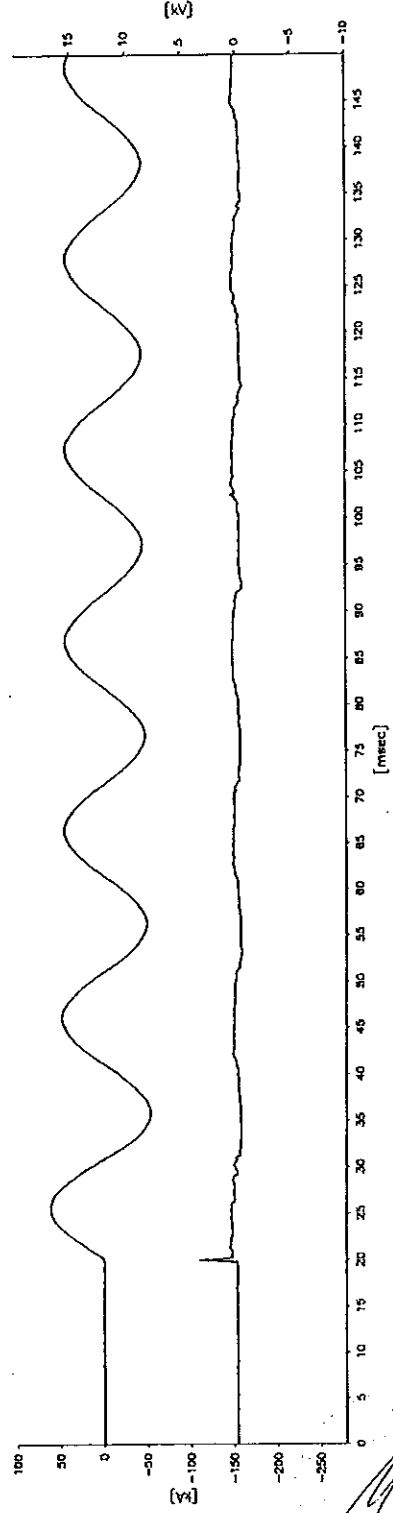
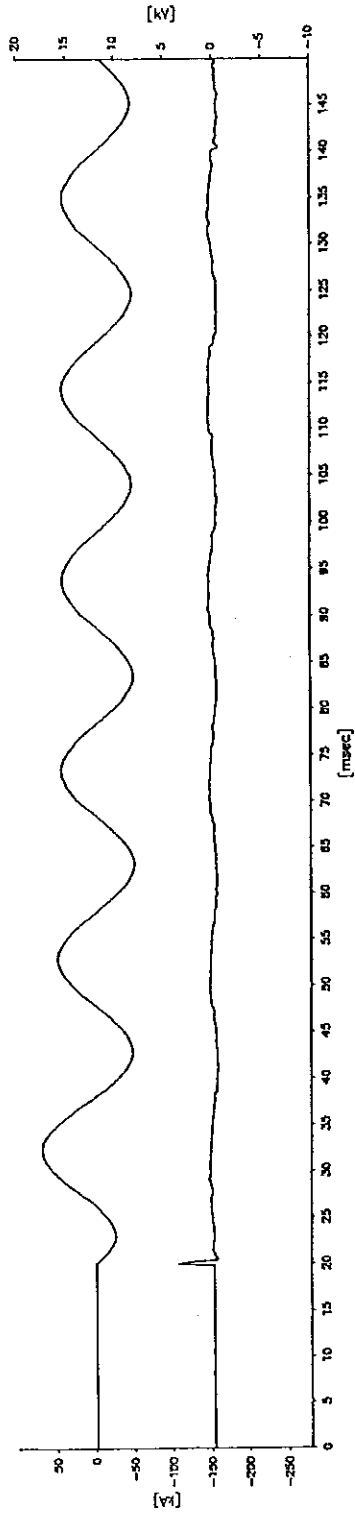
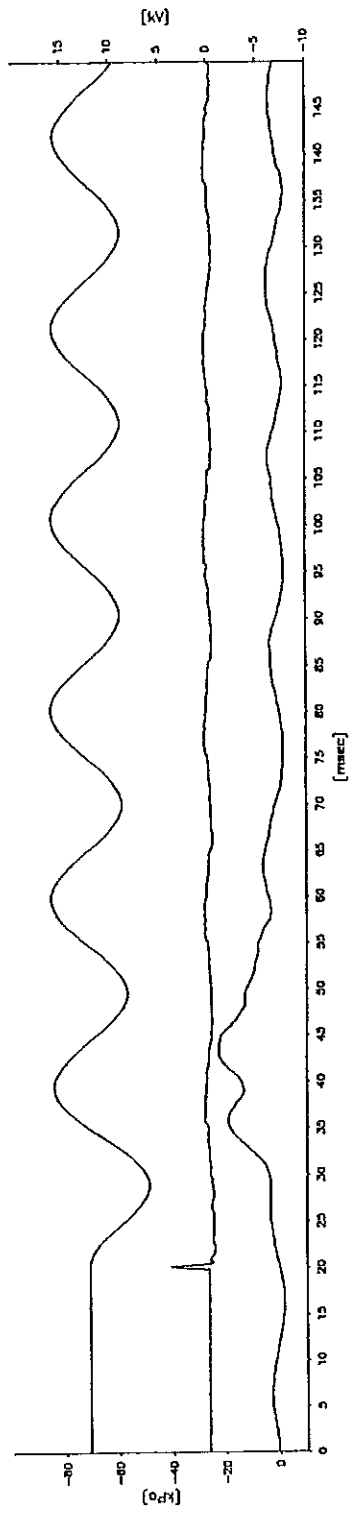
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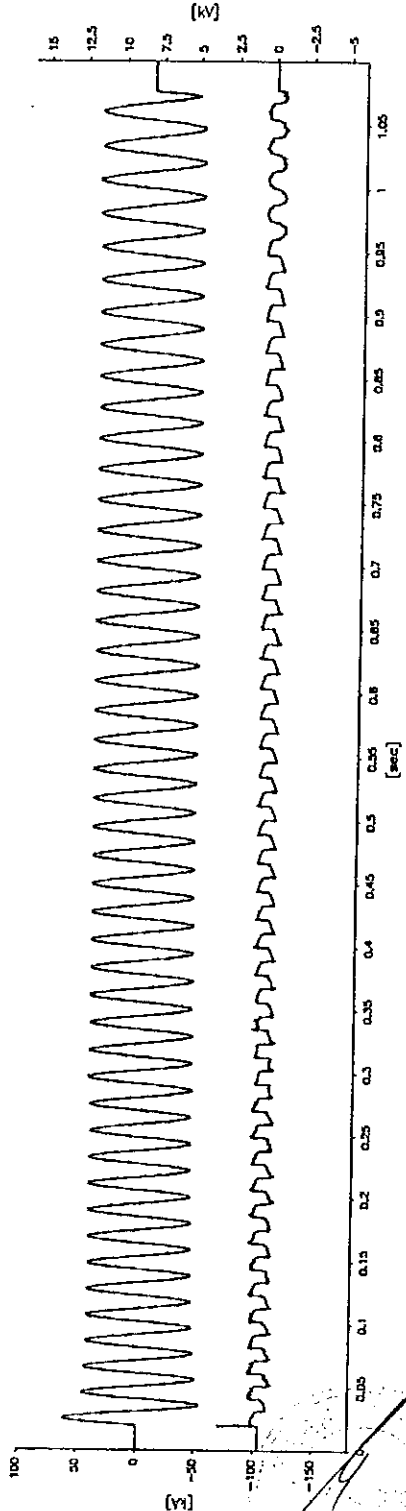
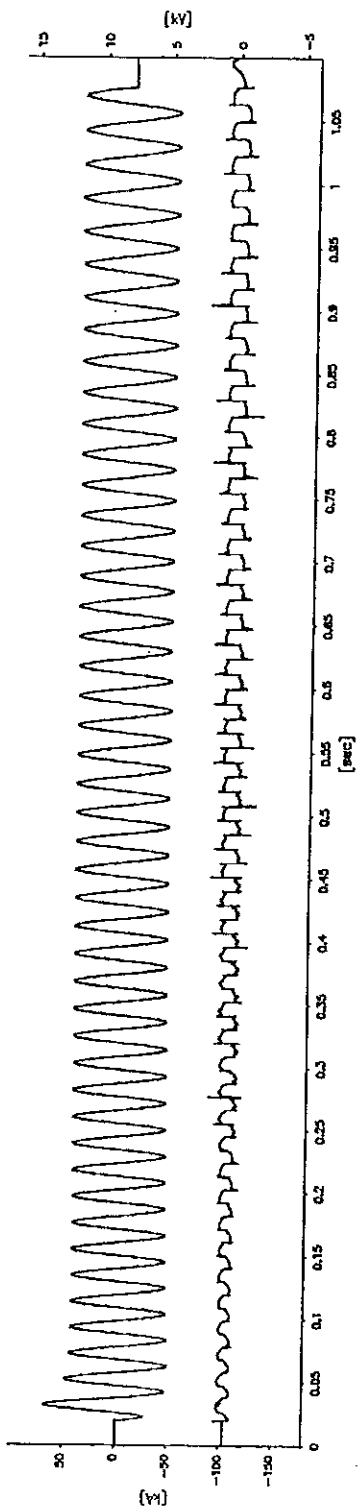
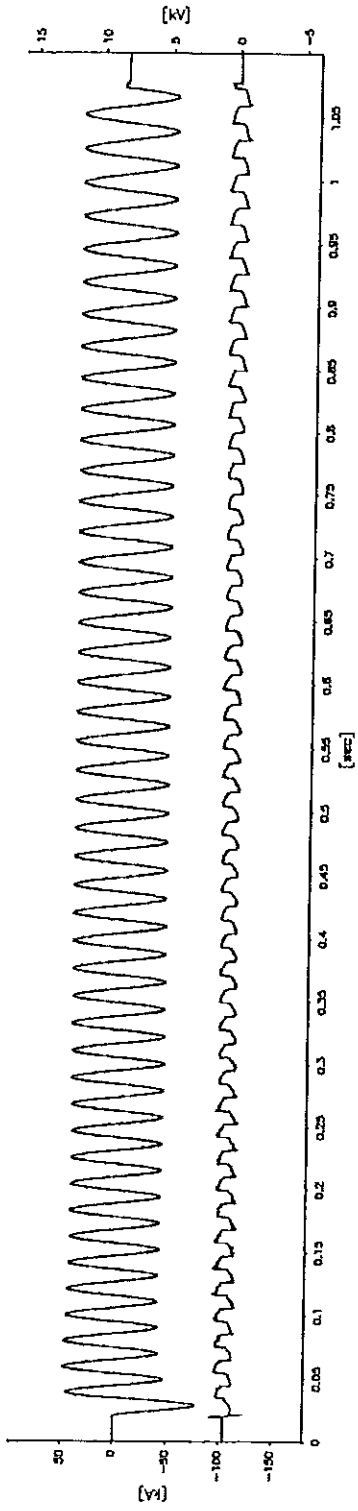
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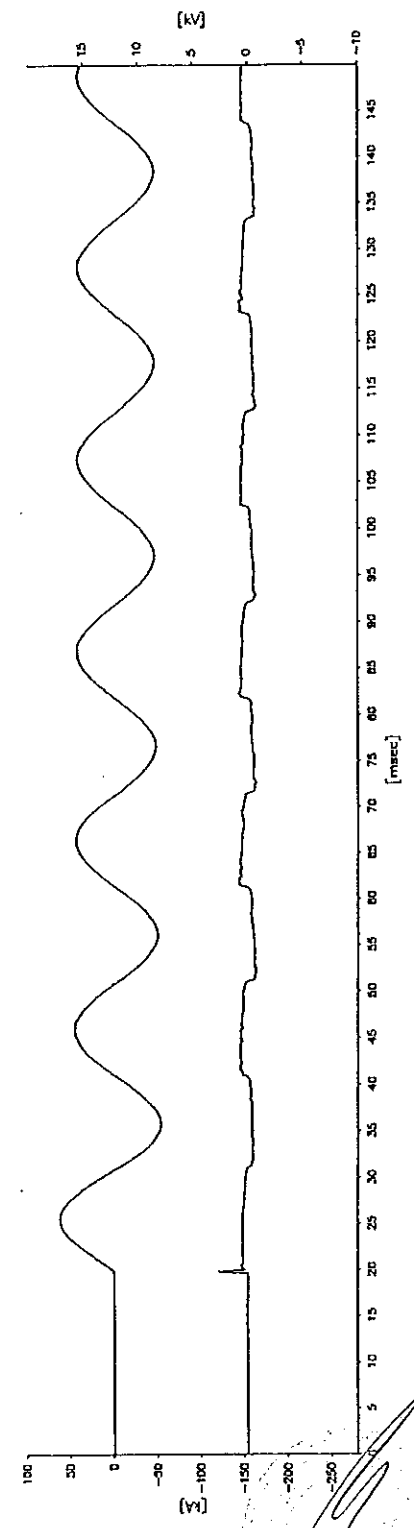
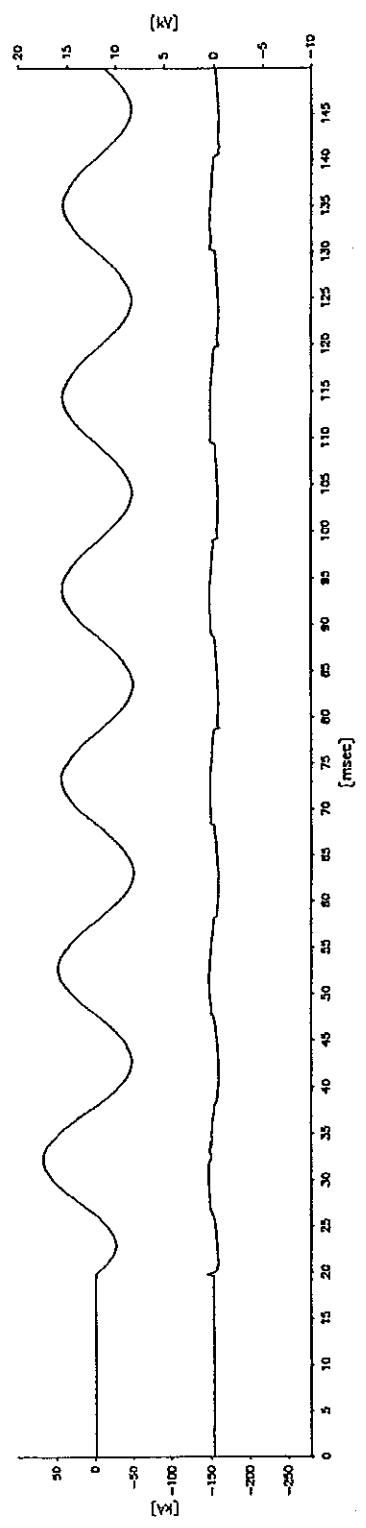
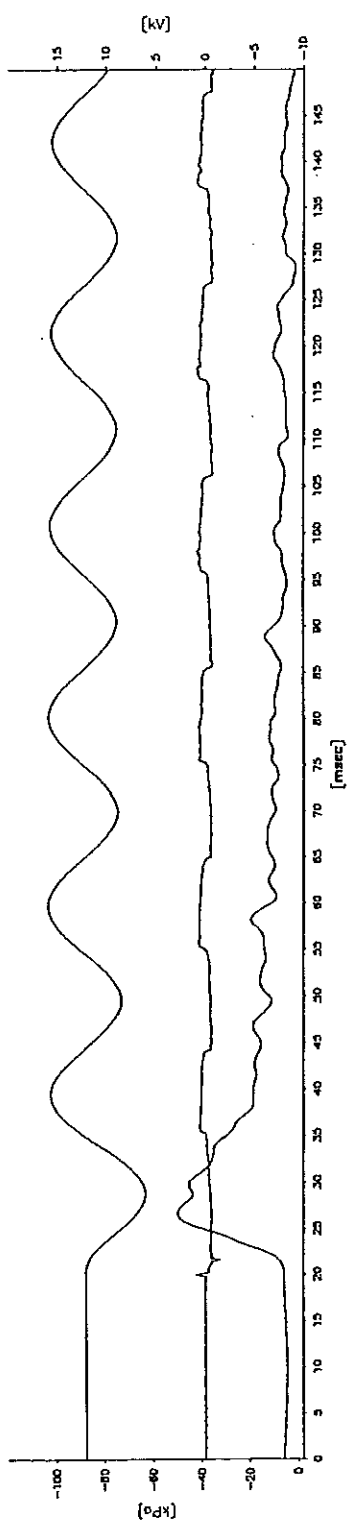
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HZ146L02.008



HZ146L02.009

12.7.2000



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HZ146L02.009



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ABB Calor Emag Laboratories



TEST REPORT No. HZ 144 F 08

Sheet 1

Issued by an Accredited Laboratory
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Copy-No. 02e

Test Object Metal-clad air-insulated switchgear type ZS1.2 consisting of three panels. Center panel equipped with vacuum circuit-breaker type VM1 1212-31.

Rated voltage	U	12 kV
Rated normal current (busbar)	I _n	1250 A
Rated frequency	f	50/60 Hz
Rated short-time withstand current	I _{th}	31.5 kA
Rated peak withstand current	I _p	80 kA
Rated duration of short-circuit current	t _{th}	3 s
Rated short-circuit breaking capacity at 12 kV	I _{sc}	31.5 kA

Manufacturer ABB Calor Emag Mittelspannung GmbH, D-40472 Ratingen

Tests performed Peak withstand current test on main circuit of the center panel with vacuum circuit-breaker with 83.1 kA and short-time withstand current test up to 32.3 kA – 3.03 s (equivalent to 32.5 kA – 3 s).

Test Specification The tests have been carried out in accordance with the client's instructions. Test procedure and test parameters were based on IEC 60694/2nd Ed./1996-05/Clause 6.6, IEC 60298/3rd Ed./1990-12/Clause 6.5, IEC 60056/4th Ed./1987/Clause 6.5.

Test Results The switchgear with vacuum circuit-breaker passed the tests successfully.

Test Date 23rd of February 2000

Client ABB Calor Emag Mittelspannung GmbH, D-40472 Ratingen



9th of June 2000
Date of Issue

E. Jüttler
Laboratory Manager

M. K. Hermann
Test Engineer

Total Number of Sheets: 16 Sheets (Test Report) + 4 Sheets (Oscillograms)

This test report refers exclusively to the object tested.
ABB Calor Emag Mittelspannung GmbH is certified according to DIN ISO 9001 by DQS under Reg. No. 373 - 02

ABB Calor Emag Laboratories Ratingen are accredited according to EN 45001 by DATech under Reg. No. DAT - P - 032/93

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High-Power Testing Laboratory

Oberhausener Straße 33
D - 40472 Ratingen

Phone + 49 (0) 21 02 12-1736
Fax + 49 (0) 21 02 12-1713



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ABB Calor Emag Laboratories



TEST REPORT No. HZ 144 F 08
Issued by an Accredited Laboratory
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Sheet 2

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	Sheet
Test Report - Cover Sheet	1
Contents	2
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Table of drawings of the Test Object	5
Drawings	6 - 10
Technical Data of Test Circuit	11
Principle Diagram of Test Circuit	12
Peak and Short-Time Withstand Current Test	13
Table of No-load Operations / Measurement of the Resistance	14
Photos	15 - 16
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TEST REPORT No. HZ 144 F 08

Sheet 3

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Technical Data of Test Object

(Ratings assigned by the manufacturer)

Switchgear

Test Object: Metal-clad air-insulated switchgear
Type: ZS1.2
Manufacturer: ABB Calor Emag Mittelspannung GmbH, D-40472 Ratingen
Serial-No.: 7550027/2001/00 (center panel) **Year of manufacture:** 2000
Drawing Nos.: See sheet-no. 5

Rated voltage	12	kV
Rated lightning impulse withstand voltage	75	kV
Rated power frequency withstand voltage	28	kV
Rated frequency	50/60	Hz
Rated current	1250	A
Rated short-circuit peak withstand current	80	kA
Rated short-time withstand current	31.5	kA
Rated short-circuit duration	3	s
Insulating medium	air	
Rated filling pressure (abs., 20 ° C)	-	kPa

Prospective values under internal-arc conditions:

Peak withstand current	80	kA
Short-time withstand current	31.5	kA
Short-circuit duration	1	s

Additional specifications and data: -

The panel was equipped with current transformers made by ABB, serial-nos. 957058, 957059 and 957060.

Ratio: 1250/5/5 A
Voltage: 12/28/75 kV 50 Hz
E 1999
31.5 kA – 3 s / 125 kA
IEC 60044-1
1S1 – 1S2 15 VA cl. 0.5
2S1 – 2S2 15 VA cl. 5P10

Date of receipt of test object: 22nd of February 2000



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DAT-P-032/93

ABB Calor Emag Laboratories



TEST REPORT No. HZ 144 F 08

Sheet 4

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Technical Data of Test Object (Ratings assigned by the manufacturer) Switching Device

Test Object: Vacuum circuit-breaker in center panel

Type: VM1 1212-31
Vacuum interrupter: 99G4S00809, 99G4S00825, 99G4S00861

Manufacturer: ABB Calor Emag Mittelspannung GmbH, D-40472 Ratingen

Serial-No.: 7006082/4002/99 **Year of manufacture:** 1999

Drawing Nos.: See sheet-no. 5

Rated voltage	12	kV
Rated lightning impulse withstand voltage	75	kV
Rated power frequency withstand voltage	28	kV
Rated frequency	50/60	Hz
Rated normal current	1000	A
Rated short-circuit breaking current	31.5	kA
Rated short-circuit making current	80	kA
DC-component	35	%
Pole factor	1.5	
Rated peak withstand current	80	kA
Rated short-time withstand current	31.5	kA
Rated duration of short-circuit	3	s
Rated operating sequence	O-0.3 s-CO-3 min-CO	
Rated times of circuit-breaker:		
- opening time	≈ 40	ms
- closing time	≈ 55	ms
Number of poles	3	
Number of units per pole	1	
Rated auxiliary voltages:		
- voltage of trip coil	220	V-DC
- voltage of closing coil	220	V-DC
- voltage of motor	-	V-DC

Additional specifications and data: -

Date of receipt of test object: 22nd of February 2000



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TEST REPORT No. HZ 144 F 08

Sheet 5

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Table of Drawings of the Test Object

The drawing submitted for identification of the test object were stamped and signed by the test engineer. The manufacturer/client has guaranteed by signature on the drawings that the equipment submitted for tests has been manufactured in accordance with the given drawings.

A copy of the following drawings is part of this Test Report:

Cubicle 12 kV, ≤ 1000 A, T.650	GCE8010450R0101,	sheet-no. 1,	index 00,
Bushing plate	GCE8005031R0101,	sheet-no. 1,	index 06,
Draw out VM1 12/17.5 kV in ZS1.2	GCE7004912R1141,	sheet-no. 7,	index 00,
Pole compl. VM1, 12 kV, 1250 A	GCE7003979R0104,	sheet-no. 1,	index 06,
VM1-Drive	GCE7004310R0104,	sheet-no. 1,	index 04.



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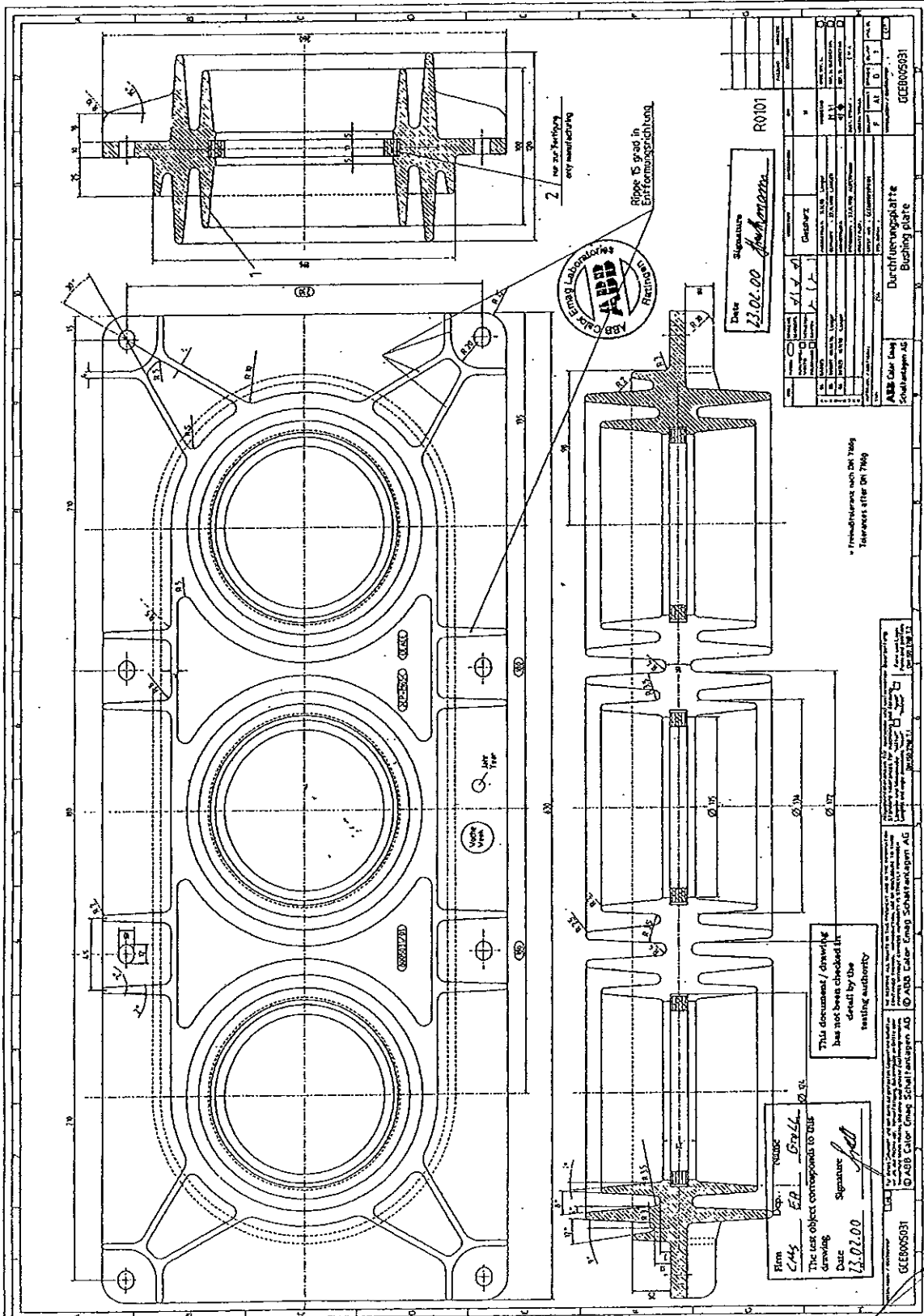
ABB Calor Emag Laboratories

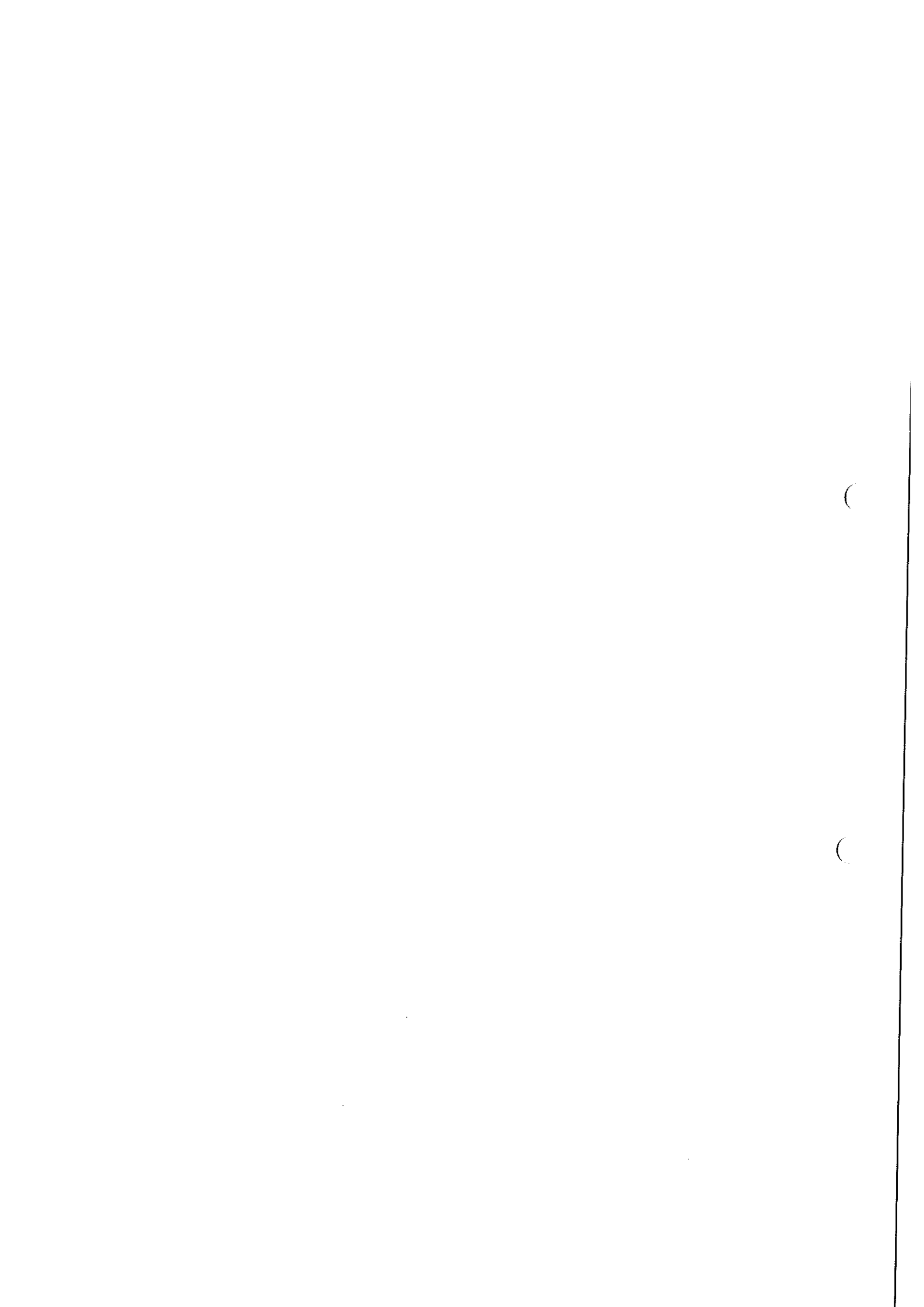


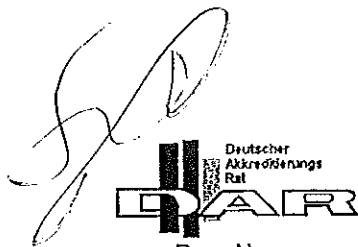
TEST REPORT No. HZ 144 F 08

Sheet 7

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DAT-P-032/93

ABB Calor Emag Laboratories



TEST REPORT No. HZ 144 F 08
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corresponding to EN 45001

Sheet 11

Technical Data of Test Circuits

Test	STC	-	-	-
Oscillogram-No. HZ 144 F 08	1 - 7	-	-	-
Number of phases (circuit)	3	-	-	-
Number of poles/phases (test object)	3	-	-	-
Power frequency Hz	50	-	-	-
Power factor $\cos \phi$	≤ 0.1	-	-	-
Earthing	Generator	earthed via 5 k Ω	-	-
	Transformer	not earthed	-	-
	Short-circuit point	earthed	-	-
Circuit diagram	Sheet no.:	12	-	-
Circuit impedance	m Ω	≈ 5	-	-
-	-	-	-	-
TRV control elements	-	-	-	-
Capacitance in parallel	μF	-	-	-
Resistance in series	Ω	-	-	-
-	-	-	-	-
-	-	-	-	-
Prospective TRV	-	-	-	-
TRV peak value u_c	kV	-	-	-
Time co-ordinate t_3	μs	-	-	-
Time delay t_d	μs	-	-	-
Based on	kV	-	-	-
Rate-of-rise	kV/ μs	-	-	-
-	-	-	-	-
-	-	-	-	-
Voltage measurements	Divider 75 k Ω / 1.1 k Ω	-	-	-
Current measurements	Transformer 50 kA / 5 A	-	-	-

Remarks:-



Reg.-Nr.
DAT-P-032/93

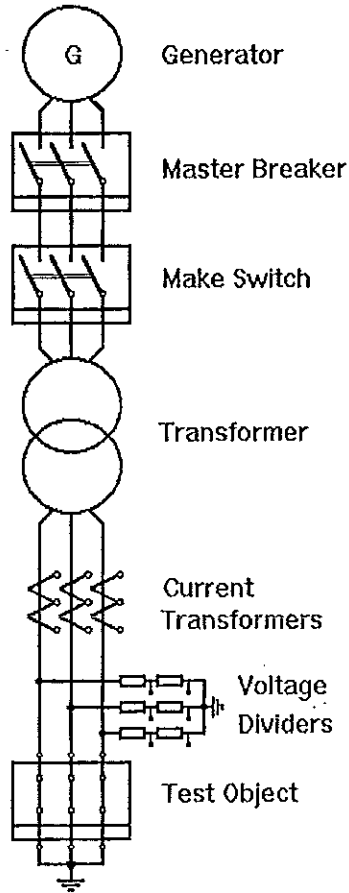
ABB Calor Emag Laboratories



TEST REPORT No. HZ 144 F 08
Issued by an Accredited Laboratory
corresponding to EN 45001

Sheet 12

Principle Diagram of Test Circuit





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DAT-P-032/93

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TEST REPORT No. HZ 144 F 08

Sheet 13

Issued by an Accredited Laboratory
corresponding to EN 45001

Peak and Short-Time Withstand Current Test

Actual values

Condition of test object before test: Switchgear new.

Connection to test object: By means of copper conductors to the busbars outside the right-hand panel, cable terminals of the center panel short-circuited and earthed.

Oscillogram-No. HZ 144 F 08			5	6	-	-	
Peak short-circuit current	L1	kA	83.1	78.7	-	-	
	L2	kA	24.8	23.8	-	-	
	L3	kA	57.6	54.7	-	-	
Short-circuit current	first cycle	L1	kA	35.1	33.5	-	-
		L2	kA	41.0	39.1	-	-
		L3	kA	34.0	32.5	-	-
	last cycle	L1	kA	28.1	30.2	-	-
		L2	kA	33.8	36.2	-	-
		L3	kA	27.3	29.3	-	-
Equivalent r.m.s. value	L1	kA	30.3	30.5	-	-	
	L2	kA	36.5	36.7	-	-	
	L3	kA	29.6	29.7	-	-	
Average value		kA	32.1	32.3	-	-	
Duration of short-circuit current		s	1.00	3.03	-	-	
Short-time current	1 s	L1	kA	30.3	-	-	-
		L2	kA	36.5	-	-	-
		L3	kA	29.6	-	-	-
			kA	32.1	-	-	-
Short-time current	3 s	L1	kA	-	30.7	-	-
		L2	kA	-	36.9	-	-
		L3	kA	-	29.9	-	-
			kA	-	32.5	-	-
Average value							

Condition of test object after test:
Switchgear and circuit-breaker without change.

Remarks:

- HZ 144 F 08 / 1: Current calibration.
- HZ 144 F 08 / 2 and 7: No-load operation before and after tests.
- HZ 144 F 08 / 3 and 4: Tests with reduced values.



Reg.-Nr.
DAT-P-032/93

ABB Calor Emag Laboratories



TEST REPORT No. HZ 144 F 08

Sheet 14

Issued by an Accredited Laboratory
corresponding to EN 45001

Actual Values of No-load Operations

Rated supply voltage of opening coil 220 V dc

	Operation	Voltage closing coil V	Closing time ms	Voltage opening coil V	Opening time ms
Test HZ 144 F 08 / 2	O	-	-	220	35.0
Test HZ 144 F 08 / 7	O	-	-	220	36.5

Measurement of the Resistance

	Phase L 1	Phase L 2	Phase L 3
Before Test HZ 144 F 08	117 $\mu\Omega$	113 $\mu\Omega$	103 $\mu\Omega$
After Test HZ 144 F 08 / 6	120 $\mu\Omega$	113 $\mu\Omega$	103 $\mu\Omega$

Measuring points: Infeeding busbar against short-circuit point in the center panel.

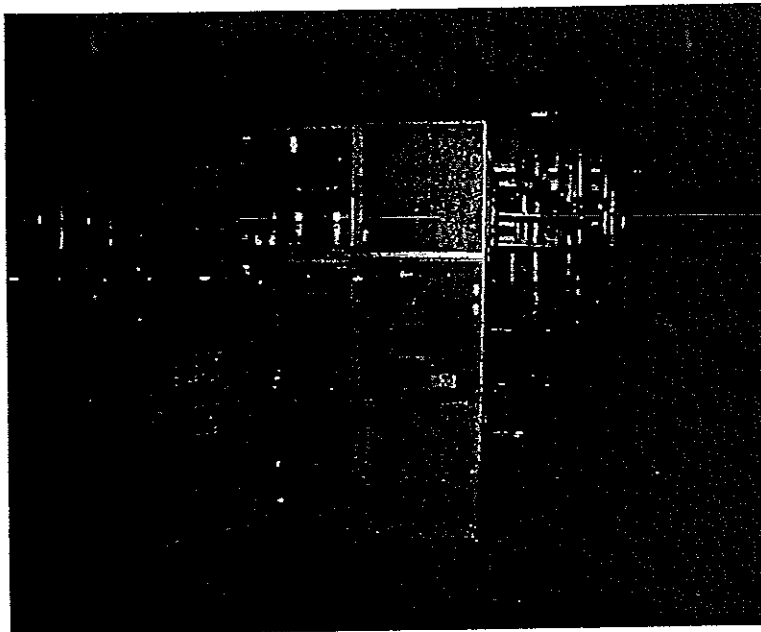


Photo No. 01
Before Test HZ 144 F 08 / 1

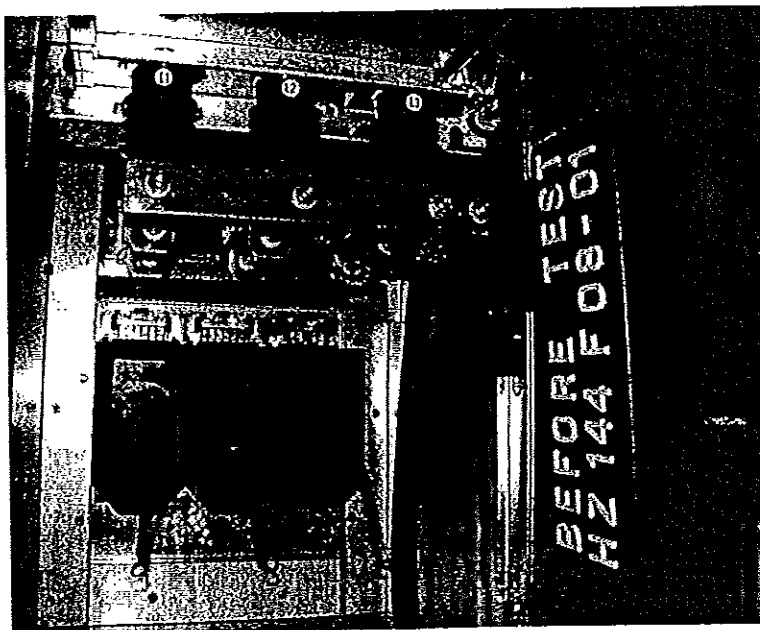


Photo No. 02
Before Test HZ 144 F 08 / 1

M

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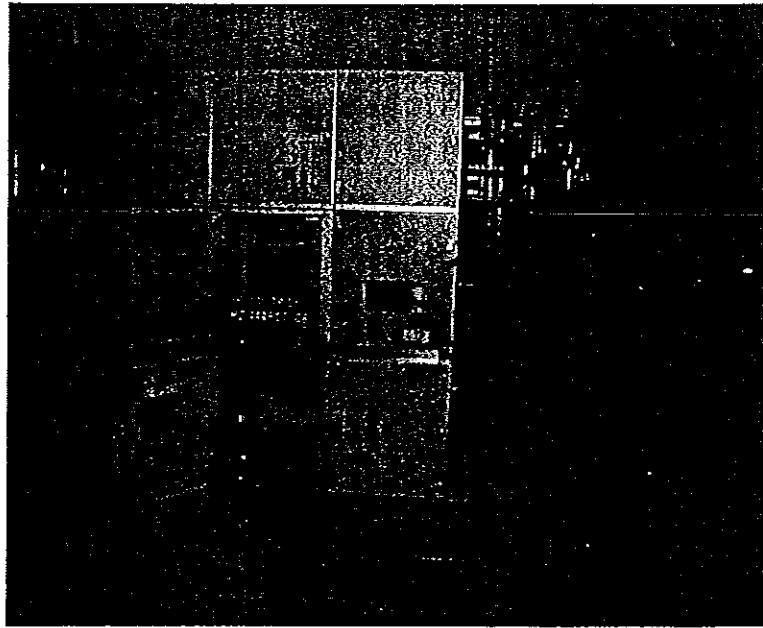


Photo No. 03
After Test HZ 144 F 08 / 6

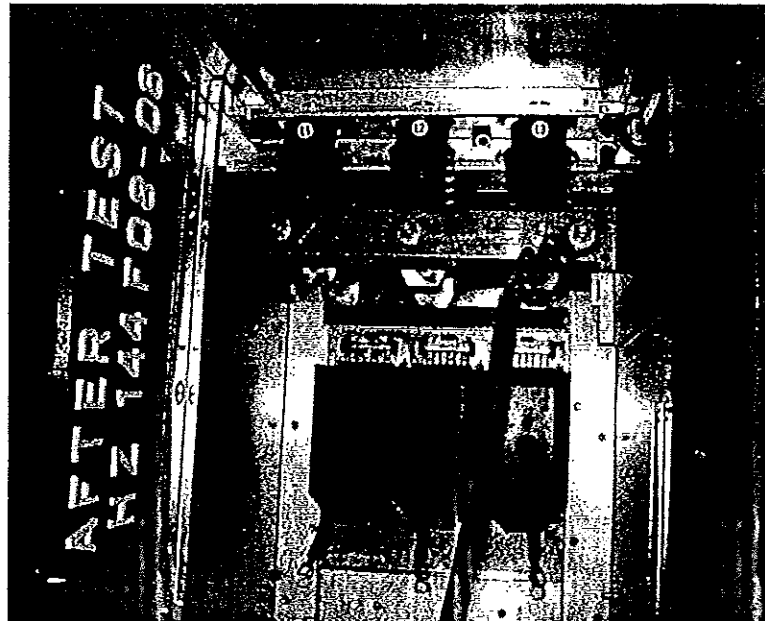


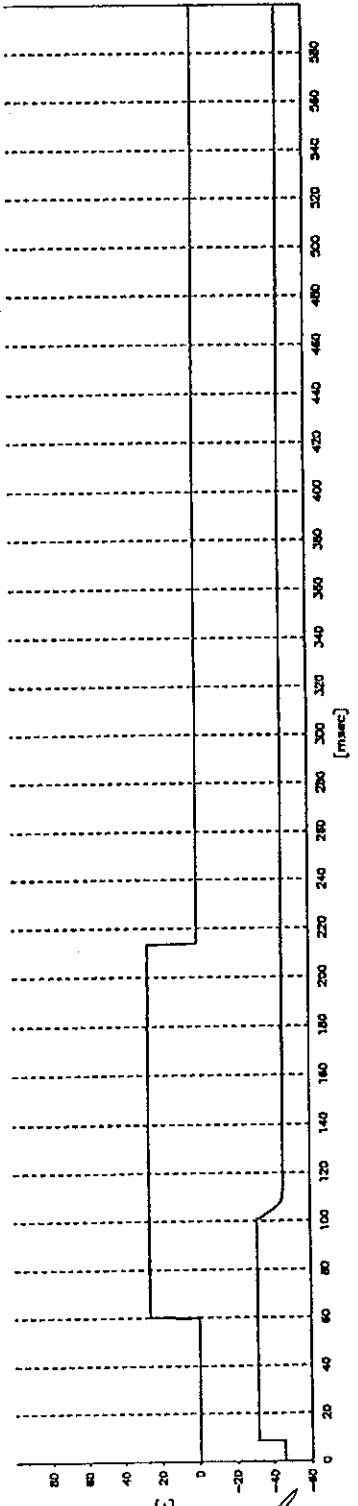
Photo No. 04
After Test HZ 144 F 08 / 6





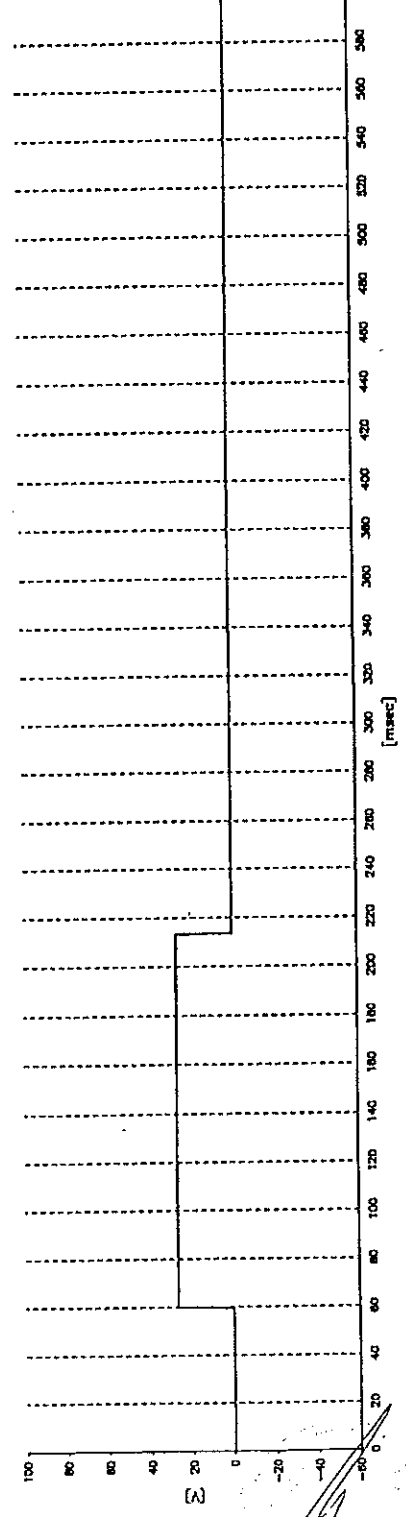
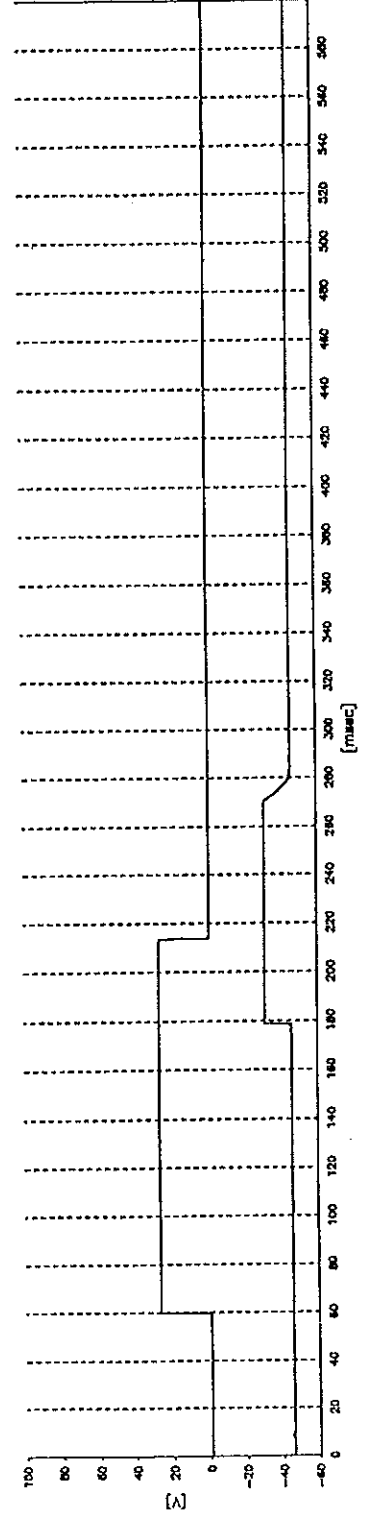
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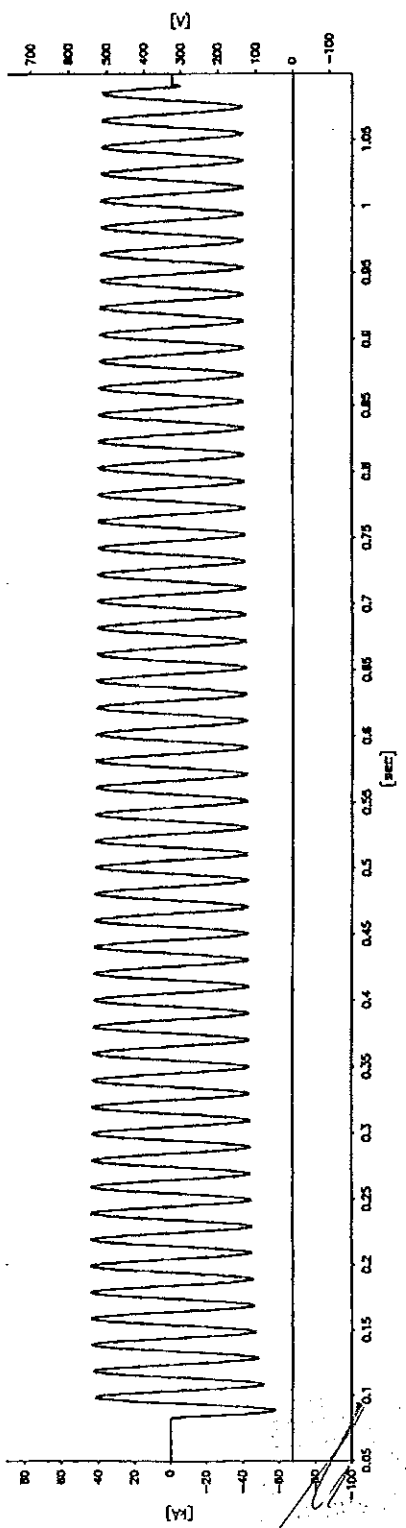
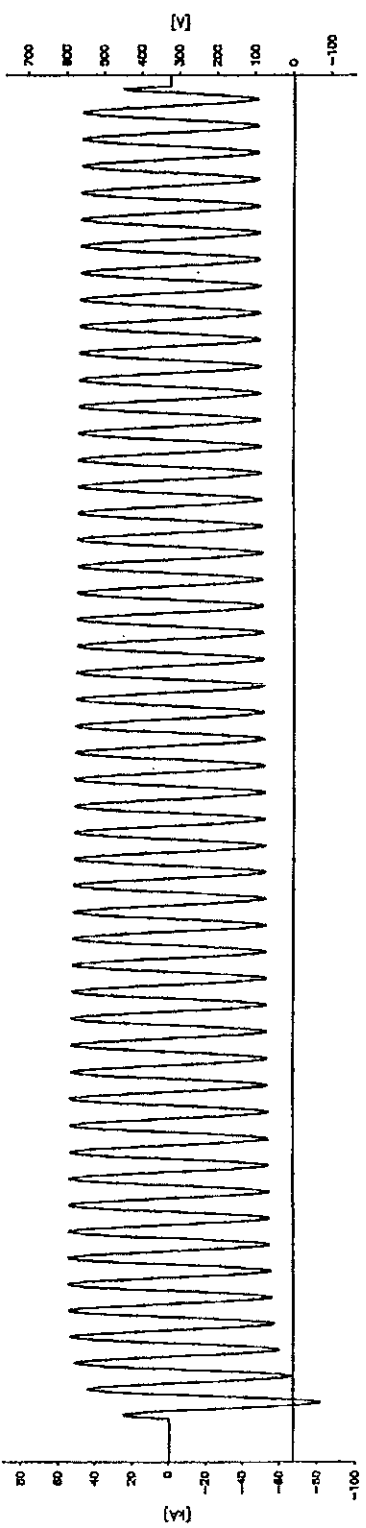
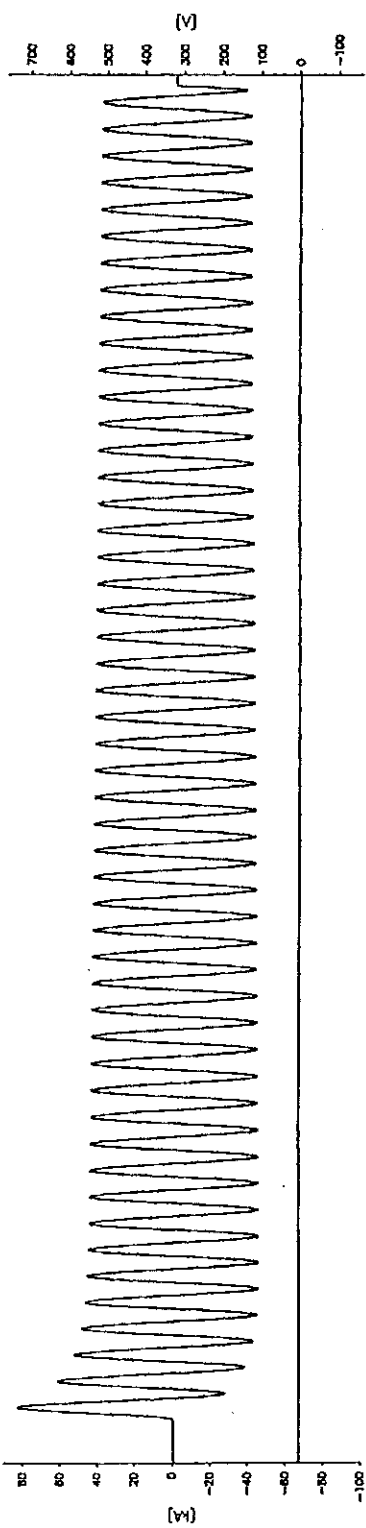
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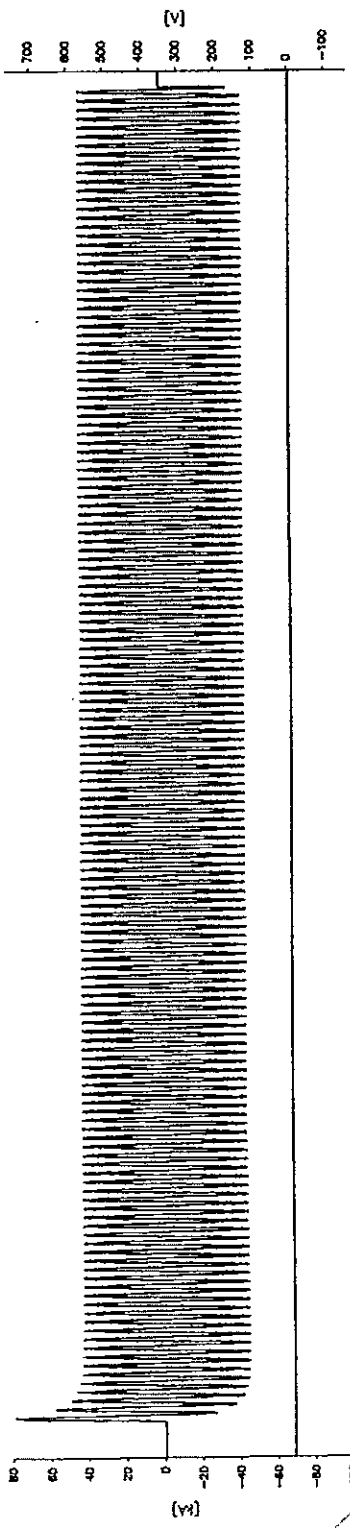
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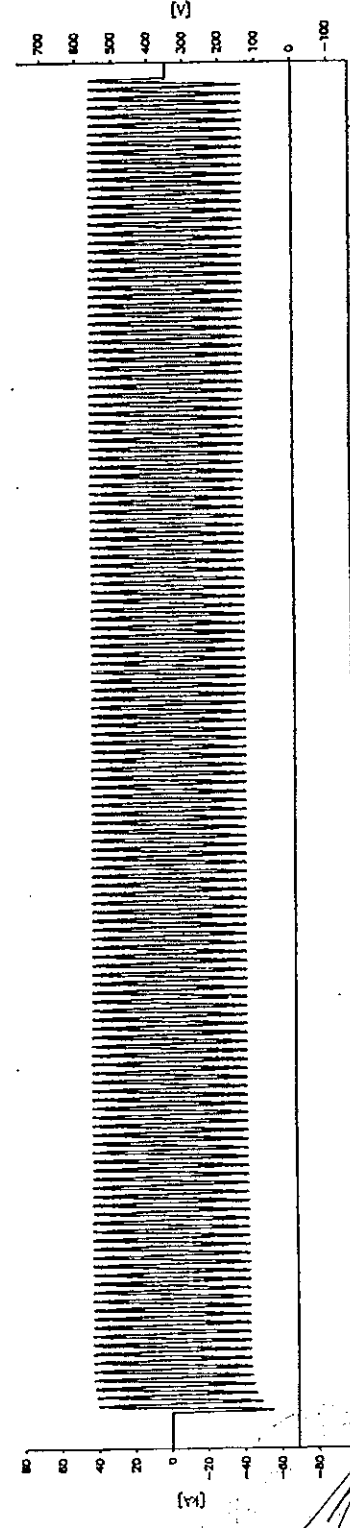
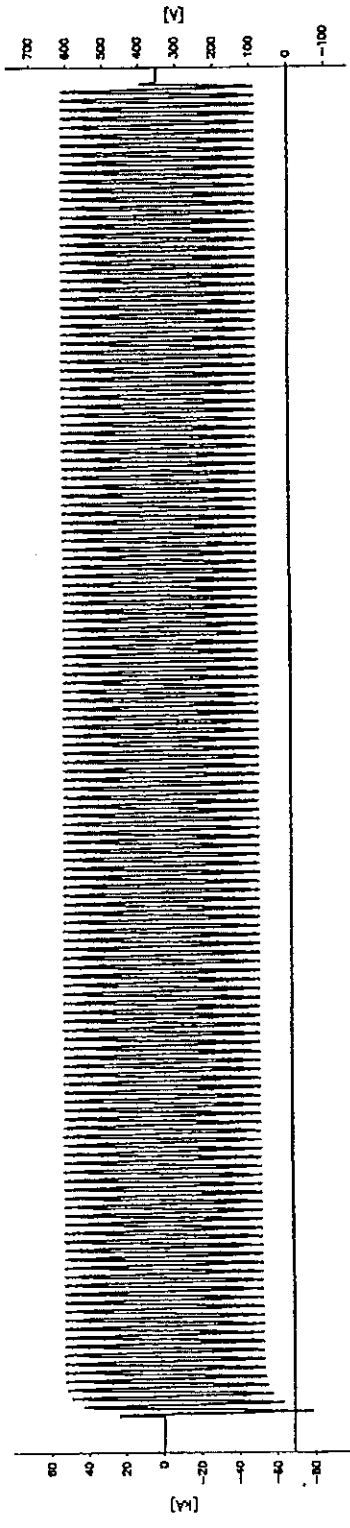
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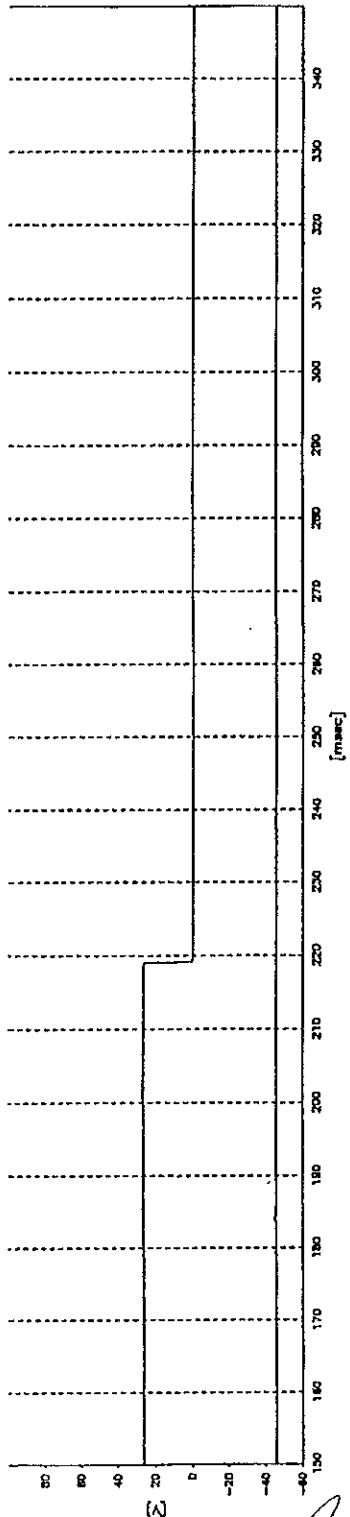


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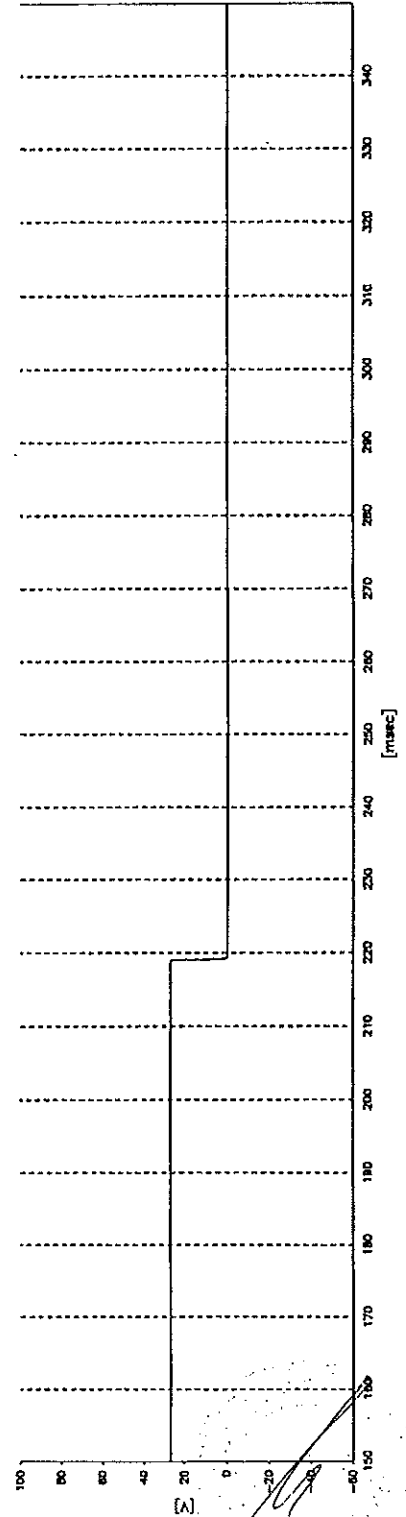
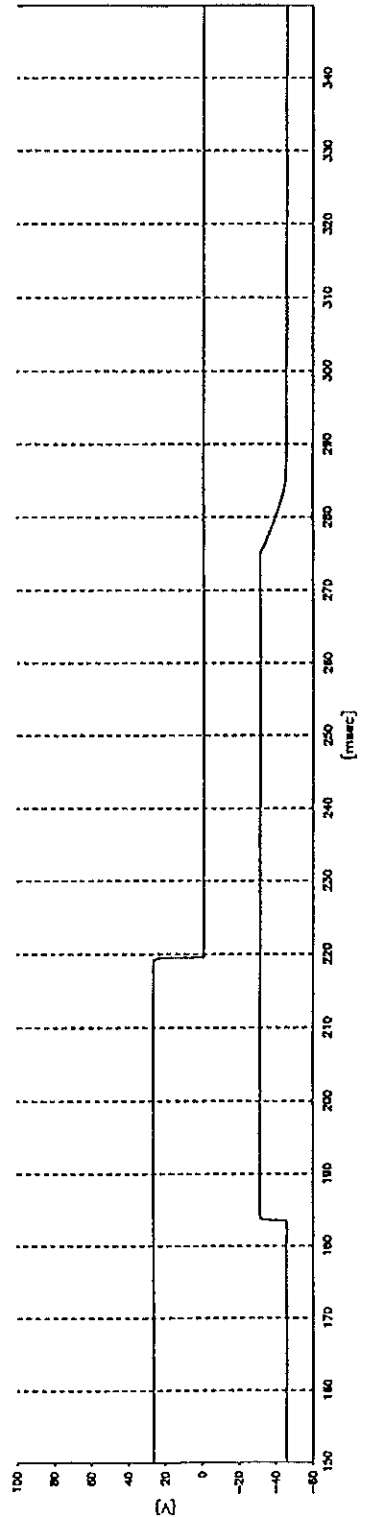
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HZ144F08.007



ABB Trasmissione & Distribuzione S.p.A.

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Internet: [//www.abb.com](http://www.abb.com)

TYPE TEST DOCUMENTATION No. 100081_C Page 1/1

Apparatus: Metal-clad switchgear type ZS1 rel 1.2 with vacuum circuit-breaker type VD4/P 12.12.31 p=210

Identification: 1VCP0000138-Rev.-,en-Technical catalogue-2003-04

Performances:	Rated voltage :	12	kV
	Rated lightning impulse withstand voltage :	75	kV
	Rated power-frequency withstand voltage :	28	kV
	Rated frequency :	50-60	Hz
	Rated normal current (busbar) :	1250	A
	Rated normal current (tee-off) :	1250	A
	Rated peak withstand current :	80	kA
	Rated short-time withstand current :	31.5	kA
	Rated duration of short circuit :	3	s

Test reports verifying rating assigned by the manufacturer:

Performances	Test according to	Test reports	
		No.	Issued by
Dielectric test	IEC 60298 Subclause 6.1	0003 Ra	PEHLA High-power Laboratories
Temperature-rise test	IEC 60298 Subclause 6.3/6.4	0009 Ra	PEHLA High-power Laboratories
Short-time and peak withstand current test	IEC 60298 Subclause 6.5	HZ 144 F08	Calor Emag Laboratories
Mechanical operation and interlock test	IEC 60298 Subclause 6.102	MZ ZS1 A03	Calor Emag Laboratories
Internal arc test	IEC 60298 Annex AA	HZ 146 L02	Calor Emag Laboratories
Mechanical operation test	IEC 62271-100 subclause 6.101.2	0316 Ra	PEHLA High-power Laboratories
Making and breaking capacity test	IEC 62271-100 subclause 6.106	0231 Ra	PEHLA High-power Laboratories

ABB T&D Unità operativa SACE T.M.S. Laboratories Dalmine are accredited according UNI CEI EN ISO/IEC 17025 by SINAL under Reg. No. 0253
 ABB Calor Emag Laboratories Ratingen are accredited according UNI CEI EN ISO/IEC 17025 by DATech under Reg. No. DAT-P-032/93
 PEHLA High-power Laboratories are accredited according UNI CEI EN ISO/IEC 17025 by DATech under Reg. No. DAT-P-032/93

Date of issue:
03/09/23

Development Dept.
G.M. Cravanzola

ABB T&D Unità operativa Sace T.M.S. is accredited by DET NORSKE VERITAS QUALITY CERTIFICATE Quacer Certificate No. CERT-07978-2001-AQ-MIL-SINCERT/B according to ISO 9001.

PEHLA

GESELLSCHAFT FÜR ELEKTRISCHE HOCHLEISTUNGSPRÜFUNGEN
Member of the Short-Circuit-Testing Liaison (STL)

Test Report

Report No.: 0003 Ra

Copy No.: 0

Contents: 17 Sheets

Equipment under test: Metal-clad air-insulated switchgear panel type ZS1.2, rated voltage 12 kV (width = 650 mm), drawing-no. GCE 8010450 R0102, with withdrawable vacuum circuit-breaker type VD4P 1212-31.

Manufacturer: ABB Calor Emag Mittelspannung GmbH, D-40472 Ratingen, Germany

Client: ABB Calor Emag Mittelspannung GmbH, D-40472 Ratingen, Germany

Testing station: PEHLA - Testing Station Ratingen

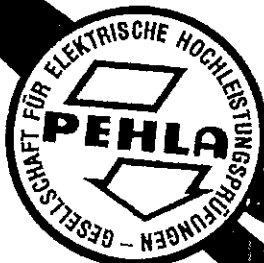
Date of test: 17th and 18th January 2000

Applied test specifications: IEC 60298: 1990-12, clauses 6.1.1, 6.1.3, 6.1.4a), 6.1.5 - 6.1.7, IEC 60694: 1996-05, clauses 6.2.1, 6.2.3 - 6.2.6.

Tests performed: Dielectric type test.

Standard lightning impulse withstand voltage test at 75 kV and power-frequency withstand voltage test at 28 kV to earth, between phases and across open switching device.

Test results: The above ZS1.2-type panel passed the dielectric type test successfully. The respective dielectric requirements are met.



GESELLSCHAFT FÜR ELEKTRISCHE
HOCHLEISTUNGSPRÜFUNGEN

Technical Committee

i.v. Koch

Mannheim, 24th April 2001

The test results relate only to the items tested.

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DAT-P-032/93

Accreditation

The PEHLA-Testing Station Ratingen has been approved by the DATech (German accreditation body for technology) according to DIN EN 45001 for tests in the field of high-voltage switchgear and controlgear and power engineering equipment (Registration-No. DAT-P-032/93).

Under reference to DIN EN 45001 PEHLA states the following:

- The accreditation of the PEHLA-Testing Station or any of its test reports by themselves in no way constitute or imply product approval by DATech or any other body.
- If someone refers to a test in an accredited PEHLA-Testing Station this reference shall include the accreditation body, i.e. DATech, the relevant scope of the accreditation and the appropriate registration number.

STL-Member

PEHLA is foundation-member of the Short-Circuit Testing Liaison (STL) which has been founded in March 1969. STL is a forum for the international cooperation of the testing organisations with the further full members ASTA (GB), CESI (I), ESEF (F), KEMA (NL), SATS (N; S, SF) and STLNA (USA). In the framework of EC, STL has been recognised in 1992 by EOTC as agreement group.

PEHLA-Documents**A Certificate**

is issued for type tests which have successfully been carried out in full compliance with the relevant specifications or standards and STL Guides valid at the time of the test.
For these tests the equipment under test must be clearly identified by technical description, drawings and additional specifications.

A Test Document

is issued for parts of type tests which have successfully been carried out in full compliance with the relevant specifications or standards and STL Guides valid at the time of test.
For these tests the equipment under test must be clearly identified by technical description, drawings and additional specifications.

A Test Report

is issued for all other tests which have been carried out according to specifications, standards or "PEHLA-Richtlinien" (PEHLA Guides) and/or clients instructions.
Similarly, this test report contains all test results, details of the conditions under which the tests were carried out, also details relating to the behaviour of the equipment during test, and its condition after the tests.

Addresses:

Office: PEHLA-Geschäftsstelle
Hallenweg 40
D-68219 Mannheim

Testing Station: PEHLA-Testing Station Ratingen
Oberhausener Str. 33
D-40472 Ratingen

Manufacturer: ABB Calor Emag Mittelspannung GmbH
Oberhausener Str. 33
D-40472 Ratingen

Client: ABB Calor Emag Mittelspannung GmbH
Oberhausener Str. 33
D-40472 Ratingen

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List of Test Participants


Representatives of the Test Committee:

Mr. A. Meier	PEHLA- Testing Station Ratingen
Mr. H. Biallas	PEHLA- Testing Station Mannheim

Test Engineer:

Mr. G. Langwieler	PEHLA- Testing Station Ratingen (17 th January 2000)
Mr. W. Schmiedel	PEHLA- Testing Station Ratingen (18 th January 2000)

Other Participants:



Technical Data of Test Object**Switchgear**

Ratings assigned by the manufacturer

Test Object: Metal-clad air-insulated switchgear panel
Type: ZS1.2
Manufacturer: ABB Calor Emag Mittelspannung GmbH, D-40472 Ratingen, Germany
Serial-No.: 07550027/2001/00
Drawing No.: GCE8010450 R0102 index 00
Year of manufacture: 2000

Rated voltage	12 kV
Rated lightning impulse withstand voltage	75 kV
Rated switching impulse withstand voltage	- kV
Rated power frequency withstand voltage	28 kV
Rated frequency	50 Hz
Rated normal current of busbar	2000 A
Rated normal current of tee-off	1000 A
Rated peak withstand current	80 kA
Rated short-time withstand current	31.5 kA
Rated duration of short-circuit	3 s
Insulating medium	air / vacuum
Rated functional pressure (abs./20 °C)	- kPa
Minimum functional pressure (abs./20 °C)	- kPa
Permissible values for internal arc faults:	
Peak current	80 kA
Short-time current	31.5 kA
Duration of short-circuit	1 s
Max. ambient air temperature	40 °C

The above switchgear panel is fully described in the mentioned drawings.

Essential characteristics and installed devices:

The above switchgear panel is fully described in the mentioned drawings.
Essential details are:

- Busbar 2 x 80 mm x 10 mm / R 5 mm, Cu, bare.
- Busbar tee-off conductor 1 x 60 mm x 10 mm / R 5 mm, Cu, bare.
- tulip insulator with contact pin $\varnothing = 35$ mm.
- Current transformer type TPU 43.11, manufacturer: ABB,
Serial-No. L1: 957058; L2: 957059; L3: 957060.
- Voltage transformer type TJC4, manufacturer: ABB,
Serial-No. L1: 903568; L2: 903569; L3: 903770.
- Earthing switch type EK6-1208-150, Serial-No. 11/357/99.
- Cable conductor 60 mm x 10 mm / R 5 mm, Cu, bare.

Date of receipt of test object: 03rd January 2000

Technical Data of Test Object**Switching Device – Circuit-Breaker**

Ratings assigned by the manufacturer

Test Object: Vacuum circuit-breaker
Type: VD4P 1212-31
Manufacturer: ABB Calor Emag Mittelspannung GmbH, D-40472 Ratingen, Germany
Serial-No.: 7006082/4001/99 **Year of manufacture:** 1999
Drawing No.: GCE 7002291 R 0152 index 00 (circuit-breaker)
Vacuum interrupter: Type VG4S, L1: No. VG4S 55830, L2: No. VG4S 55838, L3: No. VG4S 55829
Drawing No.: GCE 7003979 R 0104 index 06 (pole part)

Rated voltage	12 kV
Rated lightning impulse withstand voltage	75 kV
Rated switching impulse withstand voltage	- kV
Rated power frequency withstand voltage	28 kV
Rated frequency	50 Hz
Rated normal current	1250 A
Rated peak withstand current	80 kA
Rated short-time withstand current	31.5 kA
Rated duration of short-circuit	3 s
Rated short-circuit breaking current	
Rated short-circuit current	31.5 kA
D.C. component	30 %
Rated short-circuit making current	80 kA
Rated transient recovery voltage:	
Peak value	20.6 kV
Rate of rise	0.34 kV/ μ s
First-pole-to-clear-factor	1.5
Rated operating sequence	O-0.3 s -CO-3 min-CO
Arc extinguishing medium	vacuum
Number of poles	3
Number of units per pole	1
Rated opening time	\leq 45 ms
Rated closing time	approx. 60 ms
Rated voltage of trip coil	220 V-DC
Rated voltage of closing coil	220 V-DC
Rated supply voltage	220 V-DC
Rated frequency of supply voltage	- Hz
Max. ambient air temperature	40 °C
Further specifications:	-

Essential characteristics: -**Date of receipt of test object:** 03rd January 2000



List of Drawings

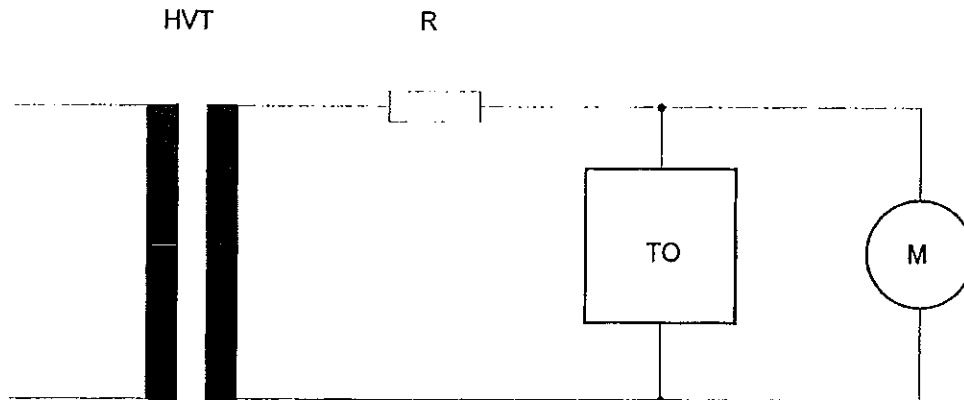


The manufacturer has guaranteed, that the equipment submitted for test has been manufactured in full accordance with the following drawings. PEHLA has verified that these drawings adequately represent the equipment tested. These drawings have been stamped and signed by PEHLA representatives and are kept

- with the test documents at the test laboratory.
 at the client.

Drawing-No.	Index	Title	Additional remarks
GCE 8010450 R 0102	00	Cubicle 12 kV, 650 wide	included in this Test Report
GCE 7002291 R 0152	00	draw out VD4-P 12/17 kV ZS1.2	included in this Test Report
GCE 7002291 R 0104	06	Pole part	--

Technical Data of Test Circuit Power Frequency Voltage



Technical Data

HVT - High Voltage Test Transformer, Type TEO 250/20, Serial-No. 268 734,
manufacturer: Meßwandler-Bau GmbH, Bamberg

Rated Voltage	260 kV
Rated Capacity	50 kVA
Short Circuit Impedance	14.6 %

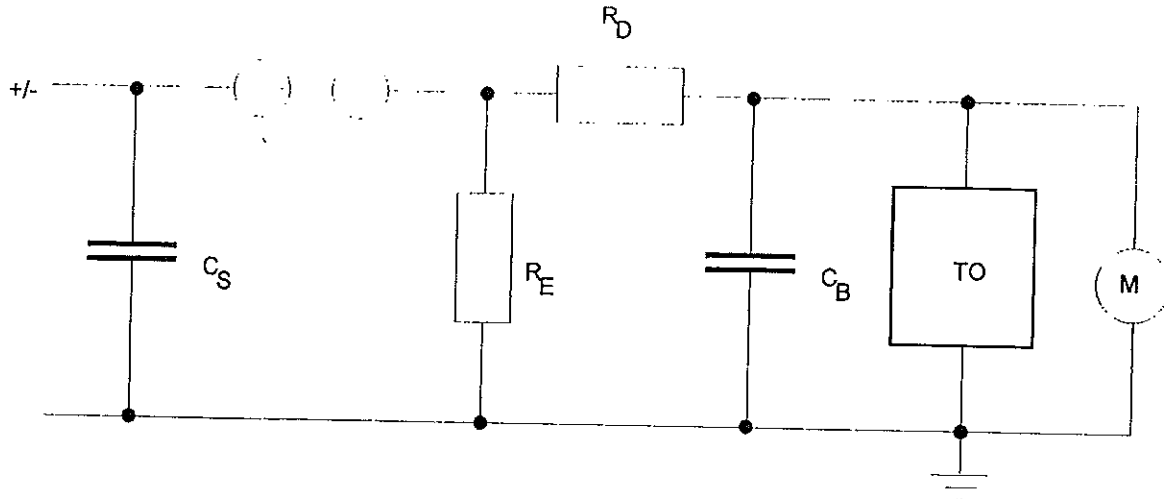
TO - Test Object

M - Voltage Measurement: Capacitive Divider Type CM 300 (Ident-No. ELK-000994) in
connection with a Peak Voltmeter Type DMI 551/Haefely
(Ident-No. ELK-000989)

Verification of Calibration:

- Capacitive Divider (Ident-No. ELK-000994, ELK-000990, ELK-000992):
calibrated in April 1998 at DEACE/LH,
Calibration Report-No. 9800086.
- Peak Voltmeter Typ DMI 551 (Ident-No. ELK-000989):
calibrated in April 1999 at DECMS/LK,
Calibration Report No. 9900076.

Technical Data of Test Circuit
Lightning Impulse Voltage 1.2/50



Technical Data

Maximum Charging Voltage	U_{Σ}	=	200 kV
Number of Stages	n	=	2
Surge Capacity per Stage	C_S	=	600 nF
Load Capacitance	C_B	=	1000 pF
Damping Resistance	R_D	=	$R_{SI} + R_{SE}$
Internal Front Resistance per Stage	R_{SI}	=	20 Ω
External Front Resistance	R_{SE}	=	300 Ω
Discharge Resistance	R_E	=	2 R_P
Tail Resistance per Stage	R_P	=	115 Ω

TO - Test Object

M - Voltage Measurement: Capacitive Divider Type CS 200 SPZ (Ident-No. ELK-000893, ELK-000894) in connection with a Peak Voltmeter Type DMI 551/ Haefely (Ident-No. ELK-000989) and Oscilloscope Type TDS520 (Ident-No. ELK-000545).

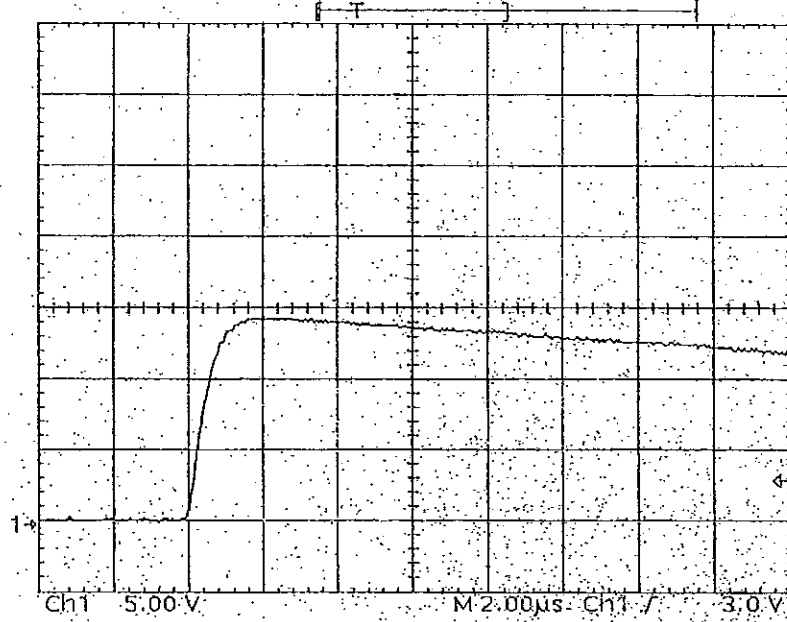
Verificatin of Calibration:

- Capacitive Divider (Ident-No. ELK-000893, ELK-000894, ELK-000922, ELK-001074):
 Calibrated in February 1998 at FGH Mannheim,
 FGH-Calibration-Report-No. 050 DKD-K-15901 98-02.
- Peak Voltmeter Type DMI 551 (Ident-No. ELK-000989):
 Calibrated in April 1999 at FGH Mannheim,
 FGH-Calibration-Report-No. 060 DKD-K-15901 99-04.
- Oscilloscope Type TDS520 (Ident-No. ELK-000545):
 Calibrated in March 1999 at DEACE/LK,
 Calibration-Report-No. 9900060.

Lightning Impulse Voltage with the Test Object connected

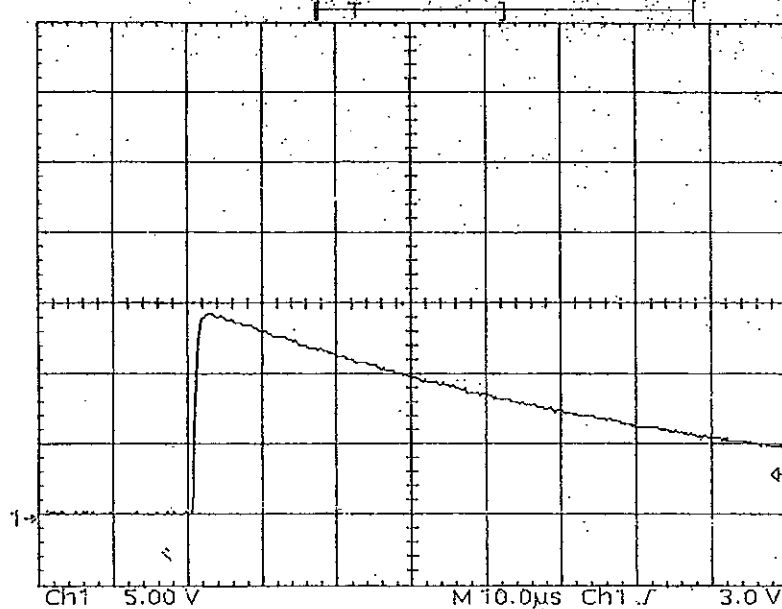
(Standard Value: $1.2 \pm 30\%$ / $50 \pm 20\%$ / peak $\pm 3\%$)

Tek Running: waiting for Trigger



$T_1 = 1.28 \mu s$

Tek Running: waiting for Trigger



$T_2 = 50.7 \mu s$

It was verified that the lightning impulse voltage during the tests was within the admissible tolerances at all test arrangements.

Atmospheric Conditions during Tests

Date of test: 17th January 2000

IEC 17A/567/Q: Corrigendum to subclause 6.2.1 of IEC60694, 2000-01 (Indices: ~ power frequency voltage; + positive lightning impulse voltage; - negative lightning impulse voltage)					
Input data		Correction factors		calculated	applied
air temperature t:	19 °C	air density correction factors	k _{1~} :	1.0252	-
air pressure b:	1035 hPa		k ₁₊ :	1.0252	-
air humidity h:	6.51 g/m ³		k ₁₋ :	1.0252	-
50% disruptive- discharge voltages	U _{B~} :	air humidity correction factors	k _{2~} :	0.9442	-
	U _{B+} :		k ₂₊ :	0.9535	-
	U _{B-} :		k ₂₋ :	0.9535	-
minimum discharge path L:	m	atmospheric correction factors	K _{1~} :	0.9680	0.9680
			K ₁₊ :	0.9776	0.9776
			K ₁₋ :	0.9776	0.9776

Date of test: 18th January 2000

IEC 17A/567/Q: Corrigendum to subclause 6.2.1 of IEC60694, 2000-01 (Indices: ~ power frequency voltage; + positive lightning impulse voltage; - negative lightning impulse voltage)					
Input data		Correction factors		calculated	applied
air temperature t:	21 °C	air density correction factors	k _{1~} :	1.0114	-
air pressure b:	1028 hPa		k ₁₊ :	1.0114	-
air humidity h:	7.32 g/m ³		k ₁₋ :	1.0114	-
50% disruptive- discharge voltages	U _{B~} :	air humidity correction factors	k _{2~} :	0.9548	-
	U _{B+} :		k ₂₊ :	0.9624	-
	U _{B-} :		k ₂₋ :	0.9624	-
minimum discharge path L:	m	atmospheric correction factors	K _{1~} :	0.9657	0.9657
			K ₁₊ :	0.9733	0.9733
			K ₁₋ :	0.9733	0.9733

Lightning Impulse Voltage Test Power Frequency Voltage Test

Test performed: Test of insulation phase-to-phase and phase-to-ground.

Date of test: 18th January 2000

Condition of test object before test: Factory new, clean and dry.

Connections to test object: Infeed of the test voltage at the led-out busbar right hand.

Front time T_1 : 1.28 μ s Time to half-value T_2 : 50.7 μ s Test frequency f : 150 Hz

All voltage values are corrected with the applied atmospheric correction factor.
The applied test voltages refer to the standard atmosphere of 20 °C, 1013 hPa and 11 g/m³.

Test Arrangement 1:			Applied power frequency voltage ~ kV	Result
Condition	Voltage applied to	Earthed		
Vacuum circuit-breaker in service position and closed.	Aa	BCbcF	28 +75 -75	1 minute/0 ¹⁾ 15/0 15/0
	Bb	ACacF	28 +75 -75	1 minute/0 ¹⁾ 15/0 15/0
	Cc	ABabF	28 +75 -75	1 minute/0 ¹⁾ 15/0 15/0

Remarks: A,a = Phase L1, B,b = Phase L2, C,c = Phase L3, F = Frame

¹⁾ Due to the voltage transformers the test frequency was increased upto 150 Hz.

Lightning Impulse Voltage Test Power Frequency Voltage Test

Test performed: Test of insulation phase-to-phase, phase-to-ground and across open switching device.

Date of test: 18th January 2000

Condition of test object before test: Factory new, clean and dry.

Connections to test object: Infeed of the test voltage at the led-out busbar right hand resp. at the cable connecting bar in cable compartment.

Front time T_1 : 1.14 μ s Time to half-value T_2 : 50.7 μ s Test frequency f: 50/150 Hz

All voltage values are corrected with the applied atmospheric correction factor.
The applied test voltages refer to the standard atmosphere of 20 °C, 1013 hPa and 11 g/m³.

Test Arrangement 2:			Applied power frequency voltage ~ kV	Result
Condition	Voltage applied to	Earthed		
Vacuum circuit-breaker in service position and open.	A	BCabcF	28 +75 -75	1 minute/0 15/0 15/0
	B	ACabcF	28 +75 -75	1 minute/0 15/1 15/0
	C	ABabcF	28 +75 -75	1 minute/0 15/0 15/0
Vacuum circuit-breaker in service position and open.	a	bcABC F	28 +75 -75	1 minute/0 ¹⁾ 15/0 15/0
	b	acABC F	28 +75 -75	1 minute/0 ¹⁾ 15/0 15/0
	c	abABC F	28 +75 -75	1 minute/0 ¹⁾ 15/0 15/0

Remarks: A,a = Phase L1, B,b = Phase L2, C,c = Phase L3, F = Frame

¹⁾ Due to the voltage transformers the test frequency was increased upto 150 Hz.

Lightning Impulse Voltage Test Power Frequency Voltage Test

Test performed: Test of insulation phase-to-phase, phase-to-ground and against shutter.

Date of test: 17th January 2000

Condition of test object before test: Factory new, clean and dry.

Connections to test object: Infeed of the test voltage at the led-out busbar right hand resp. at the cable connecting bar in the cable compartment.

Front time T_1 : 1.14 μ s

Time to half-value T_2 : 50.7 μ s

Test frequency f: 50/150 Hz

All voltage values are corrected with the applied atmospheric correction factor.
The applied test voltages refer to the standard atmosphere of 20 °C, 1013 hPa and 11 g/m³.

Test Arrangement 3:			Applied power frequency voltage ~ kV	Result
Condition	Voltage applied to	Earthed		
Vacuum circuit-breaker in test position, shutters closed.	A	BCabcF	28 +75 -75	1 minute/0 15/0 15/0
	B	ACabcF	28 +75 -75	1 minute/0 15/0 15/0
	C	ABabcF	28 +75 -75	1 minute/0 15/0 15/0
Vacuum circuit-breaker in test position, shutters closed.	a	ABCbcF	28 +75 -75	1 minute/0 ¹⁾ 15/0 15/0
	b	ABCacF	28 +75 -75	1 minute/0 ¹⁾ 15/0 15/0
	c	ABCabF	28 +75 -75	1 minute/0 ¹⁾ 15/0 15/0

Remarks: A,a = Phase L1, B,b = Phase L2, C,c = Phase L3, F = Frame

¹⁾ Due to the voltage transformers the test frequency was increased upto 150 Hz.

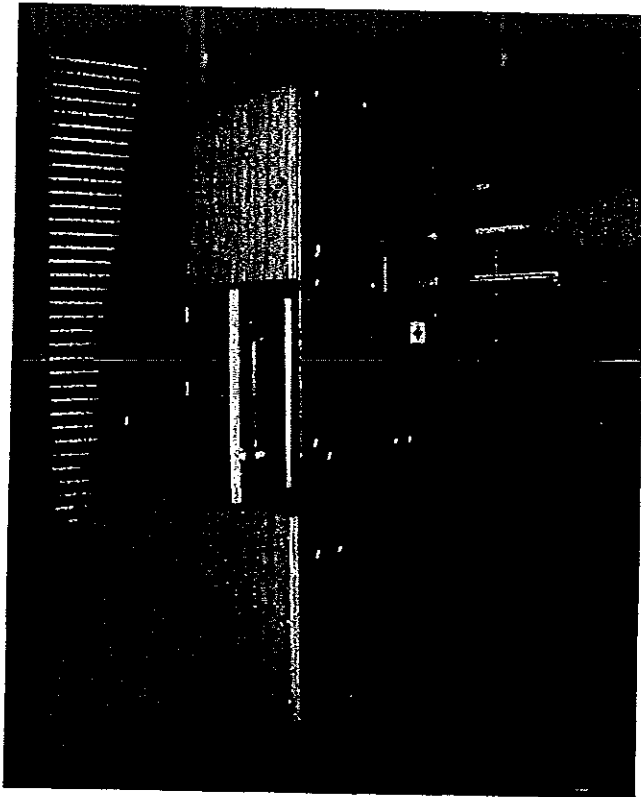
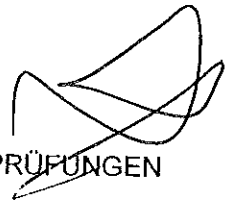


Fig. 1: ZS1.2/12 kV panel under test

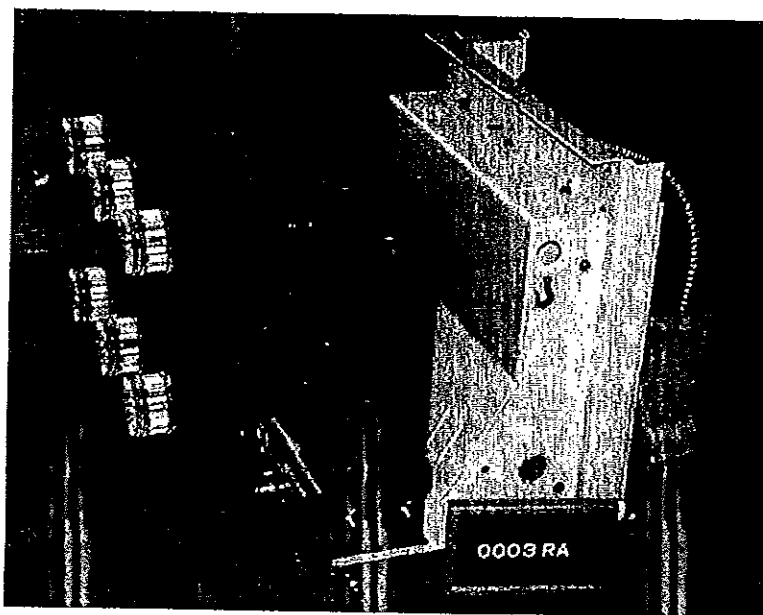


Fig. 2: Vacuum circuit-breaker type VD4P1212-31





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Sheet 1
Copy-No. 1

Test Object Three-panel arrangement of metal-clad, air insulated switchgear type ZS1.2 (650 mm, 1000 mm, 800 mm width) equipped with bushing plates

Rated voltage	U_r	12 kV
Rated normal current	I_r	1000/1600/1600 A
Rated frequency	f_r	50/60 Hz
Rated short-time withstand current	I_k	31.5 kA
Rated peak withstand current	I_p	80 kA
Rated duration of short-circuit current	t_k	3 s

Manufacturer ABB Calor Emag Mittelspannung GmbH, Oberhausener Str. 33, 40472 Ratingen, Deutschland

Tests performed Testing of the behaviour of the metal-clad switchgear under conditions of arcing due to internal faults with 31.5 kA - 1.0 s in different compartments of the three panels. For further details see sheet-no. 2 to 5.

Test Specification The test has been carried out in accordance with the client's instructions. Test procedure and test parameters were based on IEC 60298/3rd Ed/1990-12, Clause 6.108, Annex AA in conjunction with PEHLA-Recommendation No. 4 / 3.1995. (Accessibility Type A: Metal-enclosed switchgear and controlgear with accessibility restricted to authorized personnel only).

Test Results The assessment of the test was carried out in accordance with criteria 1 to 6 of the above mentioned test specifications. For further details see sheet-no. 2 to 5 and 19 to 25.

Test Date 04th to 12th July 2000

Client ABB Calor Emag Mittelspannung GmbH, Oberhausener Str. 33, 40472 Ratingen, Deutschland



12th February 2002
Date of Issue

Stefan Göttlich
Dr. Stefan Göttlich
Laboratory Manager

Andreas Brandt
Andreas Brandt
Test Engineer

Total Number of Sheets: 34 Sheets

11 Oszillograms

This test report refers exclusively to the object tested.
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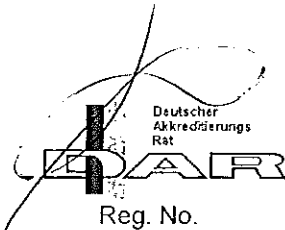
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TEST REPORT No. HZ 146 L 02

Sheet 2

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Comments on Test Arrangement and on the Test

The test object was a three-panel arrangement of a metal-clad, air insulated switchgear type ZS1.2 for 12 kV, consisting of a 650 mm width outgoing panel left-handed, of a 1000 mm width incoming panel in centre and a 800 mm width outgoing panel right-handed. The switchgear was installed in a room mock up with a ceiling height of approximately 3 m. The distance between the rear wall of the switchgear and the room mock up was approximately 0.2 m. The pressure relief took place by a top mounted pressure relief duct overcoming 1800 mm at the side wall of the left-handed panel.

Each panel was equipped with a VD4 vacuum circuit-breaker dummy and a common earthing bar of copper 30 x 8 mm².

Infeed of current was made three-phase by means of a three core cable 1 x 3 x 240 mm² through the closed bottom of the centre panel.

For all tests black cretonne indicators (cotton fabric approximately 150 g/m²) were placed in front of and on both sides of the switchgear as stated in the relevant test regulations.

During the tests the pressure gauge in the compartment under test was measured and recorded. The tests were filmed with a high-speed video camera with a frequency of 500 frames/s.

The evaluation of the RMS-value of the short-circuit current was made according to the Simpson-Formula.

Test Results:

Test-no.: HZ 146 L 02 / 03 Internal arcing test in the cable compartment of the left-handed panel (650 mm width), ignition of arc three-phase by means of a copper wire \varnothing 0.5 mm at the cable terminals.

Peak short-circuit current: 72.5 kA
Short-circuit current: 30.6 kA - 1.05 s equivalent to 31.5 kA - 1.02 s

Assessment of the test:

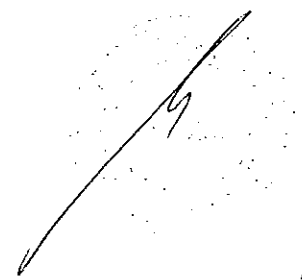
- Correctly secured doors, covers, etc. did not open (Criterion No. 1).
- Parts of the switchgear, which may cause injury to persons, did not fly off (Criterion No. 2).
- Arc did not cause holes to develop in the outer, freely accessible parts of the enclosure as a result of burning or other effects (Criterion No. 3).
- The indicators arranged vertically did not ignite (Criterion No. 4).
- The indicators arranged horizontally did not ignite (Criterion No. 5).
- All earthing connections were still effective (Criterion No. 6).

Test-no.: HZ 146 L 02 / 05 Internal arcing test in the cable compartment of the right-handed panel (800 mm width), ignition of arc three-phase by means of a copper wire \varnothing 0.5 mm at the cable terminals.

Peak short-circuit current: 77.3 kA
Short-circuit current: 31.5 kA - 1.05 s equivalent to 31.5 kA - 1.05 s

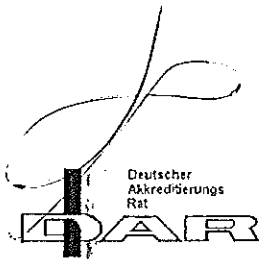
Assessment of the test:

- Correctly secured doors, covers, etc. did not open (Criterion No. 1).
- Parts of the switchgear, which may cause injury to persons, did not fly off (Criterion No. 2).
- Arc did not cause holes to develop in the outer, freely accessible parts of the enclosure as a result of burning or other effects (Criterion No. 3).
- The indicators arranged vertically did not ignite (Criterion No. 4).
- The indicators arranged horizontally did not ignite (Criterion No. 5).
- All earthing connections were still effective (Criterion No. 6).



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Sheet 4

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Test Results:

Test-no.: HZ 146 L 02 / 06 Internal arcing test in the circuit-breaker compartment of the left-handed panel (650 mm width), ignition of arc three-phase by means of a copper wire \varnothing 0.5 across the upper contact arms of the circuit-breaker.

Peak short-circuit current: 79.3 kA
Short-circuit current: 31.5 kA - 1.05 s equivalent to 31.5 kA - 1.05 s

Assessment of the test:

- Correctly secured doors, covers, etc. did not open (Criterion No. 1).
- Parts of the switchgear, which may cause injury to persons, did not fly off (Criterion No. 2).
- Arc did not cause holes to develop in the outer, freely accessible parts of the enclosure as a result of burning or other effects (Criterion No. 3).
- The indicators arranged vertically did not ignite (Criterion No. 4).
- The indicators arranged horizontally did not ignite (Criterion No. 5).
- All earthing connections were still effective (Criterion No. 6).

Test-no.: HZ 146 L 02 / 07 Internal arcing test in the busbar compartment of the right-handed panel (800 mm width), ignition of arc three-phase by means of a copper wire \varnothing 0.5 mm across the busbars.

Peak short-circuit current: 78.8 kA
Short-circuit current: 31.6 kA - 1.05 s equivalent to 31.5 kA - 1.05 s

Assessment of the test:

- Correctly secured doors, covers, etc. did not open (Criterion No. 1).
- Parts of the switchgear, which may cause injury to persons, did not fly off (Criterion No. 2).
- Arc did not cause holes to develop in the outer, freely accessible parts of the enclosure as a result of burning or other effects (Criterion No. 3).
- The indicators arranged vertically did not ignite (Criterion No. 4).
- The indicators arranged horizontally did not ignite (Criterion No. 5).
- All earthing connections were still effective (Criterion No. 6).

Test Results:

Test-no.: HZ 146 L 02 / 08 Internal arcing test in the busbar compartment of the centre panel (1000 mm width), ignition of arc three-phase by means of a copper wire \varnothing 0.5 across the busbars.

Peak short-circuit current: 77.3 kA
Short-circuit current: 31.5 kA - 1.05 s equivalent to 31.5 kA - 1.05 s

Assessment of the test:

- Correctly secured doors, covers, etc. did not open (Criterion No. 1).
- Parts of the switchgear, which may cause injury to persons, did not fly off (Criterion No. 2).
- Arc did not cause holes to develop in the outer, freely accessible parts of the enclosure as a result of burning or other effects (Criterion No. 3).
- The indicators arranged vertically did not ignite (Criterion No. 4).
- The indicators arranged horizontally did not ignite (Criterion No. 5).
- All earthing connections were still effective (Criterion No. 6).

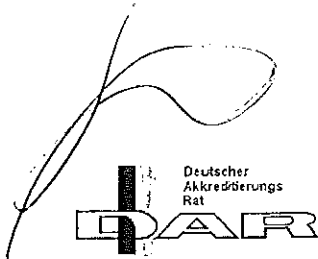
Test-no.: HZ 146 L 02 / 09 Internal arcing test in the circuit-breaker compartment of the centre panel (1000 mm width), ignition of arc three-phase by means of a copper wire \varnothing 0.5 mm across the lower contact arms of the circuit-breaker.

Peak short-circuit current: 77.2 kA
Short-circuit current: 31.3 kA - 1.05 s equivalent to 31.5 kA - 1.04 s

Assessment of the test:

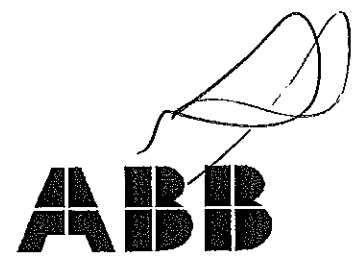
- Correctly secured doors, covers, etc. did not open (Criterion No. 1).
- Parts of the switchgear, which may cause injury to persons, did not fly off (Criterion No. 2).
- Arc did not cause holes to develop in the outer, freely accessible parts of the enclosure as a result of burning or other effects (Criterion No. 3).
- The indicators arranged vertically did not ignite (Criterion No. 4).
- The indicators arranged horizontally did not ignite (Criterion No. 5).
- All earthing connections were still effective (Criterion No. 6).





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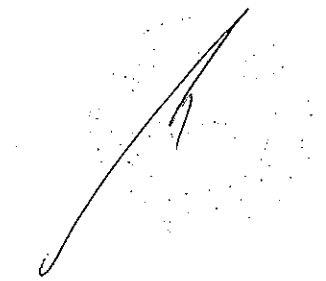


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Sheet 6

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Assessment of the Test

Extraction of IEC 60298/3rd Ed/1990-12, Annex AA

The following criteria allow for the arcing effects.
It is to be observed:

Criterion No. 1

Whether correctly secured doors, covers, etc., do not open.

Criterion No. 2

Whether parts (of the metal-enclosed switchgear and controlgear), which may cause a hazard, do not fly off. This includes large parts or those with sharp edges, for example, inspection windows, pressure relief flaps, cover plates, etc.

Criterion No. 3

Whether arcing does not cause holes to develop in the freely accessible parts of the enclosure as a result of burning or other effects.

Criterion No. 4

Whether the indicators arranged vertically do not ignite. Indicators ignited as a result of paint or stickers burning are excluded from this assessment.

Criterion No. 5

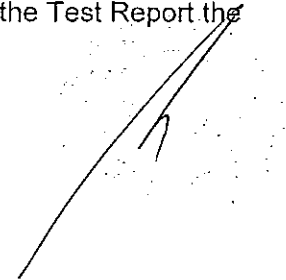
Whether the indicators arranged horizontally do not ignite. Should they start to burn during the test, the assessment criterion may be regarded as having been met, if proof is established of the fact that the ignition was caused by glowing particles rather than hot gases. Pictures taken by high-speed cameras should be produced in evidence.

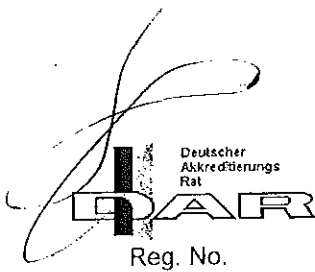
Criterion No. 6

Whether all earthing connections are still effective.

Remark:

When the PEHLA-Recommendation No. 4 is stated under *Test Specification* in the Test Report the results of each test were assessed by all six criteria.





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Participants of the Tests

Client: ABB Calor Emag Mittelspannung GmbH, 40472 Ratingen,
Deutschland

Representatives of the client:

Mr. Aufermann ABB Calor Emag Mittelspannung GmbH, 40472 Ratingen,
Deutschland
Dept. EA

Mr. Groll ABB Calor Emag Mittelspannung GmbH, 40472 Ratingen,
Deutschland
Dept. EA

Mr. Martschat ABB Calor Emag Mittelspannung GmbH, 40472 Ratingen,
Deutschland
Dept. EA

Representatives of the laboratory:

Mr. Dr. Göttlich ABB Calor Emag Mittelspannung GmbH, 40472 Ratingen,
Deutschland
Dept. LL

Test Engineer:

Mr. Strathmann ABB Calor Emag Mittelspannung GmbH, 40472 Ratingen,
Deutschland
Dept. LL



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Sheet 9

Technical Data of Test Object

(Ratings assigned by the manufacturer)
Switchgear (left-handed)

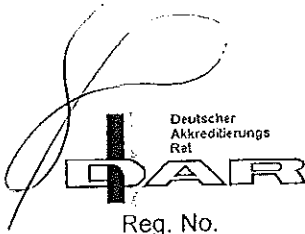
Test Object: Metal-clad, air insulated switchgear
Type: ZS1.2, 650 mm width
Manufacturer: ABB Calor Emag Mittelspannung GmbH, 40472 Ratingen, Deutschland
Serial-No.: 7550027/2001/00 **Year of manufacture:** 2000
Drawing Nos.: See sheet-no. 12

Rated voltage	12	kV
Rated lightning impulse withstand voltage	75	kV
Rated power frequency withstand voltage	28	kV
Rated frequency	50/60	Hz
Rated current (busbar)	2000	A
Rated current (tee-off)	1000	A
Rated short-circuit peak withstand current	80	kA
Rated short-time withstand current	31.5	kA
Rated short-circuit duration	3	s
Insulating medium	air	
Rated filling pressure (abs., 20 ° C)	-	kPa
Prospective values under internal-arc conditions:		
Peak withstand current	80	kA
Short-time withstand current	31.5	kA
Short-circuit duration	1	s

Additional specifications and data:

- busbars 2 x 80 mm x 10 mm / R 5 mm, Cu, bare
- tee-off bars 1 x 60 mm x 10 mm / R 5 mm, Cu, bare

Date of receipt of test object: 3rd July 2000



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Sheet 10

Technical Data of Test Object (Ratings assigned by the manufacturer) Switchgear (centre)

Test Object: Metal-clad, air insulated switchgear
Type: ZS1.2, 1000 mm width
Manufacturer: ABB Calor Emag Mittelspannung GmbH, 40472 Ratingen, Deutschland
Serial-No.: 7550027/2009/00 **Year of manufacture:** 2000
Drawing Nos.: See sheet-no. 12

Rated voltage	12	kV
Rated lightning impulse withstand voltage	75	kV
Rated power frequency withstand voltage	28	kV
Rated frequency	50/60	Hz
Rated current (busbar)	2000	A
Rated current (tee-off)	1600	A
Rated short-circuit peak withstand current	80	kA
Rated short-time withstand current	31.5	kA
Rated short-circuit duration	3	s
Insulating medium	air	
Rated filling pressure (abs., 20 ° C)	-	kPa
Prospective values under internal-arc conditions:		
Peak withstand current	80	kA
Short-time withstand current	31.5	kA
Short-circuit duration	1	s

Additional specifications and data:

- busbars 2 x 80 mm x 10 mm / R 5 mm, Cu, bare
- tee-off bars 2 x 100 mm x 10 mm / R 5 mm, Cu, bare

Date of receipt of test object: 3rd July 2000



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Technical Data of Test Object (Ratings assigned by the manufacturer) Switchgear (right-handed)

Test Object: Metal-clad, air insulated switchgear
Type: ZS1.2, 800 mm width
Manufacturer: ABB Calor Emag Mittelspannung GmbH, 40472 Ratingen, Deutschland
Serial-No.: 7550027/2005/00 **Year of manufacture:** 2000
Drawing Nos.: See sheet-no. 12

Rated voltage	12	kV
Rated lightning impulse withstand voltage	75	kV
Rated power frequency withstand voltage	28	kV
Rated frequency	50/60	Hz
Rated current (busbar)	2000	A
Rated current (tee-off)	1600	A
Rated short-circuit peak withstand current	80	kA
Rated short-time withstand current	31.5	kA
Rated short-circuit duration	3	s
Insulating medium	air	
Rated filling pressure (abs., 20 ° C)	-	kPa
Prospective values under internal-arc conditions:		
Peak withstand current	80	kA
Short-time withstand current	31.5	kA
Short-circuit duration	1	s

Additional specifications and data:

- busbars 2 x 80 mm x 10 mm / R 5 mm, Cu, bare
- tee-off bars 2 x 80 mm x 10 mm / R 5 mm, Cu, bare

Date of receipt of test object: 3rd July 2000



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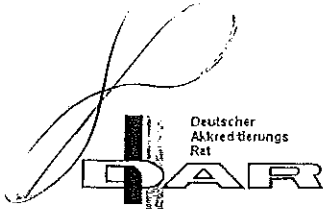
Table of Drawings of Test Objects

The drawings submitted for identification of the test object were stamped and signed by the test engineer.

The manufacturer/client has guaranteed by signature on the drawings that the equipment submitted for tests has been manufactured in accordance with the given drawings.

A copy of the following drawing is part of this Test Report:

ZS 1.2, feeder panel 12 kV, PW.650	GCE8010450R0101, sheet 1, index 00,
ZS 1.2, feeder panel 12 kV, PW.1000	GCE8010452R0110, sheet 19, index 00,
ZS 1.2, feeder panel 12 kV, PW.800	GCE8010451R0103, sheet 3, index 00,
Type Test Arrangement (internal fault) ZS1.2 - Panel	GCEP800241 sheet 1, index 00



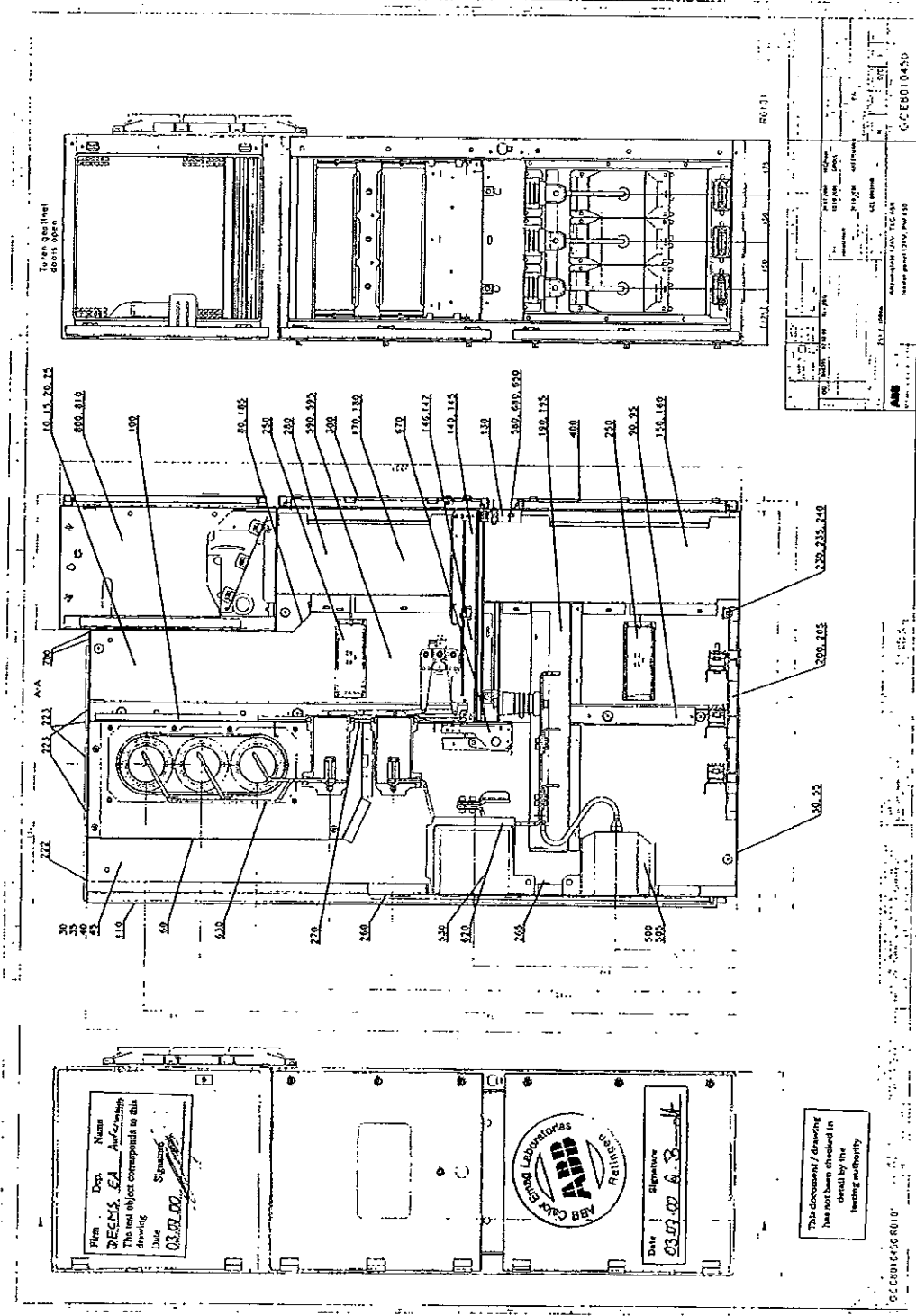
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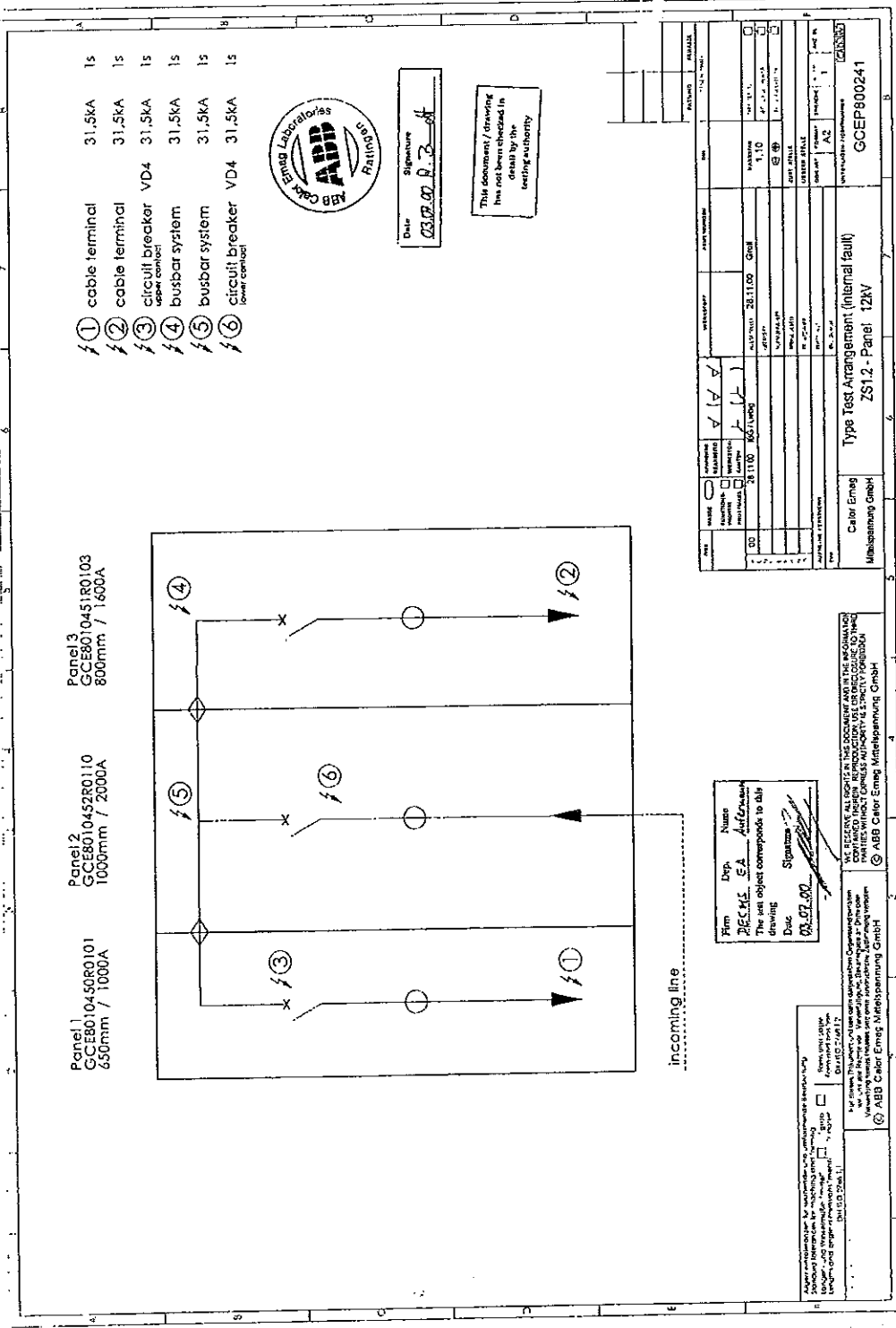
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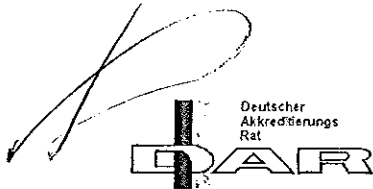


NAME	Calor Emag Mittelspannung GmbH
ADDRESS	...
TYPE	Type Test Arrangement (internal fault) ZS12 - Panel 12RV
TEST NUMBER	GOEP800241
DATE	03.02.00
SCALE	1:1
PROJECT	...
REVISION	...
APPROVED BY	...
TESTED BY	...
DATE OF TEST	...
TEST REPORT NO.	...
TEST REPORT DATE	...

Firm: BECHM SA Auftrags-Nr.: ...
 The test object corresponds to this drawing.
 Date: 03.02.00
 Signature: [Signature]

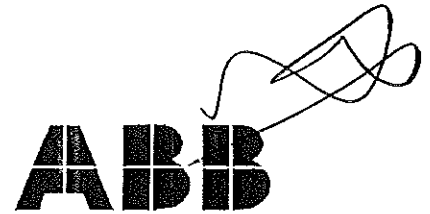
ABB CALOR EMAG LABORATORIES IS THE ACCREDITED TEST LABORATORY FOR THE PRODUCTION OF THE TEST OBJECTS. THE TEST OBJECTS ARE PRODUCED BY THE MANUFACTURER. THE TEST OBJECTS ARE PRODUCED BY THE MANUFACTURER. THE TEST OBJECTS ARE PRODUCED BY THE MANUFACTURER.

ABB Calor Emag Mittelspannung GmbH
 ...



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TEST REPORT No. HZ 146 L 02
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Sheet 17

Technical Data of Test Circuit

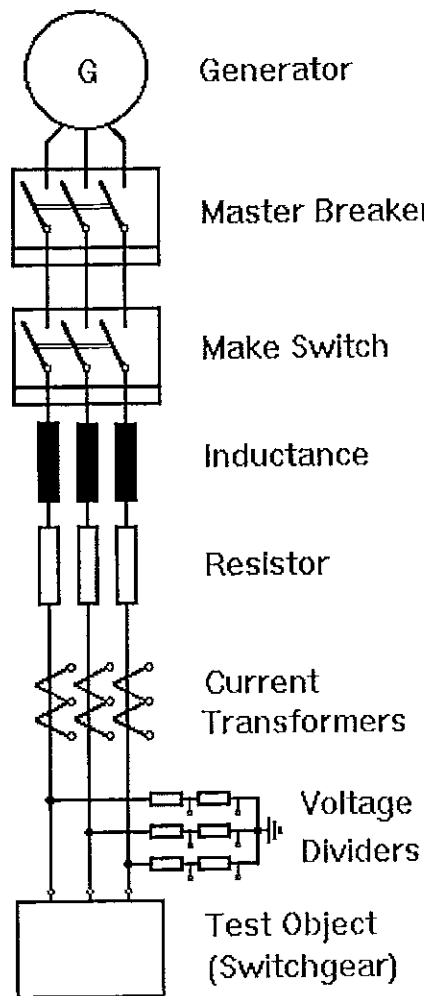
Test	Internal fault	-	-	-
Oscillogram-No. HZ 146 L 02	02 - 09	-	-	-
Number of phases (circuit)	3	-	-	-
Number of poles/phases (test object)	3	-	-	-
Power frequency Hz	50	-	-	-
Power factor $\cos \varphi$	≤ 0.15	-	-	-
Earthing	Generator	earthed via 5 k Ω	-	-
	Transformer	not earthed	-	-
	Short-circuit point	not earthed	-	-
Circuit diagram Sheet no.:	18	-	-	-
Circuit impedance m Ω	≈ 120	-	-	-
-	-	-	-	-
TRV control elements	-	-	-	-
Capacitance in parallel μF	-	-	-	-
Resistance in series Ω	-	-	-	-
-	-	-	-	-
-	-	-	-	-
Prospective TRV	-	-	-	-
TRV peak value u_c kV	-	-	-	-
Time co-ordinate t_3 μs	-	-	-	-
Time delay t_d μs	-	-	-	-
Based on kV	-	-	-	-
Rate-of-rise kV/ μs	-	-	-	-
-	-	-	-	-
-	-	-	-	-
Voltage measurements	Divider 375 k Ω / 2 k Ω	-	-	-
Current measurements	Transformer 50 kA / 5 A	-	-	-

Remarks:

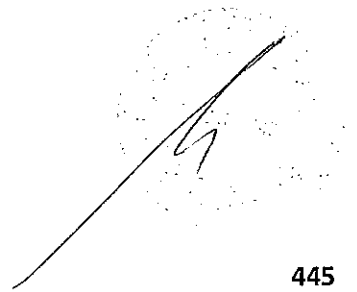
HZ 146 L 02 / 01: Current calibration

HZ 146 L 02 / 04: Pre-test

Principle Diagram of Test Circuit







Determination of the Prospective Short-Circuit Current

Condition of test object before test: -

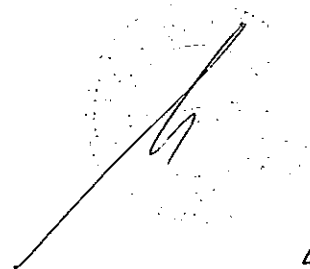
Arrangement: See sheet-no. 2

Connection: Infeed of current was made three-phase by means of a three core cable
1 x 3 x 240 mm² through the closed bottom of the centre panel.

For the determination of the prospective short-circuit current the infeeding busbars of the test plant were short-circuited and earthed outside the switchgear under test.

Test-No.: HZ 146 L 02 / 02		Applied voltage (phase-to-phase) 6.5 kV		Duration of short-circuit current 1.05 s
	Peak short-circuit current kA	Short-circuit current:		Arithmetic mean value kA
		first cycle kA	last cycle kA	
L1	81.9	37.4	30.0	30.2
L2	27.7	36.4	30.5	30.7
L3	67.2	37.2	29.8	30.0
Average value		37.0	30.1	30.3
Equivalent duration of short-circuit current 1.01 s			corresponding to a short-circuit current of 31.5 kA	

Remarks: -

Internal Arcing Test

Condition of test object before test: Switchgear factory-new.

Arrangement: See sheet-no.: 2

Connection: Infeed of current was made three-phase by means of a three core cable 1 x 3 x 240 mm² through the closed bottom of the centre panel.

Ignition: Internal arcing test in the cable compartment of the left-handed panel (650 mm width), ignition of arc three-phase by means of a copper wire Ø 0.5 mm at the cable terminals.

Test-No.: HZ 146 L 02 / 03		Applied voltage (phase-to-phase) 6.5 kV		Duration of short-circuit current 1.05 s
	Peak short-circuit current kA	Short-circuit current:		Arithmetic mean value kA
		first cycle kA	last cycle kA	
L1	72.5	37.1	30.4	30.2
L2	27.0	36.0	30.9	31.0
L3	60.7	37.4	30.1	30.6
Average value		36.9	39.8	30.6
Equivalent duration of short-circuit current 1.02 s			corresponding to a short-circuit current of 31.5 kA	

Remarks and condition of test object after test:
The condition of the switchgear before and after test is shown on the photos on sheet-no. 26 to 34. The measured pressure gauge was about 75 kPa.

Assessment of the test:

- Correctly secured doors, covers, etc. did not open (Criterion No. 1).
- Parts of the switchgear, which may cause injury to persons, did not fly off (Criterion No. 2).
- Arc did not cause holes to develop in the outer, freely accessible parts of the enclosure as a result of burning or other effects (Criterion No. 3).
- The indicators arranged vertically did not ignite (Criterion No. 4).
- The indicators arranged horizontally did not ignite (Criterion No. 5).
- All earthing connections were still effective (Criterion No. 6).






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Internal Arcing Test

Condition of test object before test: as after test HZ 146 L 02 / 03.

Arrangement: See sheet-no.: 2

Connection: Infeed of current was made three-phase by means of a three core cable 1 x 3 x 240 mm² through the closed bottom of the centre panel.

Ignition: Internal arcing test in the cable compartment of the right-handed panel (800 mm width), ignition of arc three-phase by means of a copper wire Ø 0.5 mm at the cable terminals.

Test-No.: HZ 146 L 02 / 05		Applied voltage (phase-to-phase) 6.65 kV		Duration of short-circuit current 1.05 s
	Peak short-circuit current kA	Short-circuit current:		Arithmetic mean value kA
		first cycle kA	last cycle kA	
L1	77.3	38.3	30.9	31.4
L2	25.7	36.7	31.2	31.3
L3	60.9	37.7	31.7	31.7
Average value		37.6	31.3	31.5
Equivalent duration of short-circuit current 1.05 s			corresponding to a short-circuit current of 31.5 kA	

Remarks and condition of test object after test:

The condition of the switchgear before and after test is shown on the photos on sheet-no. 26 to 34. The measured pressure gauge was about 57 kPa.

Assessment of the test:

- Correctly secured doors, covers, etc. did not open (Criterion No. 1).
- Parts of the switchgear, which may cause injury to persons, did not fly off (Criterion No. 2).
- Arc did not cause holes to develop in the outer, freely accessible parts of the enclosure as a result of burning or other effects (Criterion No. 3).
- The indicators arranged vertically did not ignite (Criterion No. 4).
- The indicators arranged horizontally did not ignite (Criterion No. 5).
- All earthing connections were still effective (Criterion No. 6).

Internal Arcing Test

Condition of test object before test: as after test HZ 146 L 02 / 05.

Arrangement: See sheet-no.: 2

Connection: Infeed of current was made three-phase by means of a three core cable 1 x 3 x 240 mm² through the closed bottom of the centre panel.

Ignition: Internal arcing test in the circuit-breaker compartment of the left-handed panel (650 mm width), ignition of arc three-phase by means of a copper wire \varnothing 0.5 across the upper contact arms of the circuit-breaker

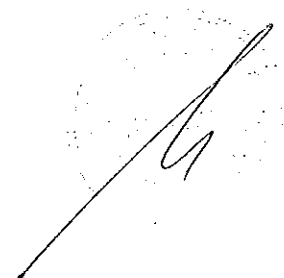
Test-No.: HZ 146 L 02 / 06		Applied voltage (phase-to-phase) 6.65 kV		Duration of short-circuit current 1.05 s
	Peak short-circuit current kA	Short-circuit current: first cycle kA		Arithmetic mean value kA
		last cycle kA		
L1	79.3	38.7	30.3	31.0
L2	26.1	37.1	32.3	31.8
L3	62.6	38.3	32.0	31.6
Average value		38.0	31.5	31.5
Equivalent duration of short-circuit current 1.05 s			corresponding to a short-circuit current of 31.5 kA	

Remarks and condition of test object after test:

The condition of the switchgear before and after test is shown on the photos on sheet-no. 26 to 34. The measured pressure gauge was about 48 kPa.

Assessment of the test:

- Correctly secured doors, covers, etc. did not open (Criterion No. 1).
- Parts of the switchgear, which may cause injury to persons, did not fly off (Criterion No. 2).
- Arc did not cause holes to develop in the outer, freely accessible parts of the enclosure as a result of burning or other effects (Criterion No. 3).
- The indicators arranged vertically did not ignite (Criterion No. 4).
- The indicators arranged horizontally did not ignite (Criterion No. 5).
- All earthing connections were still effective (Criterion No. 6).

Internal Arcing Test

Condition of test object before test: as after test HZ 146 L 02 / 06.

Arrangement: See sheet-no.: 2

Connection: Infeed of current was made three-phase by means of a three core cable 1 x 3 x 240 mm² through the closed bottom of the centre panel.

Ignition: Internal arcing test in the busbar compartment of the right-handed panel (800 mm width), ignition of arc three-phase by means of a copper wire Ø 0.5 mm across the busbars.

Test-No.: HZ 146 L 02 / 07		Applied voltage (phase-to-phase) 6.65 kV		Duration of short-circuit current 1.05 s
	Peak short-circuit current kA	Short-circuit current: first cycle kA		Arithmetic mean value kA
		last cycle kA		
L1	78.8	39.0	32.0	31.8
L2	23.3	36.6	31.4	31.3
L3	60.3	38.4	31.6	31.6
Average value		38.0	31.7	31.6
Equivalent duration of short-circuit current 1.05 s			corresponding to a short-circuit current of 31.5 kA	

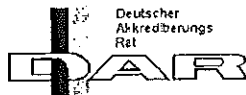
Remarks and condition of test object after test:

The condition of the switchgear before and after test is shown on the photos on sheet-no. 26 to 34. The measured pressure gauge was about 27 kPa.

Assessment of the test:

- Correctly secured doors, covers, etc. did not open (Criterion No. 1).
- Parts of the switchgear, which may cause injury to persons, did not fly off (Criterion No. 2).
- Arc did not cause holes to develop in the outer, freely accessible parts of the enclosure as a result of burning or other effects (Criterion No. 3).
- The indicators arranged vertically did not ignite (Criterion No. 4).
- The indicators arranged horizontally did not ignite (Criterion No. 5).
- All earthing connections were still effective (Criterion No. 6).



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Internal Arcing Test

Condition of test object before test: as after test HZ 146 L 02 / 07.

Arrangement: See sheet-no.: 2

Connection: Infeed of current was made three-phase by means of a three core cable 1 x 3 x 240 mm² through the closed bottom of the centre panel.

Ignition: Internal arcing test in the busbar compartment of the centre panel (1000 mm width), ignition of arc three-phase by means of a copper wire Ø 0.5 across the busbars.

Test-No.: HZ 146 L 02 / 08		Applied voltage (phase-to-phase) 6.65 kV		Duration of short-circuit current 1.05 s
	Peak short-circuit current kA	Short-circuit current: first cycle last cycle kA kA		Arithmetic mean value kA
L1	77.3	38.5	30.8	31.2
L2	25.4	37.4	32.1	32.2
L3	61.4	38.4	31.4	31.2
Average value		38.1	31.4	31.5
Equivalent duration of short-circuit current 1.05 s			corresponding to a short-circuit current of 31.5 kA	

Remarks and condition of test object after test:

The condition of the switchgear before and after test is shown on the photos on sheet-no. 26 to 34. The measured pressure gauge was about 23 kPa.

Assessment of the test:

- Correctly secured doors, covers, etc. did not open (Criterion No. 1).
- Parts of the switchgear, which may cause injury to persons, did not fly off (Criterion No. 2).
- Arc did not cause holes to develop in the outer, freely accessible parts of the enclosure as a result of burning or other effects (Criterion No. 3).
- The indicators arranged vertically did not ignite (Criterion No. 4).
- The indicators arranged horizontally did not ignite (Criterion No. 5).
- All earthing connections were still effective (Criterion No. 6).



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Sheet 25

Internal Arcing Test

Condition of test object before test: as after test HZ 146 L 02 / 08.

Arrangement: See sheet-no.: 2

Connection: Infeed of current was made three-phase by means of a three core cable 1 x 3 x 240 mm² through the closed bottom of the centre panel.

Ignition: Internal arcing test in the circuit-breaker compartment of the centre panel (1000 mm width), ignition of arc three-phase by means of a copper wire Ø 0.5 mm across the lower contact arms of the circuit-breaker.

Test-No.: HZ 146 L 02 / 09		Applied voltage (phase-to-phase) 6.65 kV		Duration of short-circuit current 1.05 s
	Peak short-circuit current kA	Short-circuit current: first cycle kA		Arithmetic mean value kA
L1	77.2	38.0	31.4	31.2
L2	27.1	37.0	32.0	31.7
L3	62.1	38.0	30.5	31.0
Average value		37.7	31.3	31.3
Equivalent duration of short-circuit current 1.04 s			corresponding to a short-circuit current of 31.5 kA	

Remarks and condition of test object after test:

The condition of the switchgear before and after test is shown on the photos on sheet-no 26 to 34.
The measured pressure gauge was about 44 kPa.

Assessment of the test:

- Correctly secured doors, covers, etc. did not open (Criterion No. 1).
- Parts of the switchgear, which may cause injury to persons, did not fly off (Criterion No. 2).
- Arc did not cause holes to develop in the outer, freely accessible parts of the enclosure as a result of burning or other effects (Criterion No. 3).
- The indicators arranged vertically did not ignite (Criterion No. 4).
- The indicators arranged horizontally did not ignite (Criterion No. 5).
- All earthing connections were still effective (Criterion No. 6).

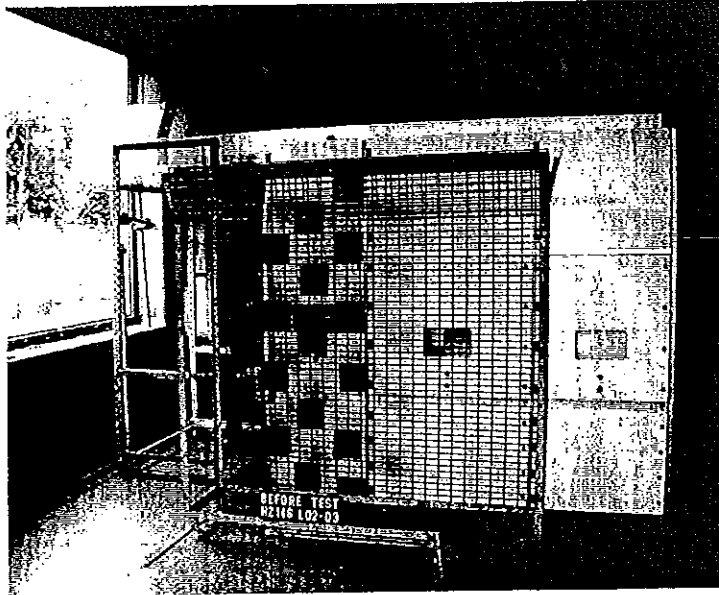


Photo No. 01
Before Test HZ 146 L 02 / 03

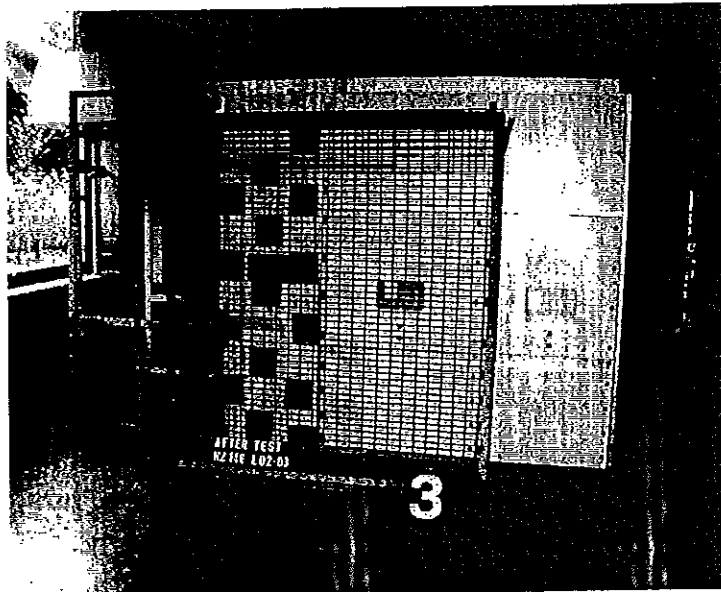


Photo No. 02
After Test HZ 146 L 02 / 03



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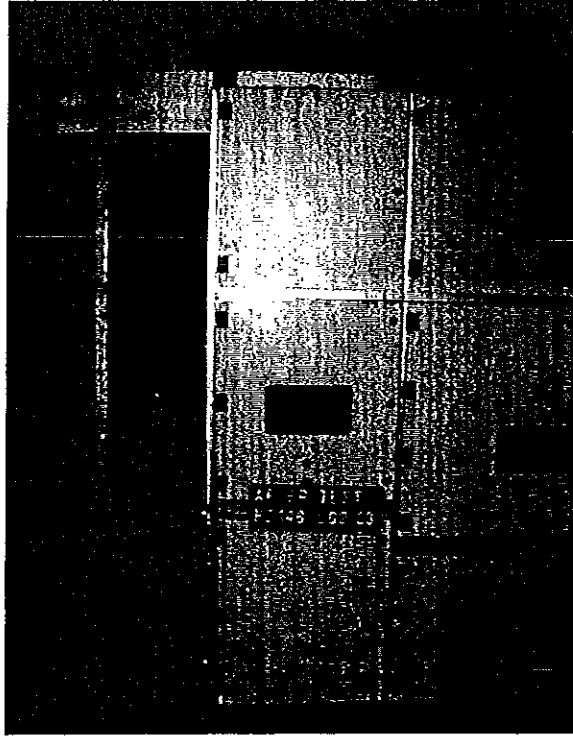


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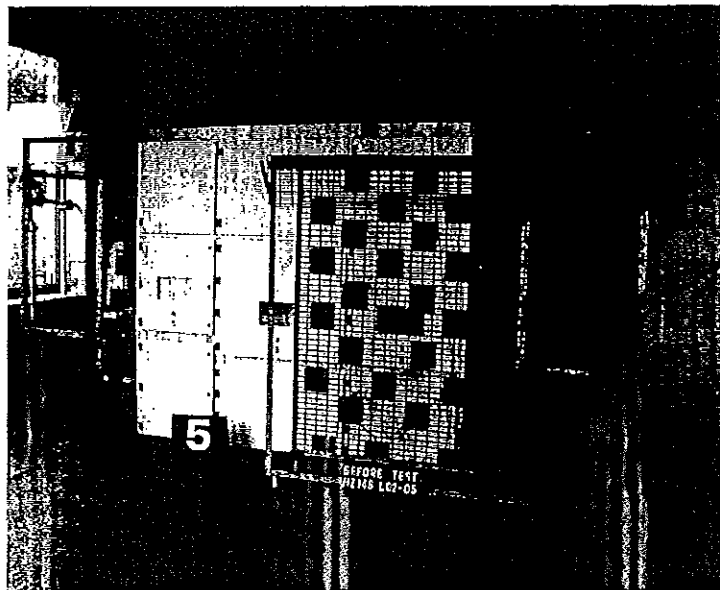


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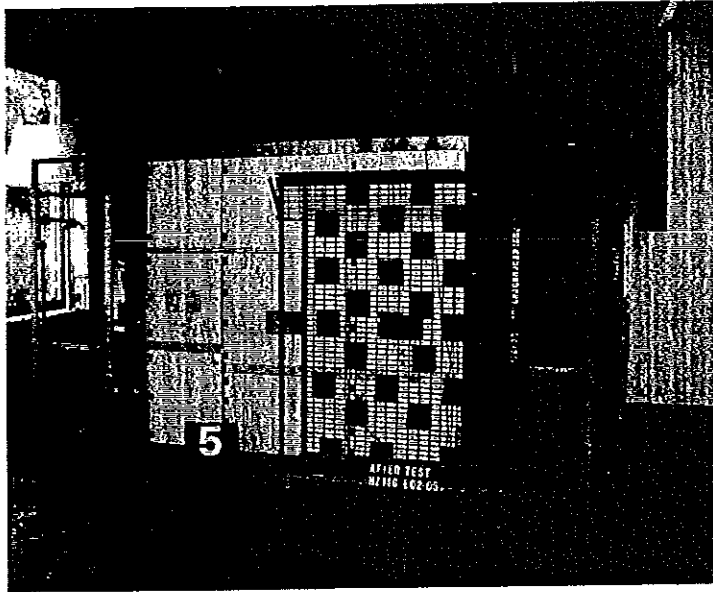


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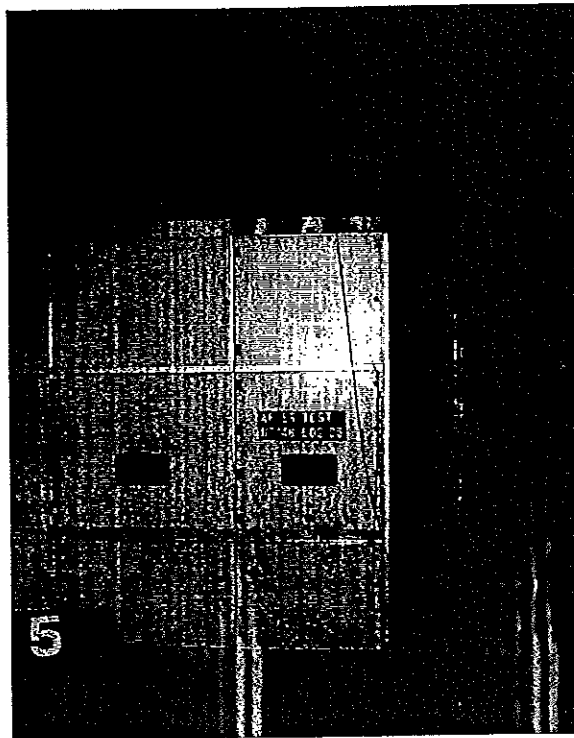


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After Test HZ 146 L 02 / 05



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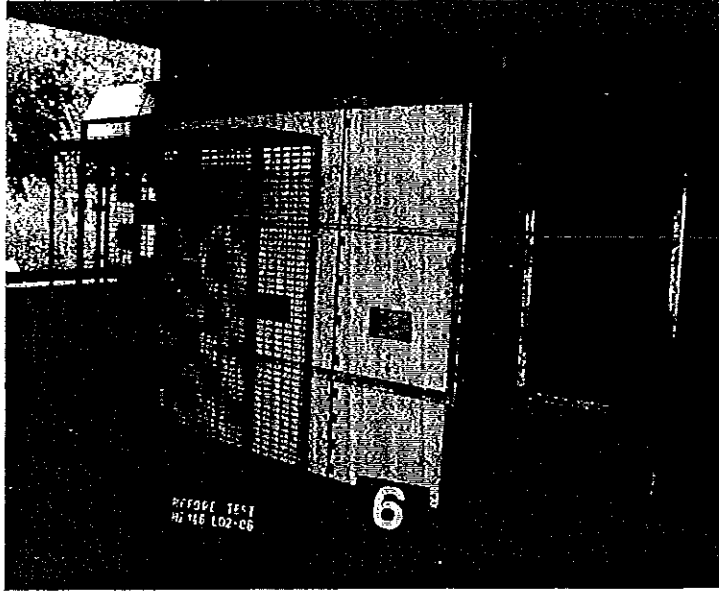


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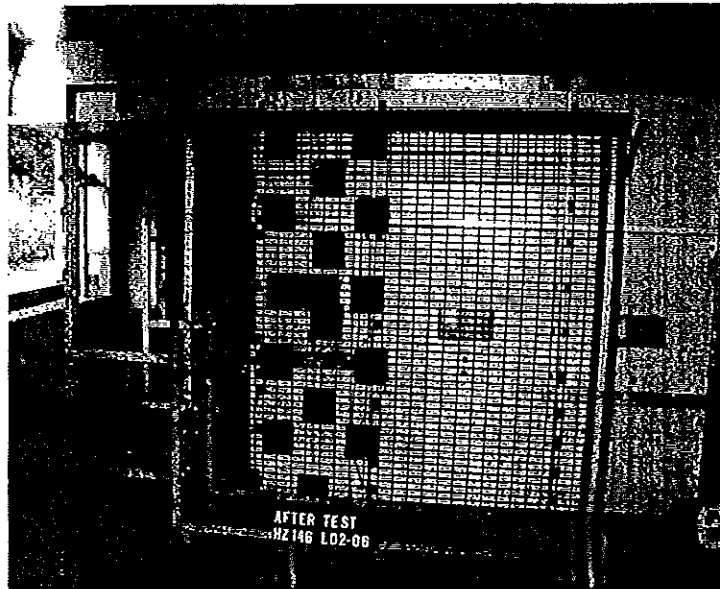
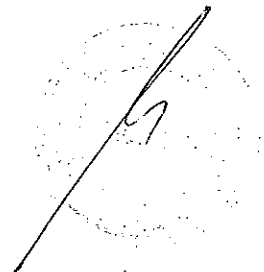
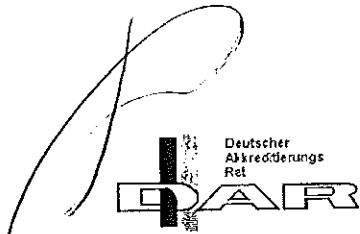


Photo No. 08
After Test HZ 146 L 02 / 06





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Sheet 30

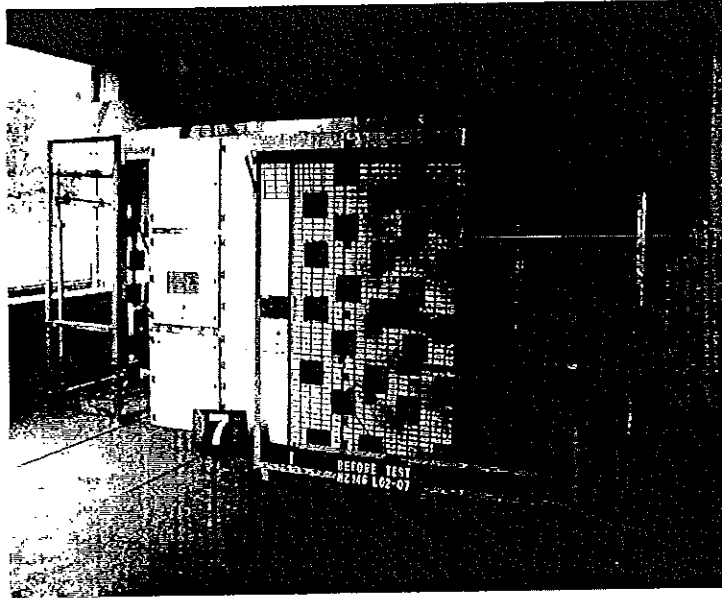


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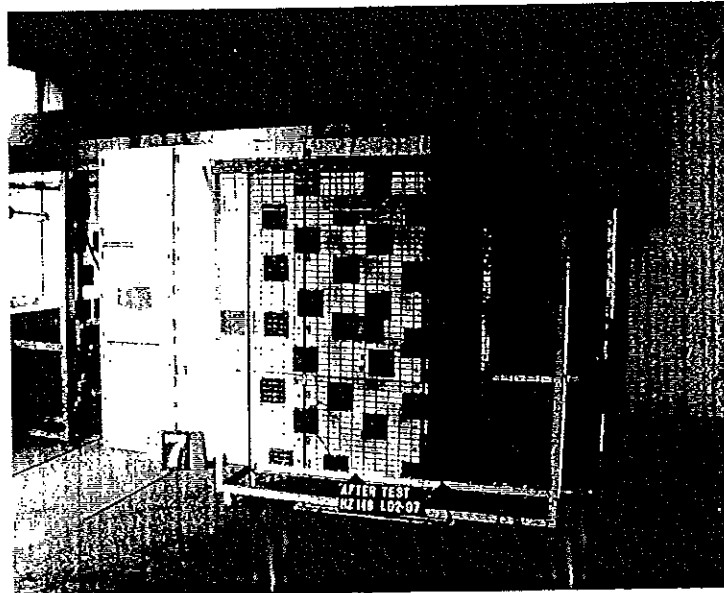
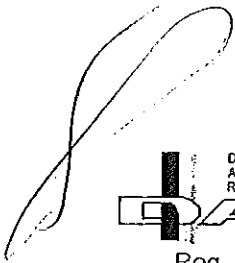
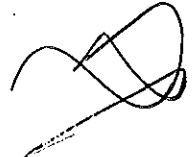


Photo No. 10
After Test HZ 146 L 02 / 07



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Sheet 31

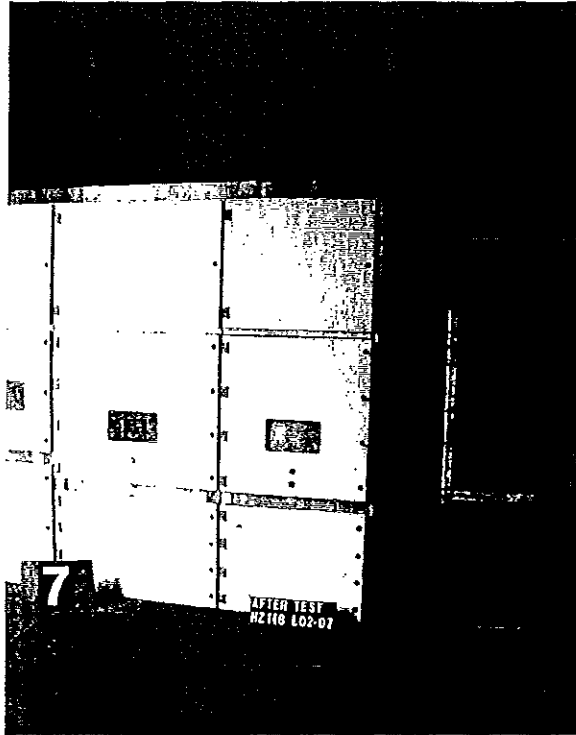


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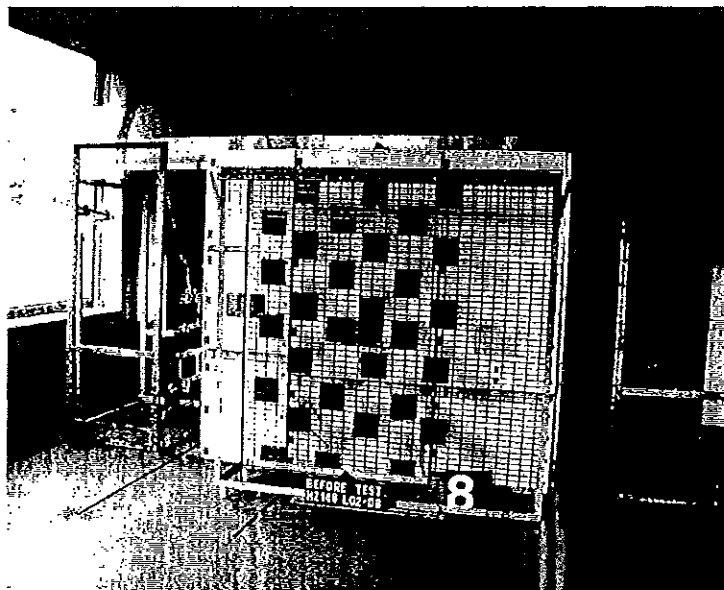


Photo No. 12
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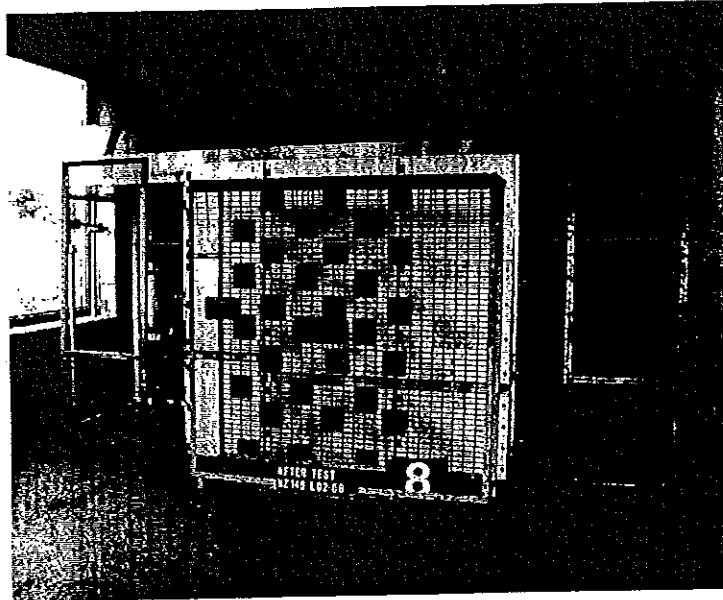


Photo No. 13
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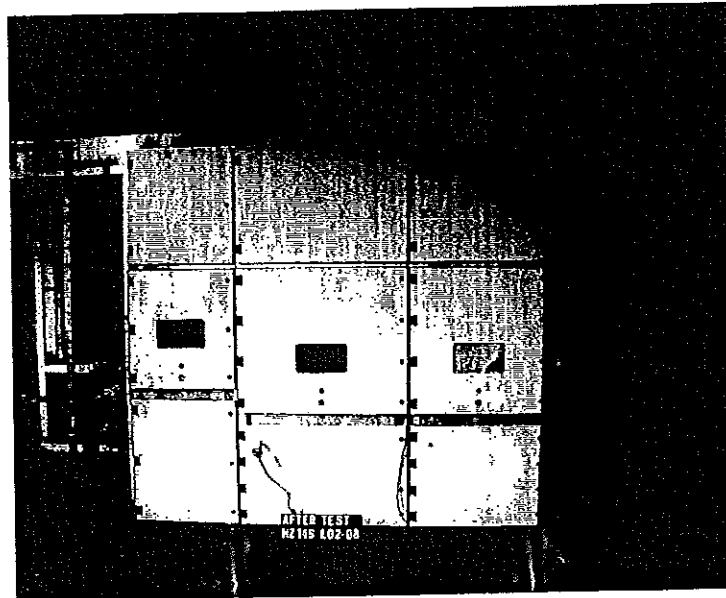


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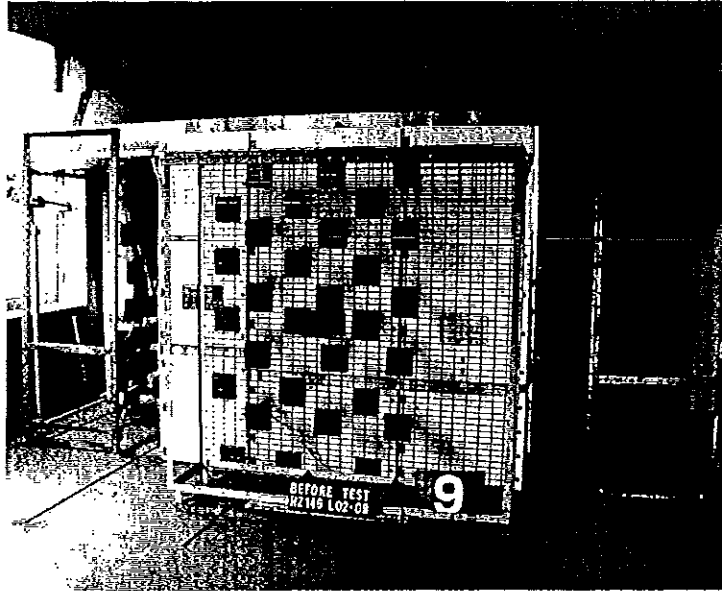


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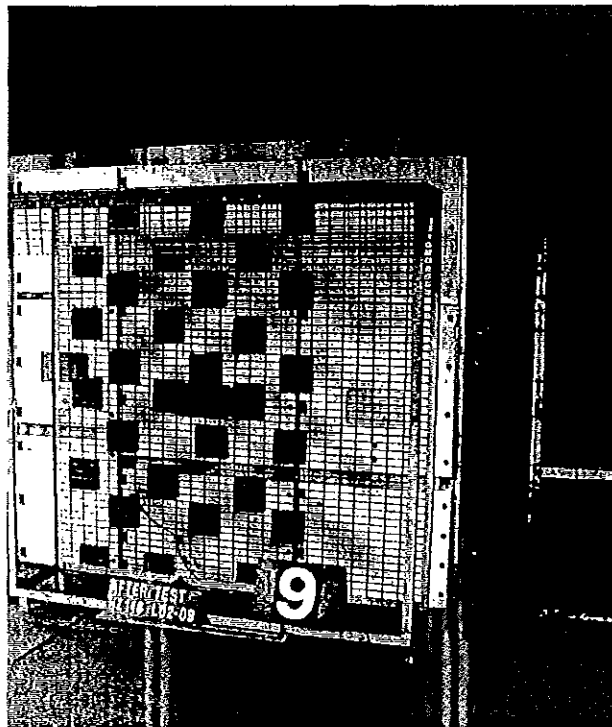


Photo No. 16
After Test HZ 146 L 02 / 09



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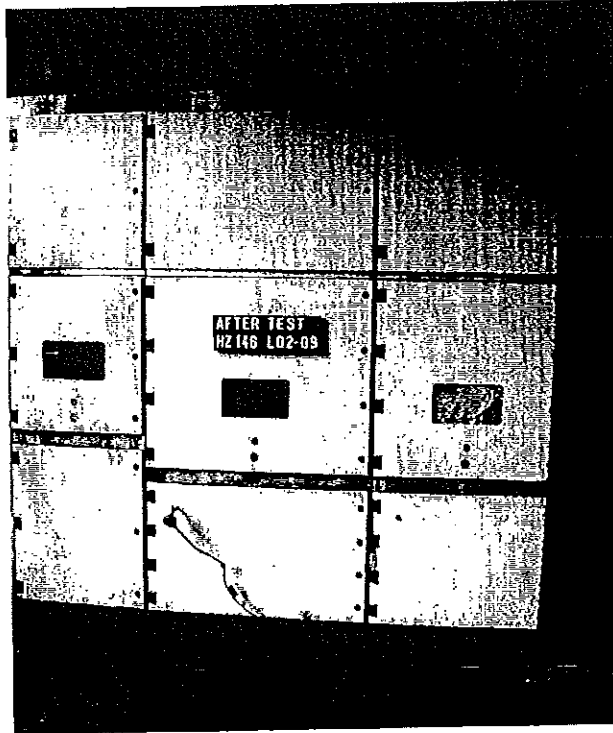
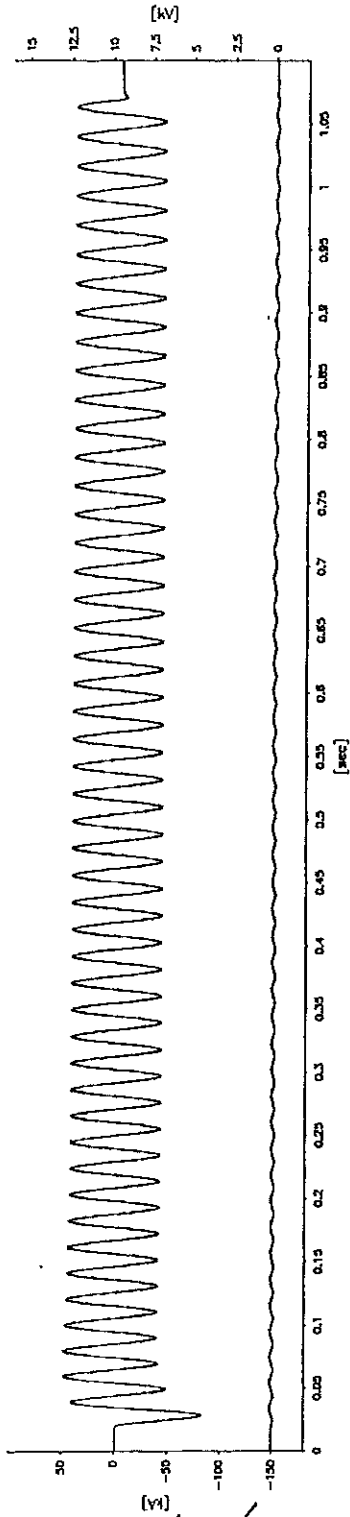
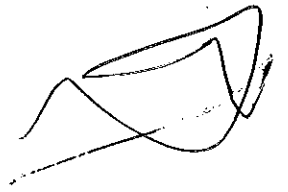
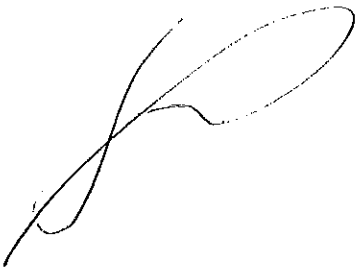
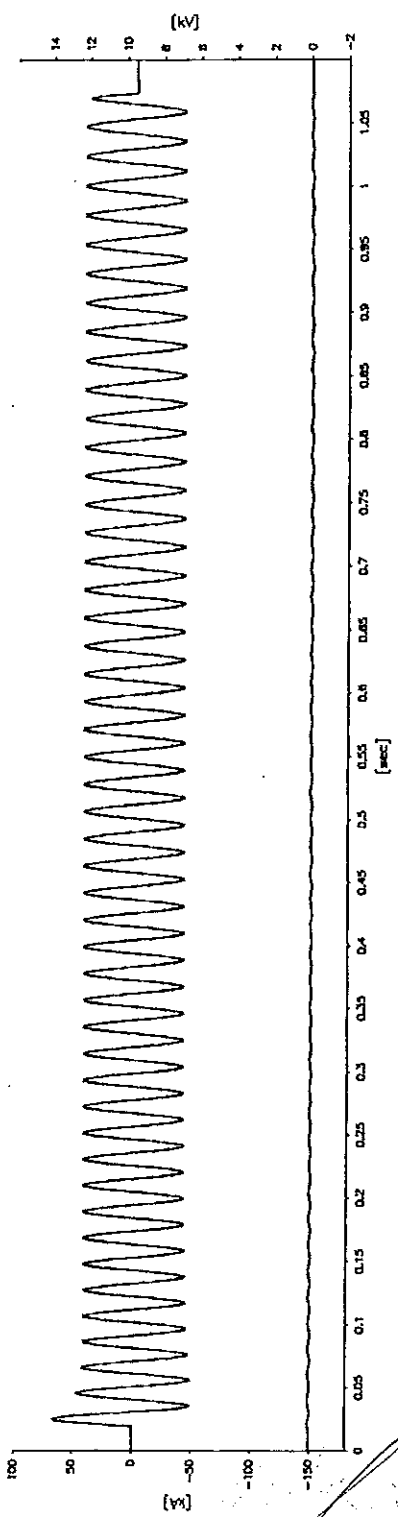
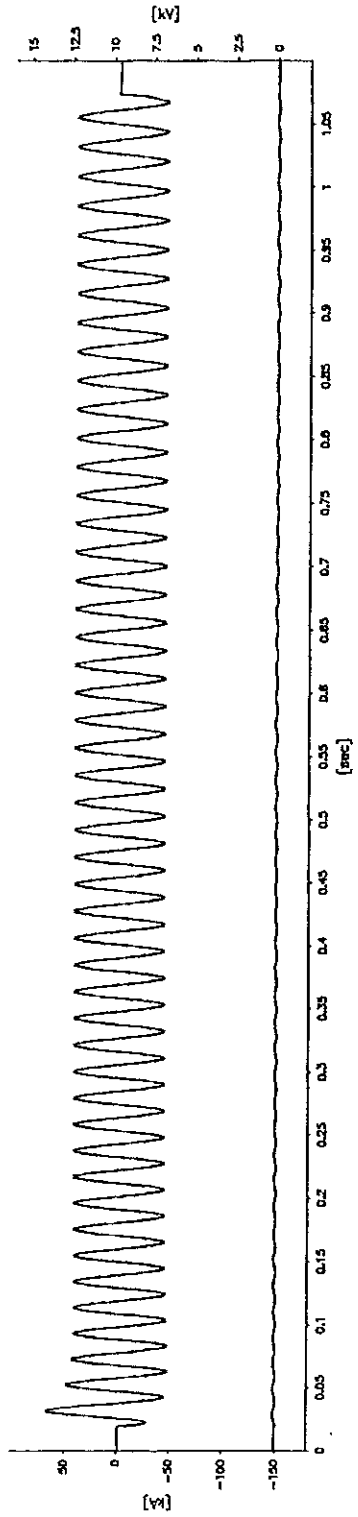
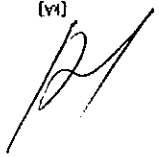


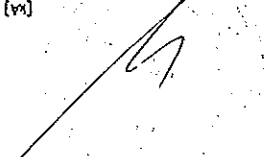
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After Test HZ 146 L 02 / 09



6.7.2000

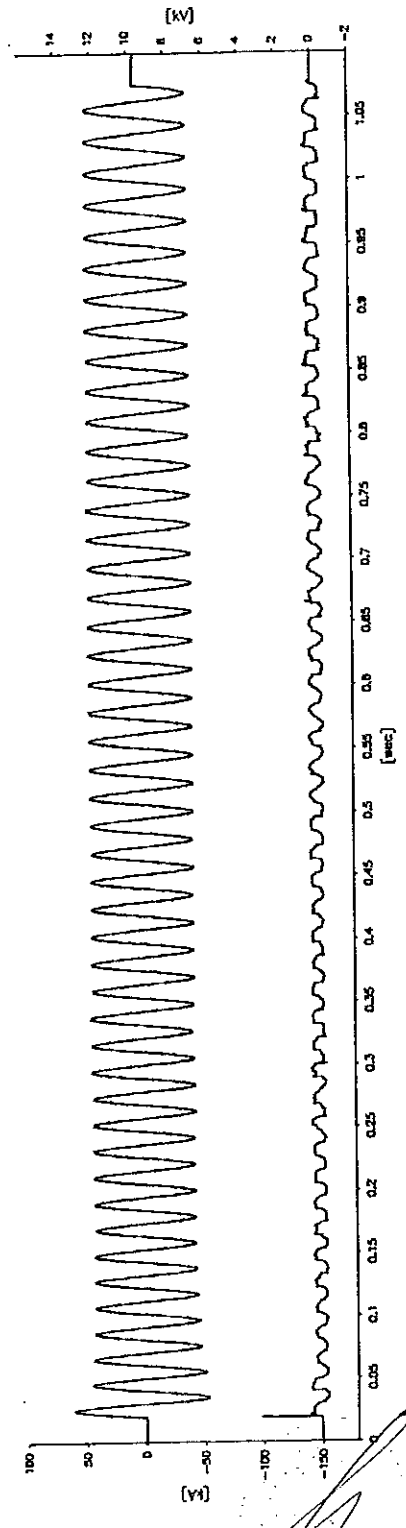
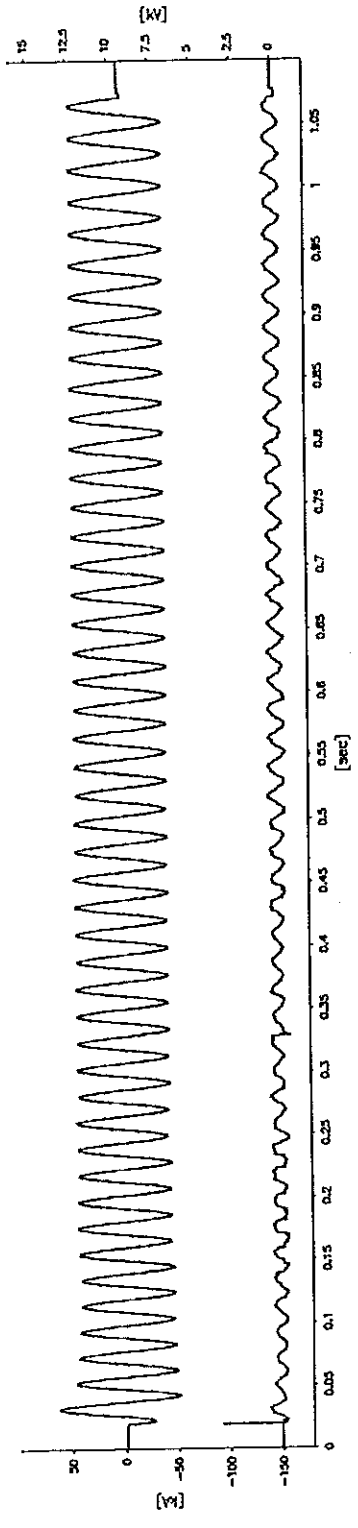
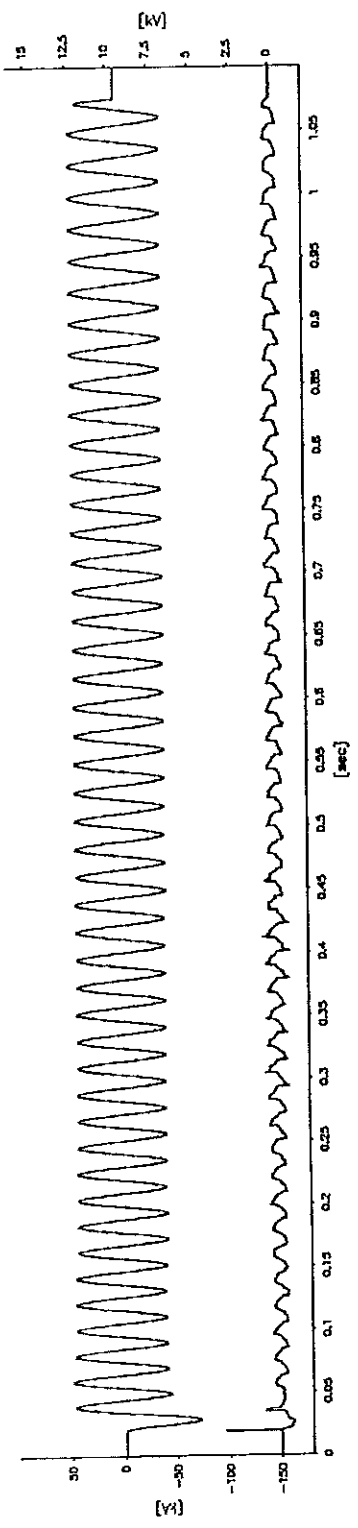


HZ146L02.002



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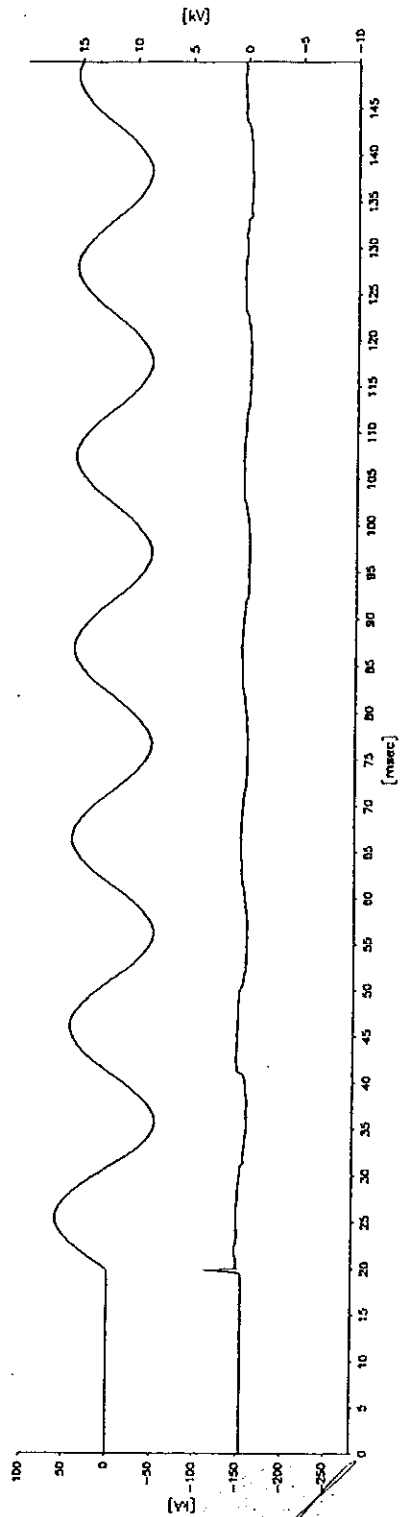
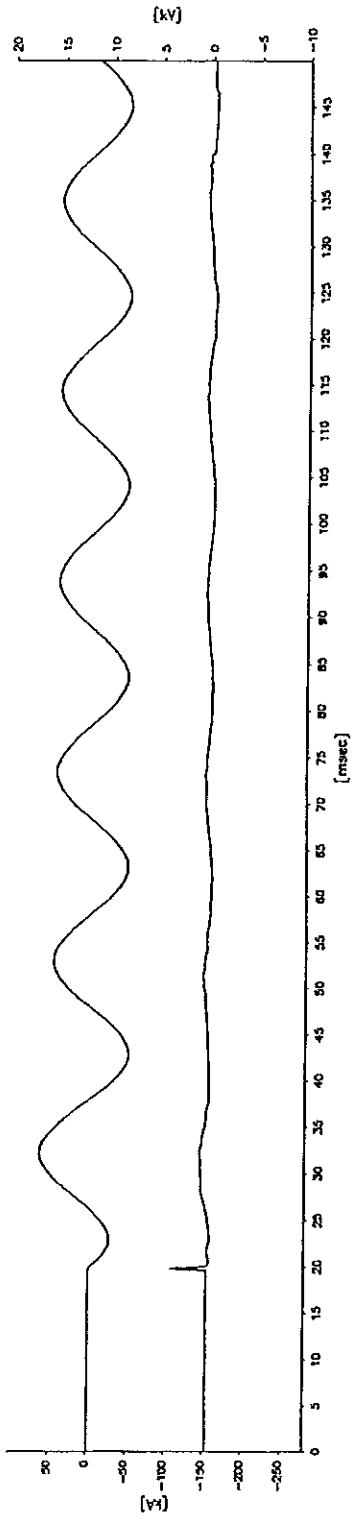
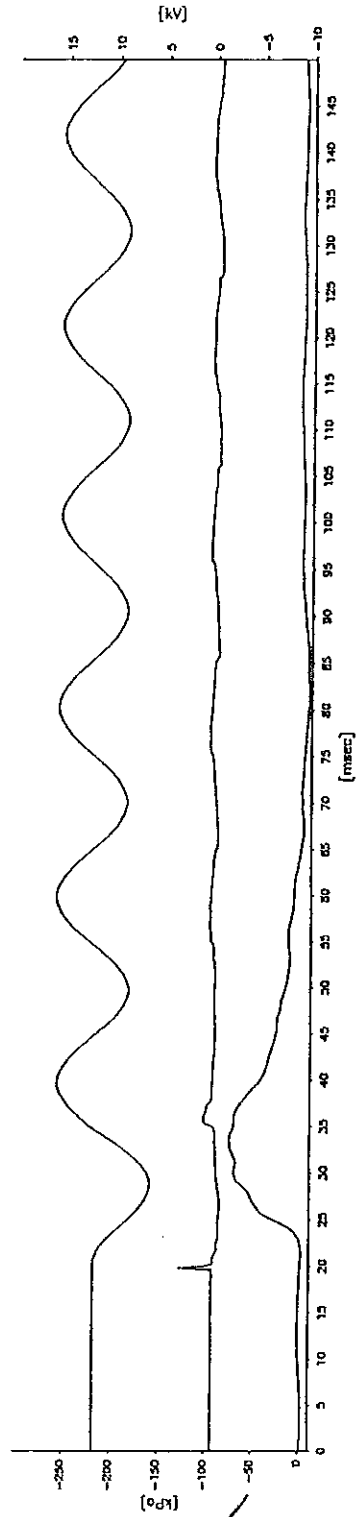
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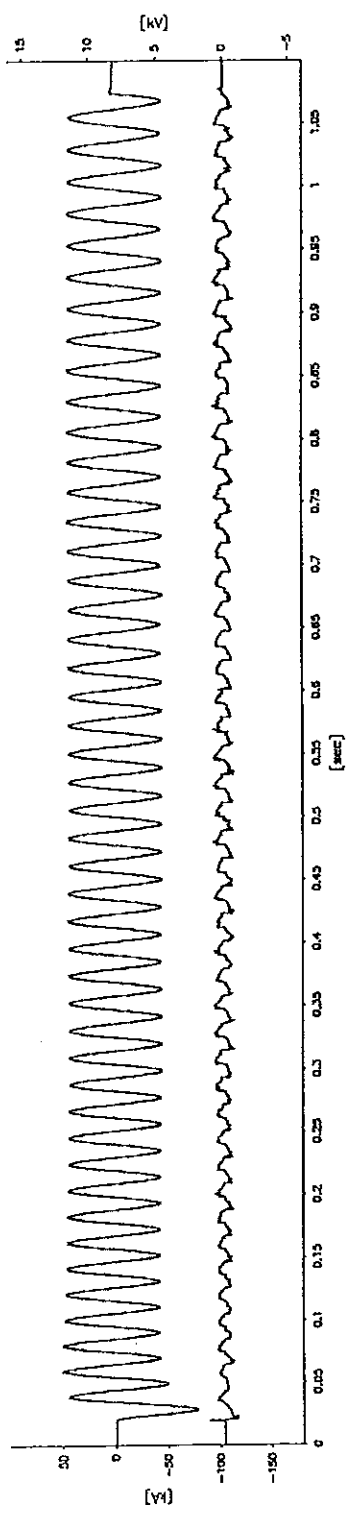
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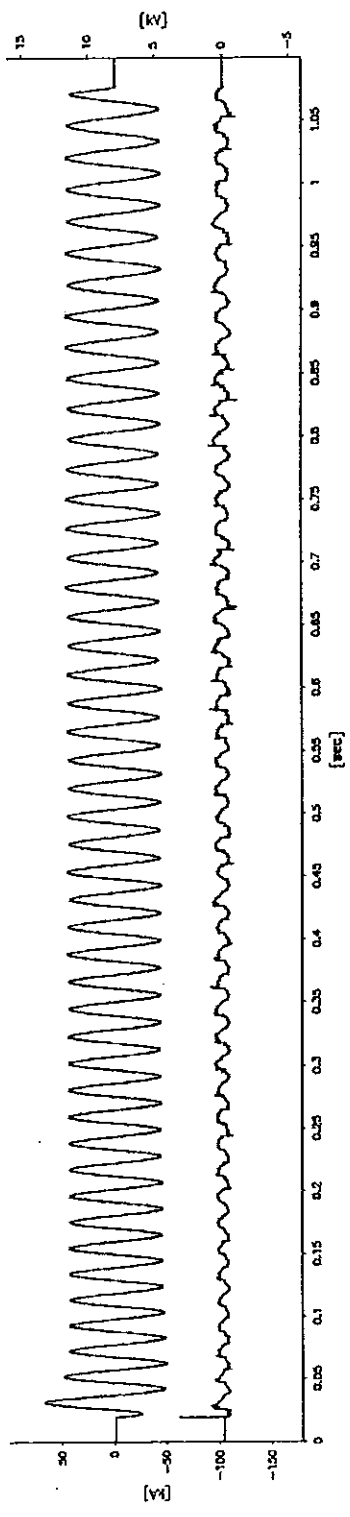
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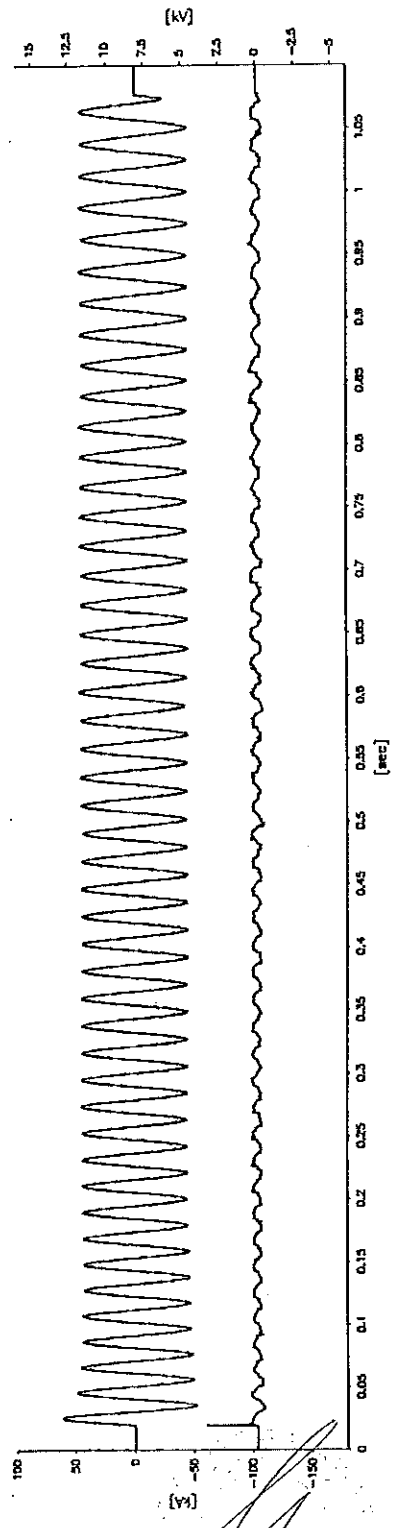


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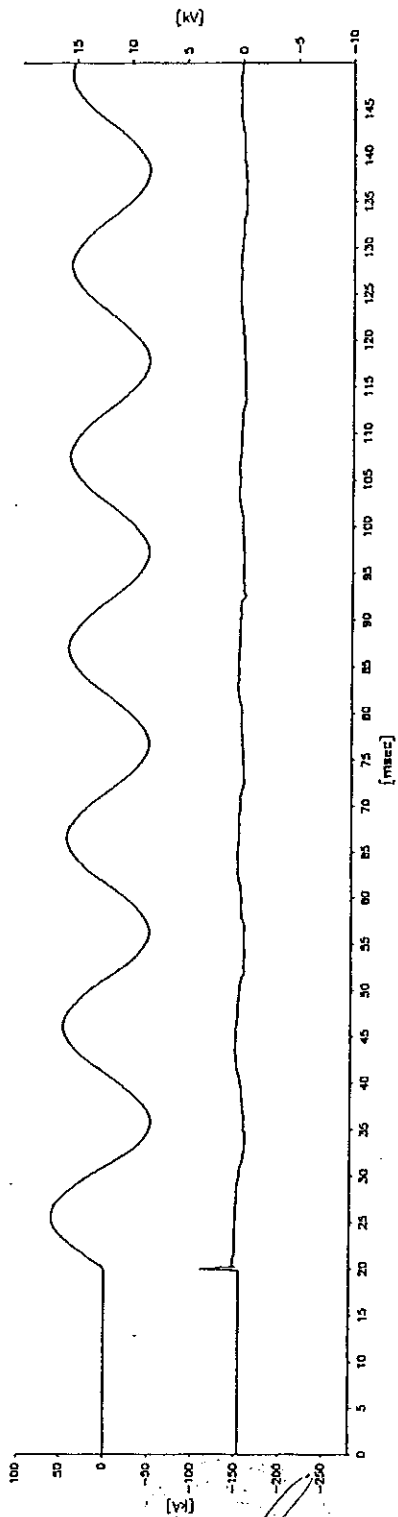
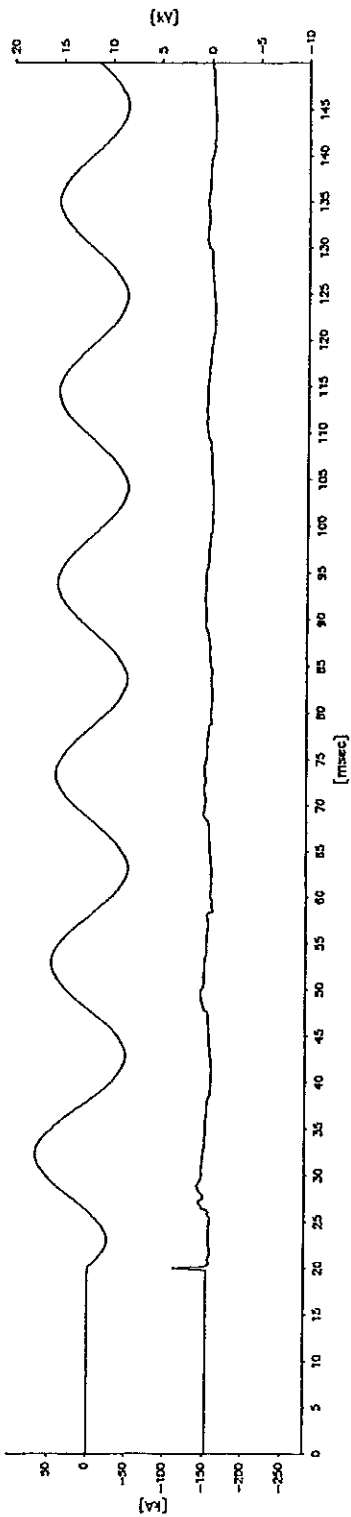
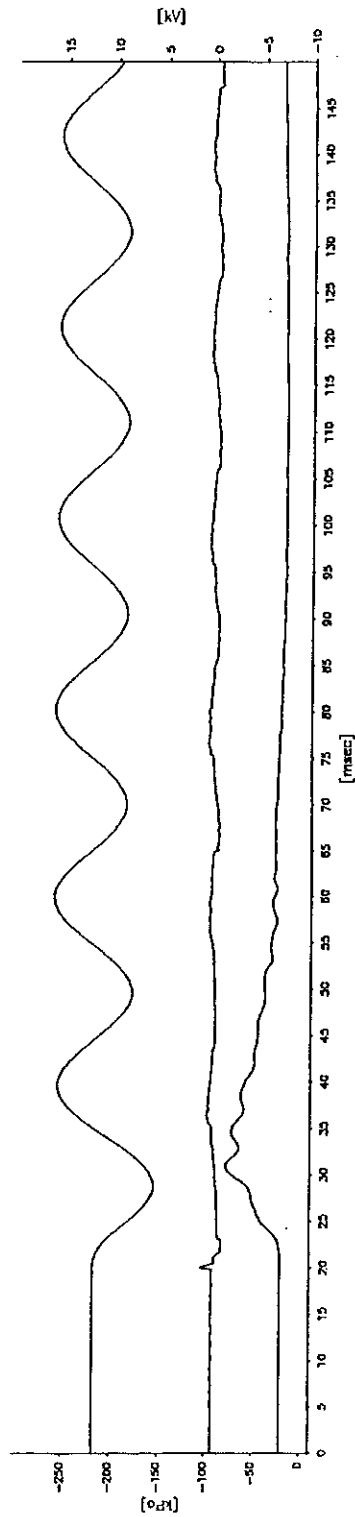


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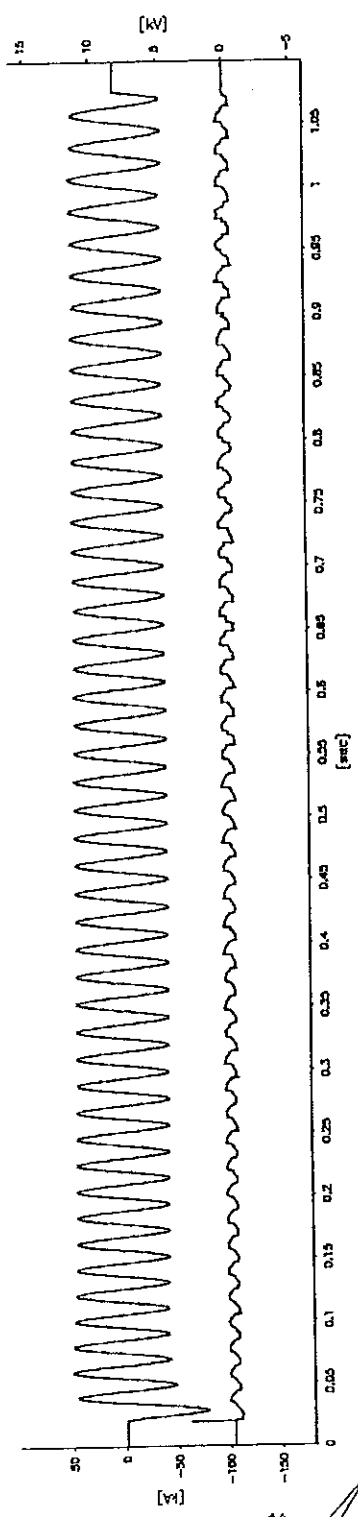
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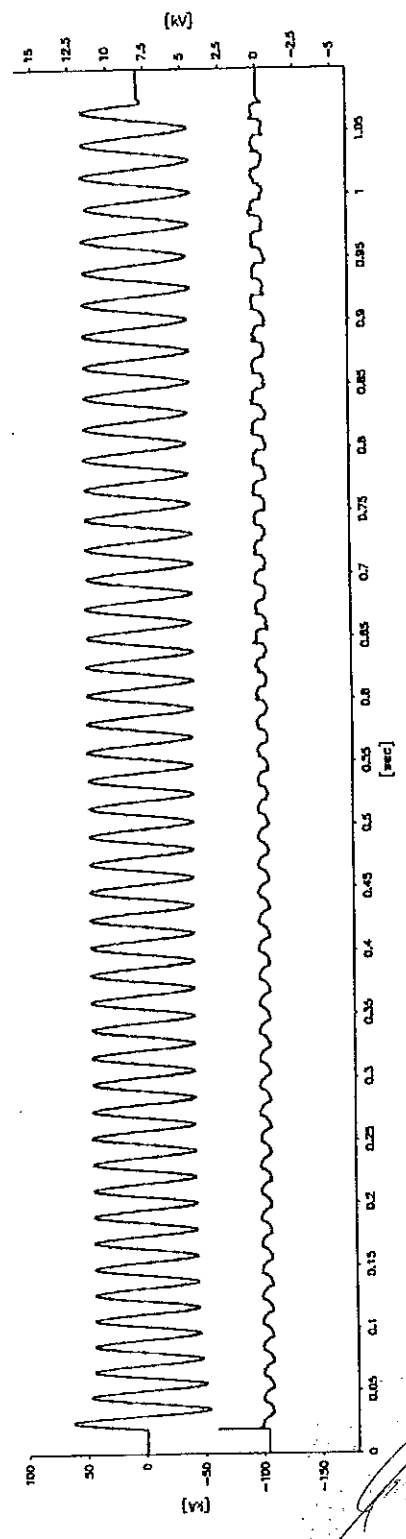
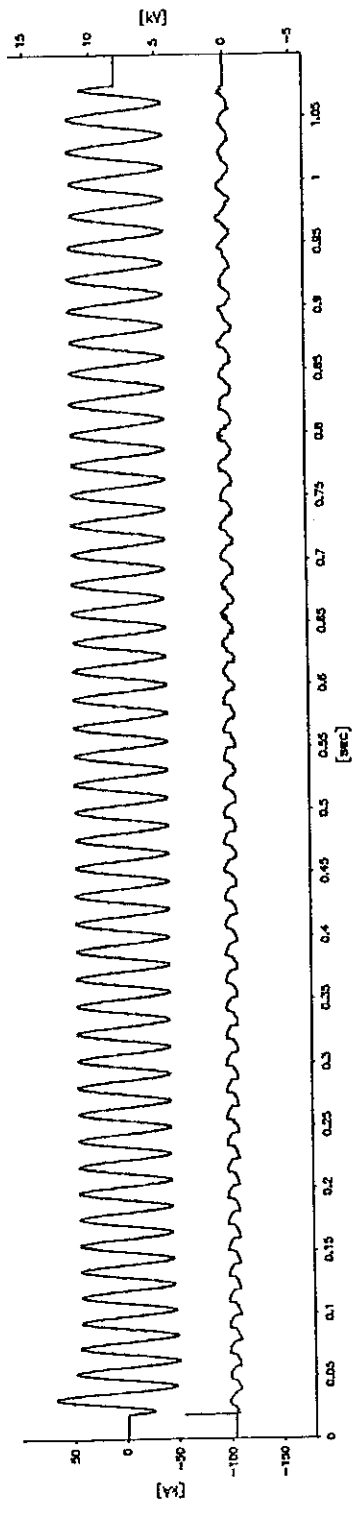
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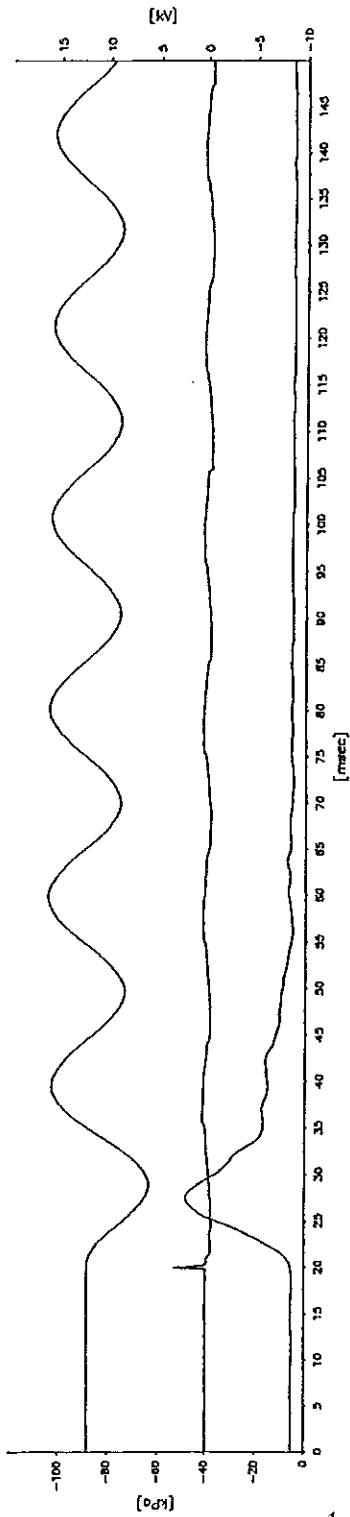
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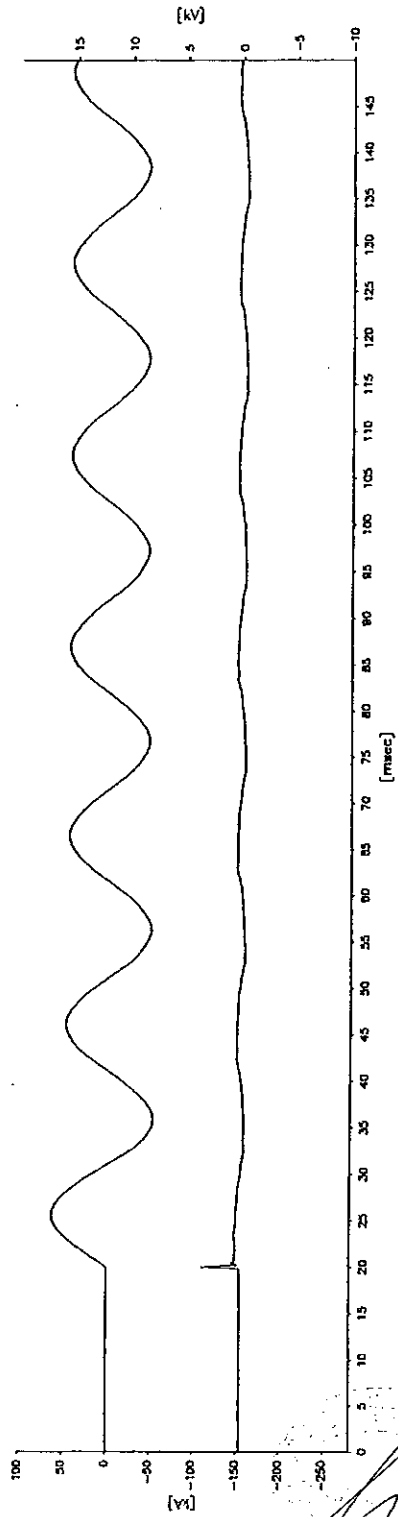
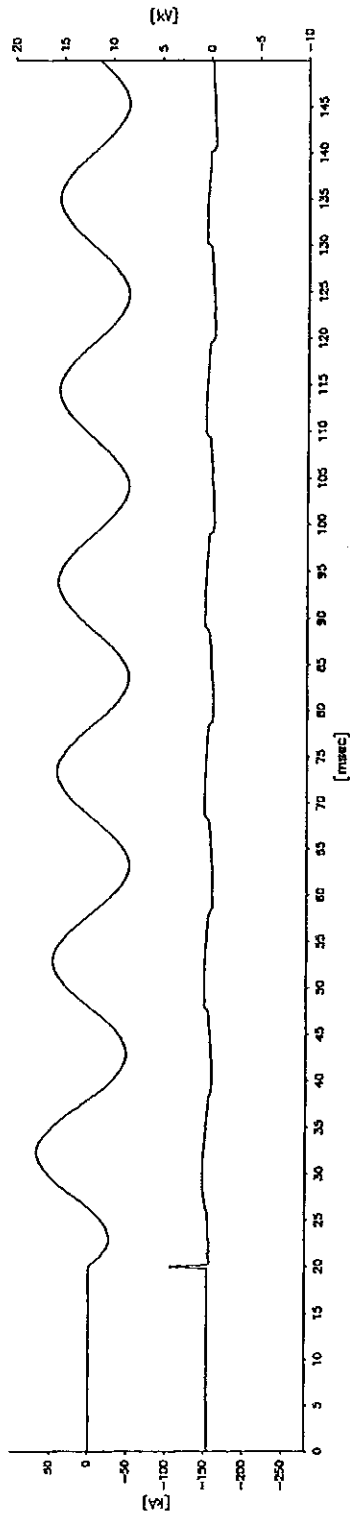
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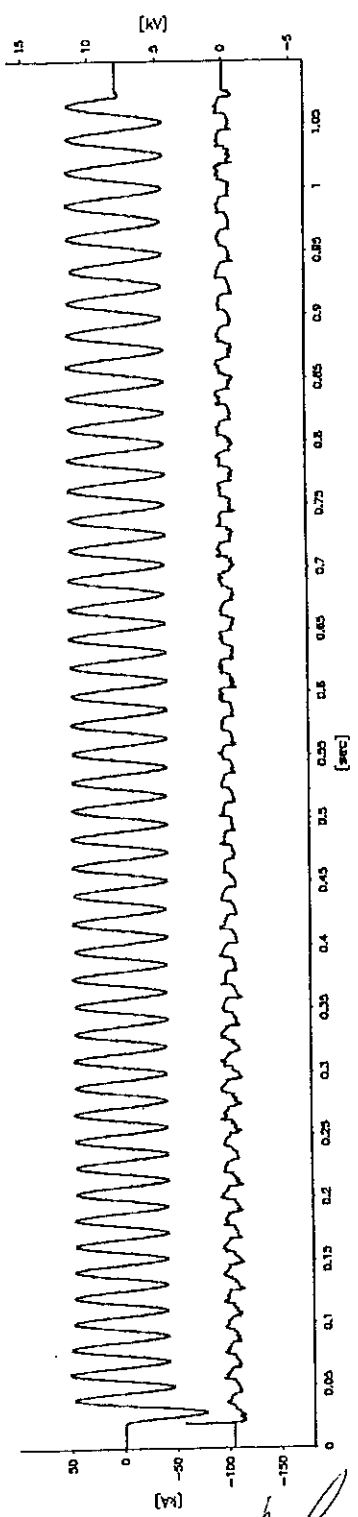
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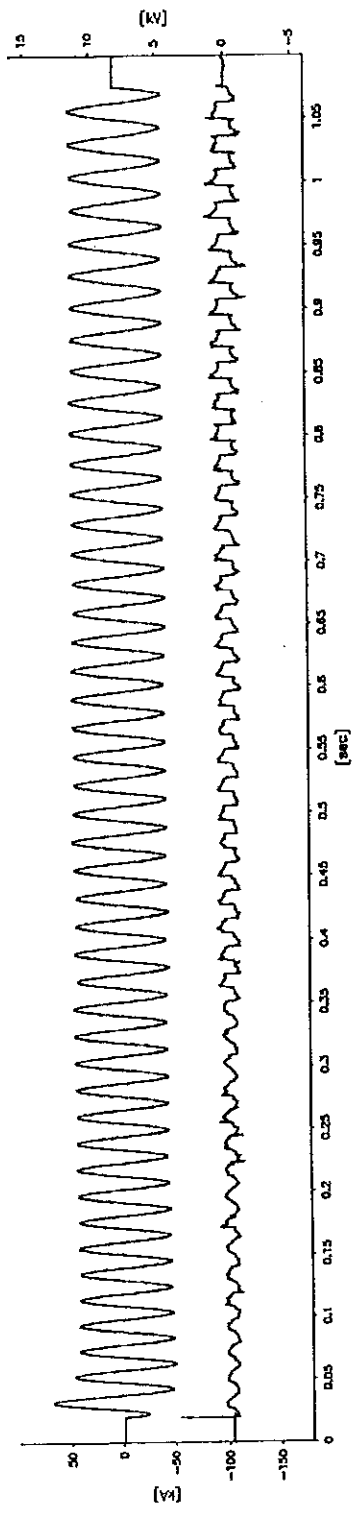
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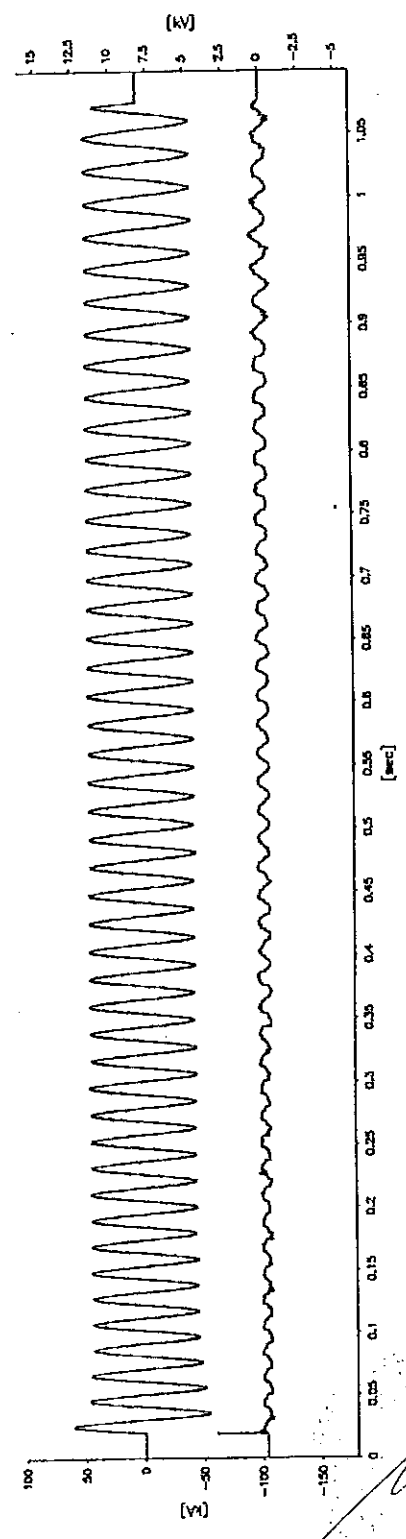


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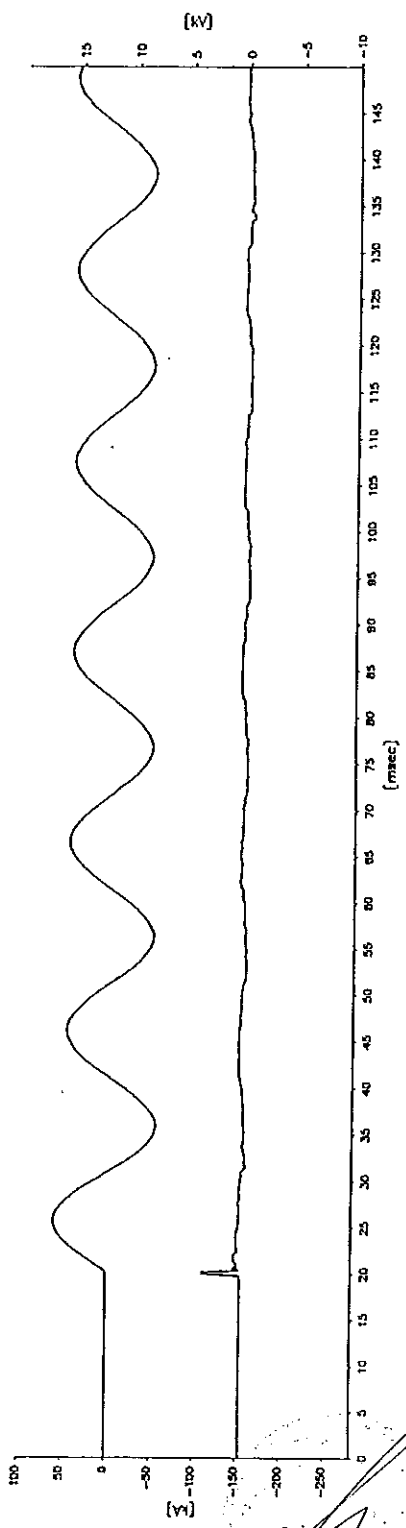
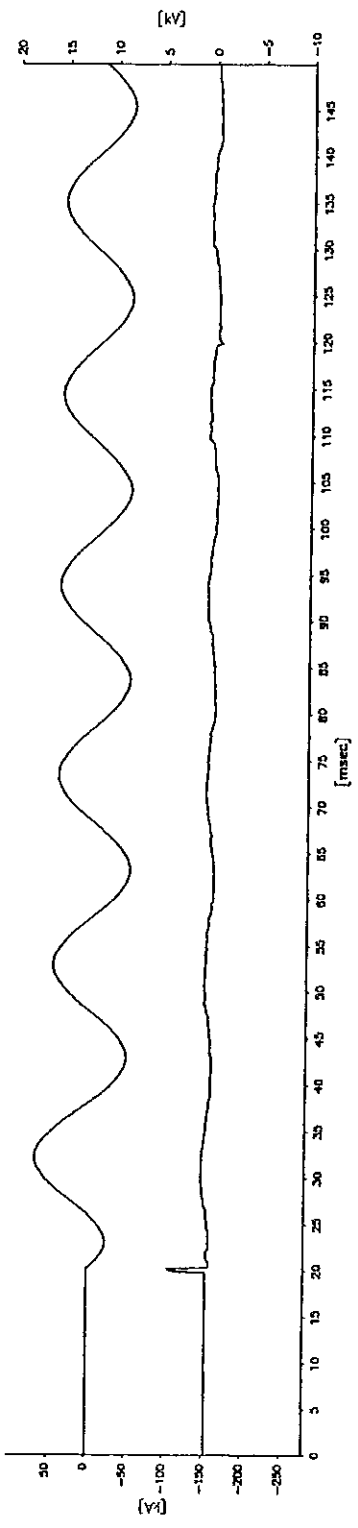
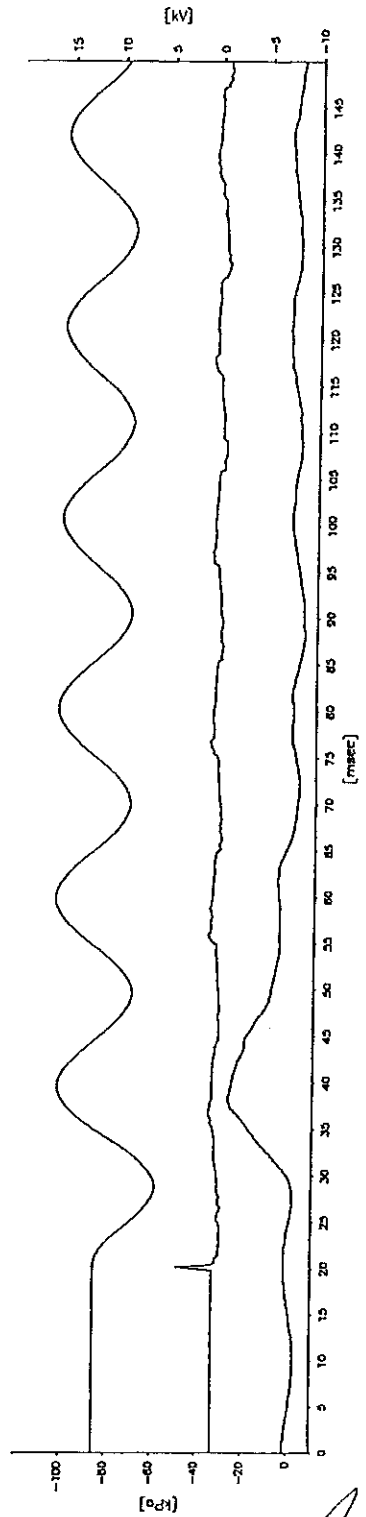


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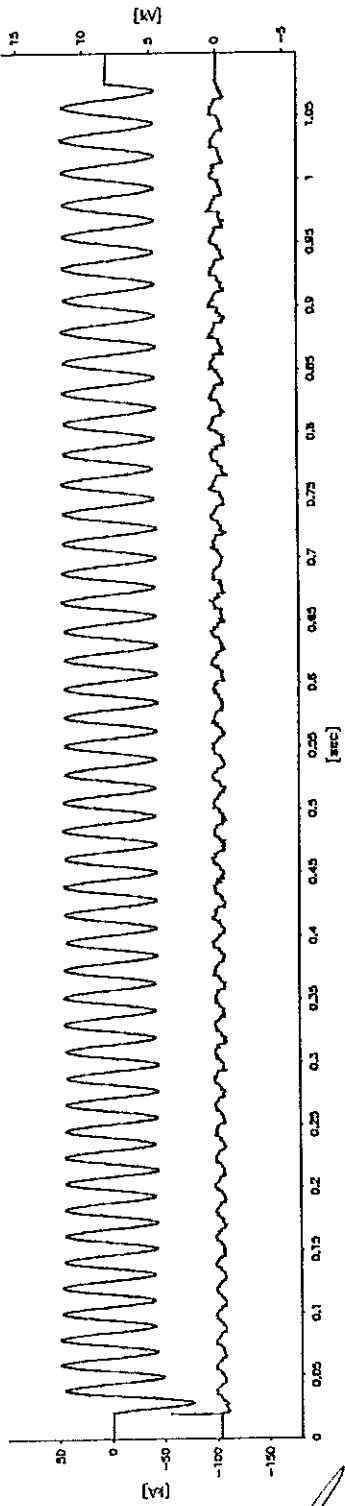


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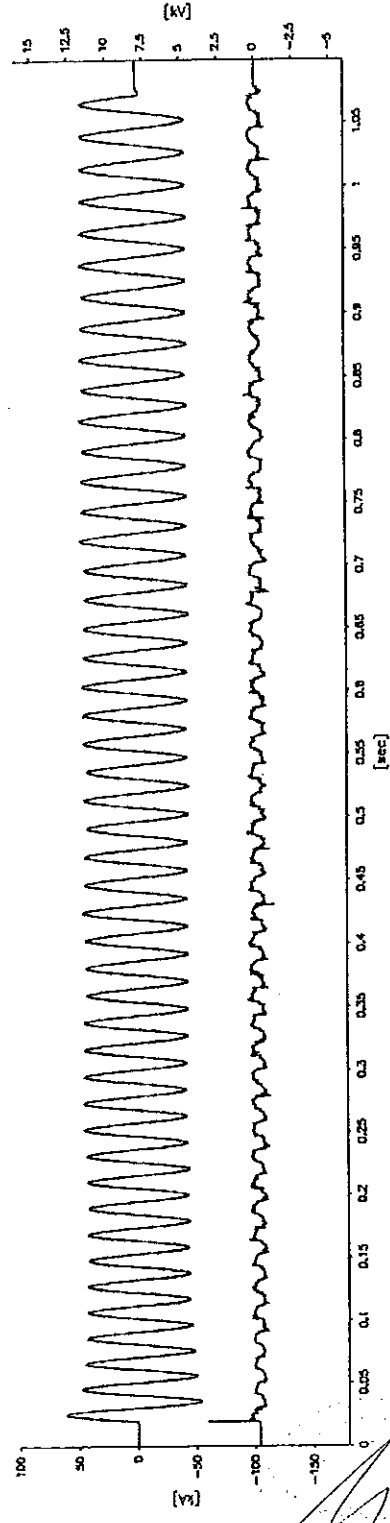
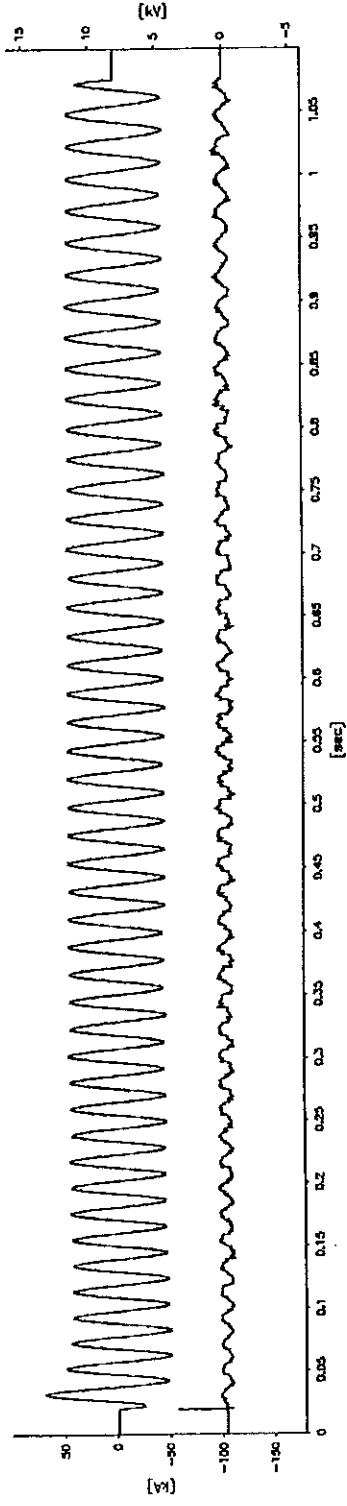
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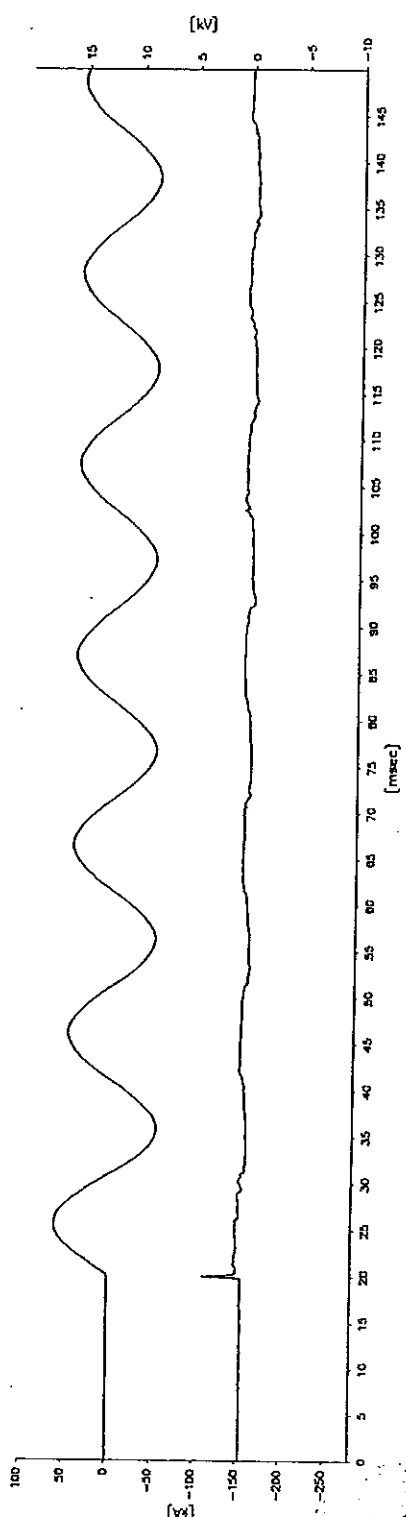
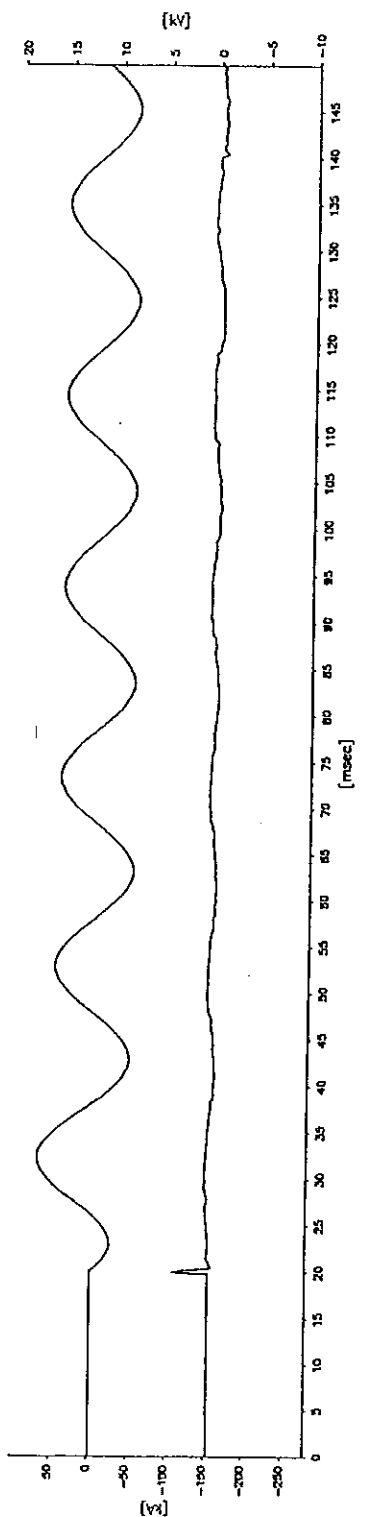
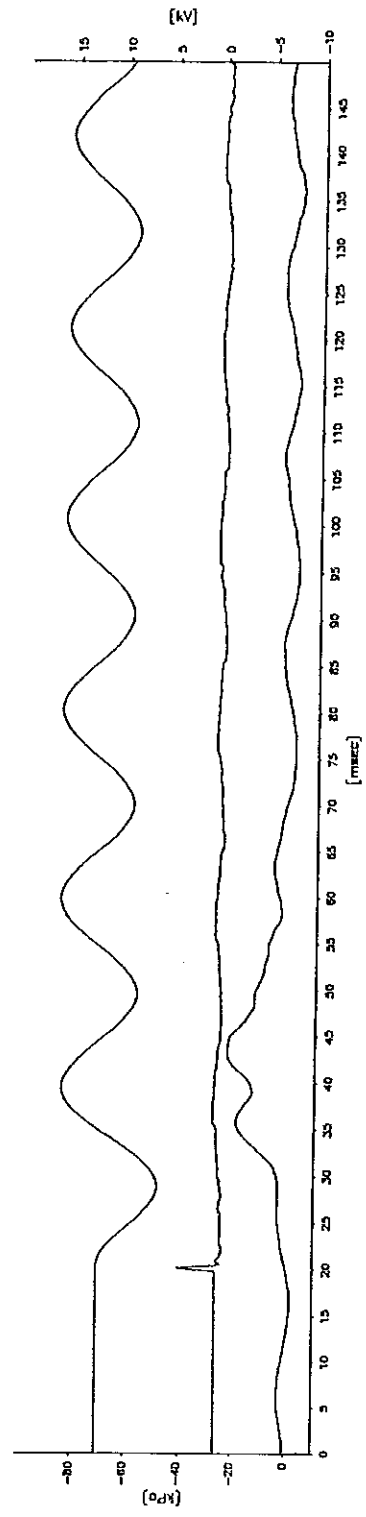
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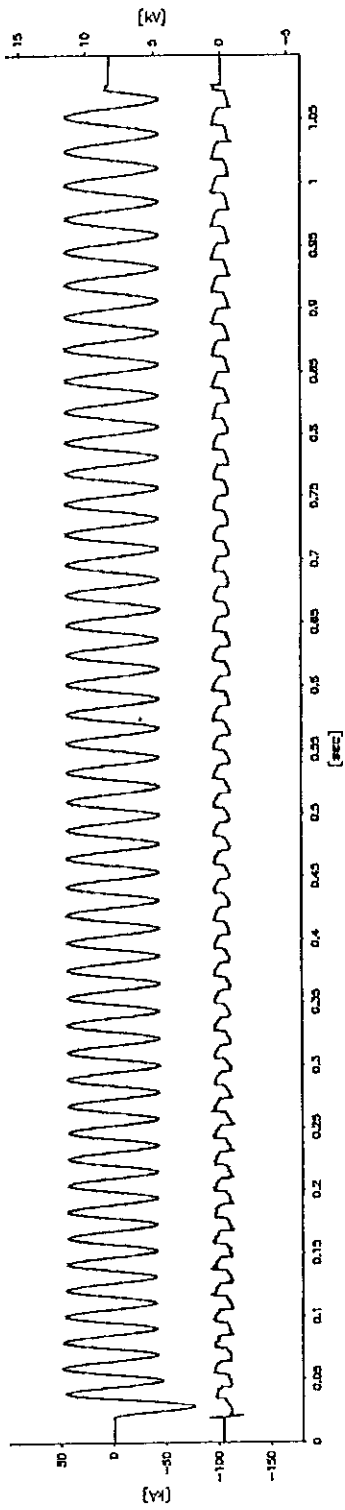
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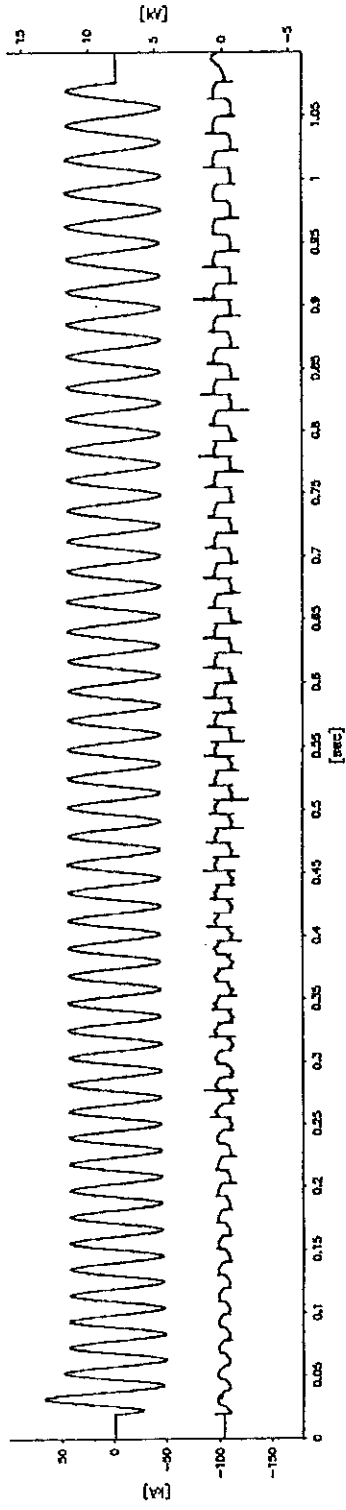
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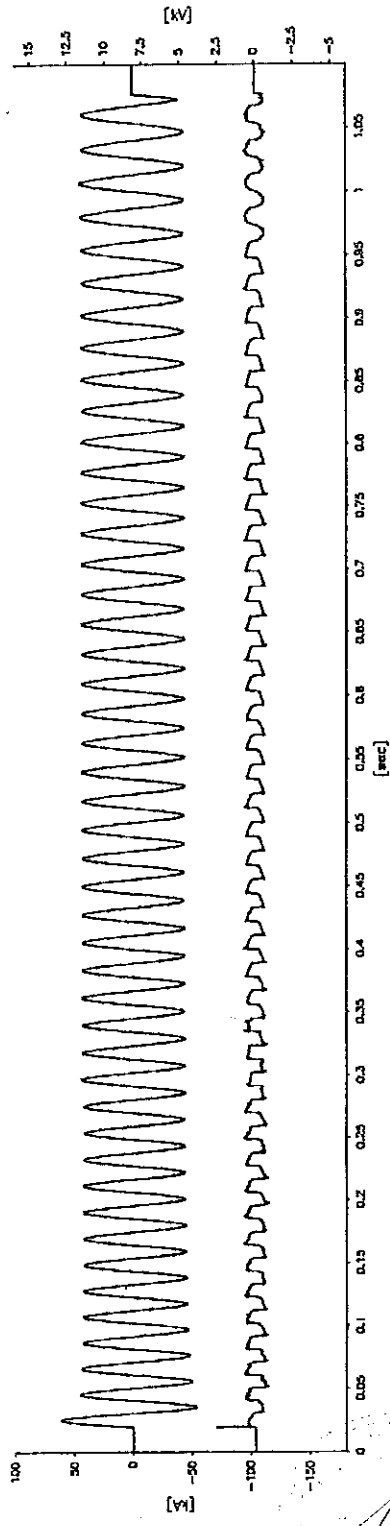


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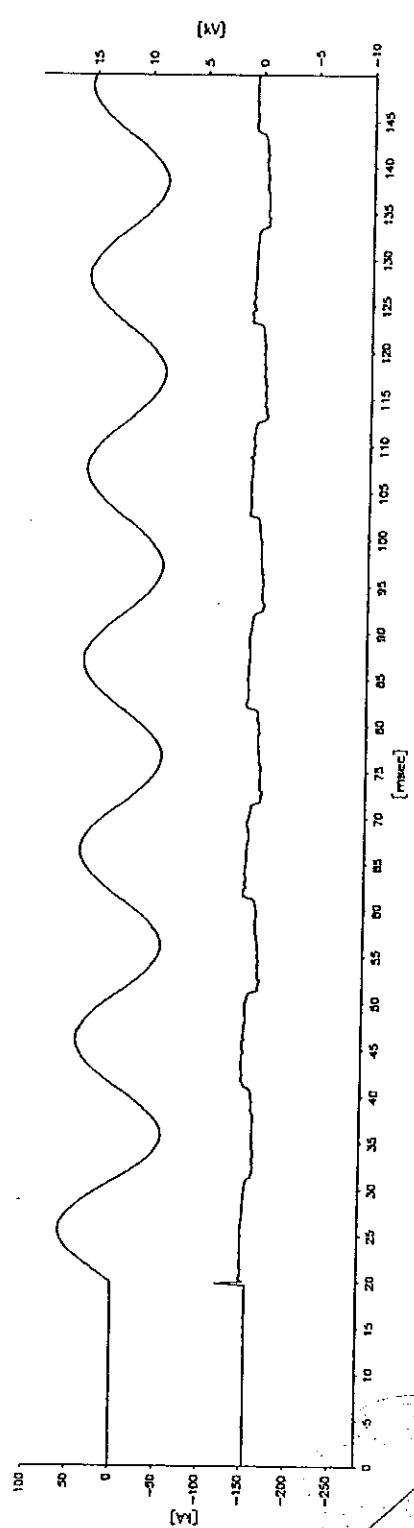
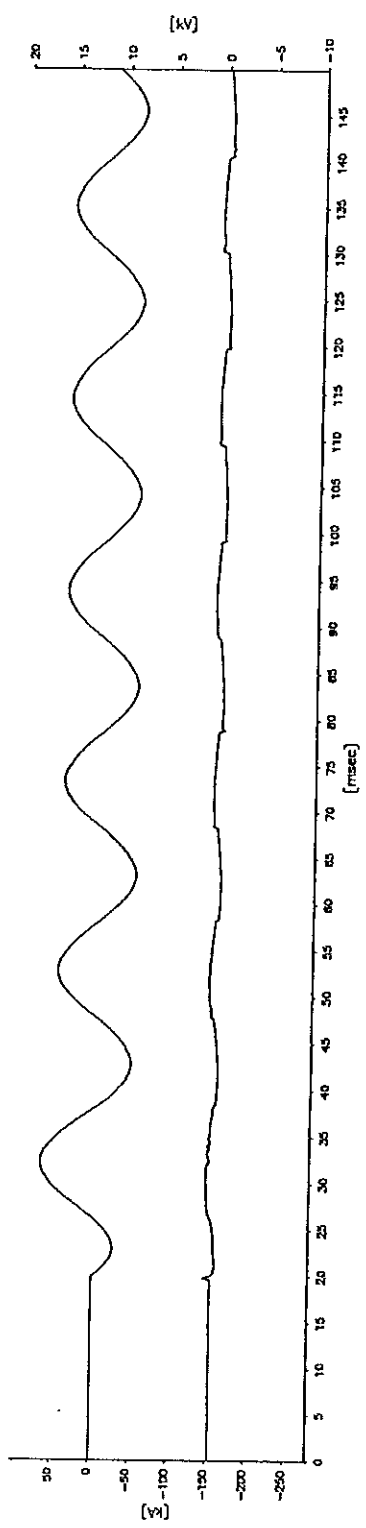
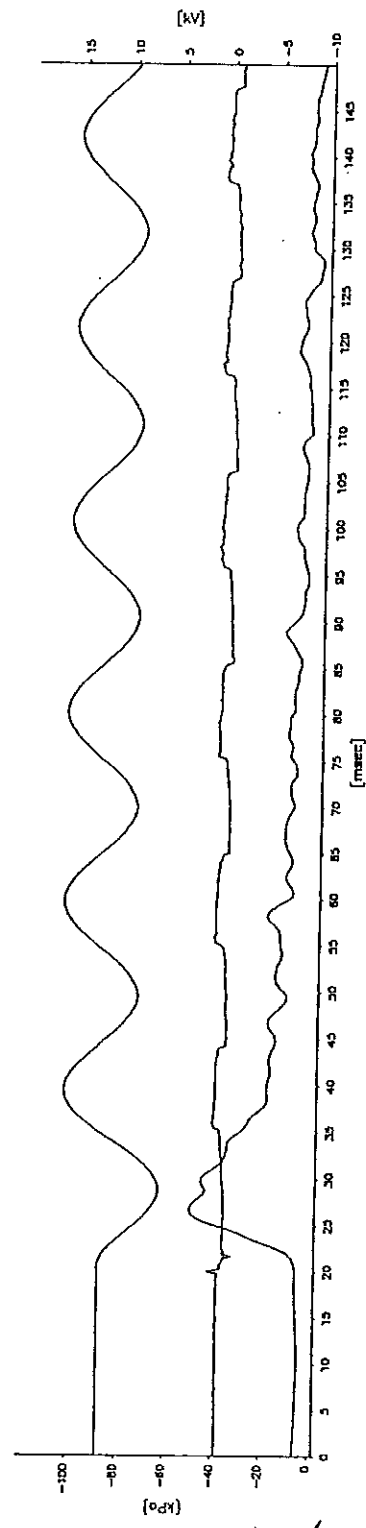


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PEHLA

GESELLSCHAFT FÜR ELEKTRISCHE HOCHLEISTUNGSPRÜFUNGEN
Member of the Short-Circuit-Testing Liaison (STL)

Test Document

Report No.: 0020 Ra

Copy No.:

0

Contents: 11 Sheets

Equipment under test: Metal-clad air-insulated switchgear panel from a 12 kV switchgear type ZS1.2 (T = 1000 mm), drawing-no. GCE 8010452 R0112, with withdrawable vacuum circuit-breaker type VD4P 1225-31 and with earthing switch type EK6-1208-275

Manufacturer: ABB Calor Emag Mittelspannung GmbH, D-40472 Ratingen, Germany

Client: ABB Calor Emag Mittelspannung GmbH, D-40472 Ratingen, Germany

Testing station: PEHLA-Prüffeld Ratingen

Date of test: 08th May 2000

Applied test specifications:
IEC 60298, 3rd edition, 1990-12, clause 6.102
IEC 60694, 2nd edition, 1996-5

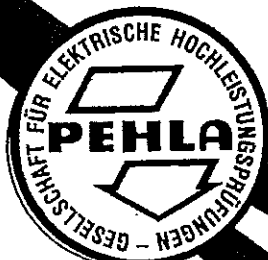
According to STL Objectives and Operating Principles PEHLA issues a Test Document following exclusively the above mentioned test specifications and the STL Guides wherever applicable.

Tests performed:

Mechanical operation test comprising 50 operations of the vacuum circuit-breaker type VD4P 1225-31, 50 operations of the earthing switch type EK6 and 25 manual insertions and withdrawals of the withdrawable part. The interlocks of the circuit-breaker, withdrawable part and the earthing switch were tested in the respective position.

Test results:

All switching devices, removable parts and the mechanical and electrical interlocks passed the mechanical operation test successfully. They were in proper working order and the effort to operate them was practically the same before and after the test.



GESELLSCHAFT FÜR ELEKTRISCHE
HOCHLEISTUNGSPRÜFUNGEN

Technical Committee

Mannheim, 10th October 2000

The test results relate only to the items tested.

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The PEHLA-Prüffeld Ratingen has been approved by the DATech (German accreditation body for technology) according to DIN EN 45001 for tests in the field of high-voltage switchgear and controlgear and power engineering equipment (Registration-No. DAT-P-032/93).

Under reference to DIN EN 45001 PEHLA states the following:

- The accreditation of the PEHLA-Prüffeld or any of its test reports by themselves in no way constitute or imply product approval by DATech or any other body.
- If someone refers to a test in an accredited PEHLA-Prüffeld this reference shall include the accreditation body, i.e. DATech, the relevant scope of the accreditation and the appropriate registration number.

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PEHLA is foundation-member of the Short-Circuit Testing Liaison (STL) which has been founded in March 1969. STL is a forum for the international cooperation of the testing organisations with the further full members ASTA (GB), CESI (I), ESEF (F), KEMA (NL), SATS (N; S, SF) and STLNA (USA). In the framework of EC, STL has been recognised in 1992 by EOTC as agreement group.

PEHLA-Documents

A Certificate

is issued for type tests which have successfully been carried out in full compliance with the relevant specifications or standards and STL Guides valid at the time of the test.

For these tests the equipment under test must be clearly identified by technical description, drawings and additional specifications.

A Test Document

is issued for parts of type tests which have successfully been carried out in full compliance with the relevant specifications or standards and STL Guides valid at the time of test.

For these tests the equipment under test must be clearly identified by technical description, drawings and additional specifications.

A Test Report

is issued for all other tests which have been carried out according to specifications, standards or "PEHLA-Richtlinien" (PEHLA Guides) and/or clients instructions.

Similarly, this test report contains all test results, details of the conditions under which the tests were carried out, also details relating to the behaviour of the equipment during test, and its condition after the tests.

Addresses:

Office: PEHLA-Geschäftsstelle
Hallenweg 40
D-68219 Mannheim

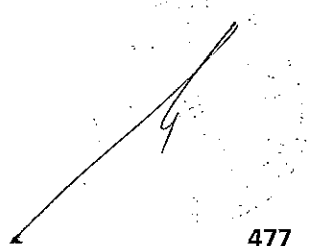
Testing Station: PEHLA-Prüffeld Ratingen
Oberhausener Str. 33
D-40472 Ratingen

Manufacturer: ABB Calor Emag Mittelspannung GmbH
Oberhausener Str. 33
D-40472 Ratingen

Client: ABB Calor Emag Mittelspannung GmbH
Oberhausener Str. 33
D-40472 Ratingen

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Photo of the Test Object	11



List of Test Participants

Representatives of Test Committee:


Mr. U. Köster	PEHLA-Testing Station Ratingen
Mr. W. Stolz	PEHLA-Testing Station Mannheim

Test Engineer:

Mr. U. Koal	PEHLA-Testing Station Ratingen
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Other Participants:

Mr. L. Hörbelt	PEHLA-Testing Station Ratingen
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Technical Data of Test Object

Switchgear

Ratings assigned by the manufacturer

Test Object: Metalclad air-insulated switchgear panel
Type: ZS1.2
Manufacturer: ABB Calor Emag Mittelspannung GmbH, D-40472 Ratingen, Germany
Serial-No.: 07550027/2010/00 **Year of manufacture:** 2000
Drawing No.: GCE8010452 R0112 index 00

Rated voltage	12 kV
Rated lightning impulse withstand voltage	75 kV
Rated switching impulse withstand voltage	- kV
Rated power frequency withstand voltage	28 kV
Rated frequency	50/60 Hz
Rated normal current of busbar	2500 A
Rated normal current of feeder	2500 A
Rated peak withstand current	80 kA
Rated short-time withstand current	31,5 kA
Rated duration of short-circuit	3 s
Insulating medium	air / vacuum
Rated operating pressure (abs./20 °C)	- MPa
Minimum operating pressure (abs./20 °C)	- MPa
Max. ambient air temperature	40 °C
Permissible values for internal arc faults:	
Peak current	80 kA
Short-time current	31,5 kA
Duration of short-circuit	1 s

Essential characteristics and installed devices:

Date of receipt of test object: 08th May 2000



Technical Data of Test Object
Switching Device
Ratings assigned by the manufacturer

Test Object: Vacuum circuit-breaker
Type: VD4P 1225-31
Manufacturer: ABB Calor Emag Mittelspannung GmbH, D-40472 Ratingen, Germany
Serial-No.: 07007054/4001/00 **Year of manufacture:** 2000
Drawing No.: GCE 7000162 R1178 index 00 (breaker)
Vacuum interrupter: L1: No. 00G4S01115, L2: No. 00G4S01116, L3: No. 00G4S01117
Drawing No.: GCE 7005535 R0101 index 02 (interrupter)

Rated voltage	12 kV
Rated lightning impulse withstand voltage	75 kV
Rated switching impulse withstand voltage	- kV
Rated power frequency withstand voltage	28 kV
Rated frequency	50/60 Hz
Rated nominal current	2500 A
Rated peak withstand current	80 kA
Rated short-time withstand current	31.5 kA
Rated duration of short-circuit	3 s
Rated short-circuit breaking current	
Rated short-circuit current	31.5 kA
D.C. component	30 %
Rated short-circuit making current	80 kA
Rated transient recovery voltage	
Peak value	- kV
Rate of rise	- kV/ μ s
First-pole-to-clear-factor	1.5
Rated operating sequence	O-0.3s-CO-3min-CO
Arc extinguishing medium	vacuum
Rated pressure / Minimal pressure (20 °C)	MPa
Insulating medium	
Rated pressure / Minimal pressure (20 °C)	MPa
Driving mechanism	
Type of drive	VD4 drive
Rated pressure / Minimal pressure (20 °C)	MPa
Number of poles	3
Number of units per pole	1
Rated opening time	\leq 45 ms
Rated closing time	Approx. 60 ms
Rated voltage of opening release	220 V
Rated voltage of closing release	220 V
Rated supply voltage	220 V
Rated frequency of supply voltage	- Hz
Max. ambient air temperature	40 °C
Further specifications:	-

Essential characteristics:

Date of receipt of test object: 08th May 2000

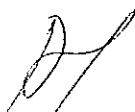
Technical Data of Test Object
Switching Device
Ratings assigned by the manufacturer

Test Object: Earthing switch
Type: EK6-1208-275
Manufacturer: ABB Calor Emag Mittelspannung GmbH, D-40472 Ratingen, Germany
Serial-No.: 02/032/00 **Year of manufacture:** 2000
Drawing No.: GCE7169312 R0116 index 20
Vacuum interrupter:
Drawing No.:

Rated voltage	12 kV
Rated lightning impulse withstand voltage	75 kV
Rated switching impulse withstand voltage	- kV
Rated power frequency withstand voltage	28 kV
Rated frequency	50/60 Hz
Rated nominal current	- A
Rated peak withstand current	80 kA
Rated short-time withstand current	31.5 kA
Rated duration of short-circuit	3 s
Rated short-circuit breaking current	
Rated short-circuit current	31.5 kA
D.C. component	- %
Rated short-circuit making current	80 kA
Rated transient recovery voltage	
Peak value	- kV
Rate of rise	- kV/ μ s
First-pole-to-clear-factor	-
Rated operating sequence	-
Arc extinguishing medium	-
Rated pressure / Minimal pressure (20 °C)	MPa
Insulating medium	
Rated pressure / Minimal pressure (20 °C)	MPa
Driving mechanism	
Type of drive	-
Rated pressure / Minimal pressure (20 °C)	MPa
Number of poles	3
Number of units per pole	-
Rated opening time	- ms
Rated closing time	- ms
Rated voltage of opening release	- V
Rated voltage of closing release	- V
Rated supply voltage	- V
Rated frequency of supply voltage	- Hz
Max. ambient air temperature	40 °C
Further specifications:	-

Essential characteristics:

Date of receipt of test object: 08th May 2000




List of Drawings

The manufacturer has guaranteed, that the equipment submitted for test has been manufactured in full accordance with the following drawings. PEHLA has verified that these drawings adequately represented the equipment tested. These drawings have been stamped and signed by PEHLA representatives and are kept

- with the test documents at the test laboratory.
 at the client.

Drawing-No.	Revision	Title	Additional remarks
GCE 8010452 R0112	Index 00	Switchgear 12 kV PW.1000	
GCE 7000162 R1178	Index 00	Draw out VD4-P for ZS1.2	
GCE7169312 R0116	Index 20	Earthing switch EK6 12-24 kV	

A copy of the following drawings is part of this Test Report:

Metalclad air-insulated switchgear panel GCE 8010452 R0112 index 00

Mechanical Operation Test

List of interlocks:

1. Withdrawable part in test-position
 - Circuit-breaker ON: prevented to move the withdrawable part in service-position
2. Withdrawable part in service-position
 - Circuit-breaker ON: prevented to move the withdrawable part in test-position
3. Withdrawable part between service and test position:
 - prevented to switch ON the circuit-breaker
4. Withdrawable part in test-position
 - Circuit-breaker OFF and earthing switch ON: prevented to move the withdrawable part in service-position
5. Withdrawable part in test-position
 - circuit-breaker ON and earthing switch ON: prevented to move the withdrawable part in service-position
6. Withdrawable part not in test-position
 - prevented to switch ON the earthing switch

All the above mentioned interlocks were checked, for this the circuit-breaker and the earthing switch were operated 50 times and the withdrawable part was inserted and withdrawn 25 times.



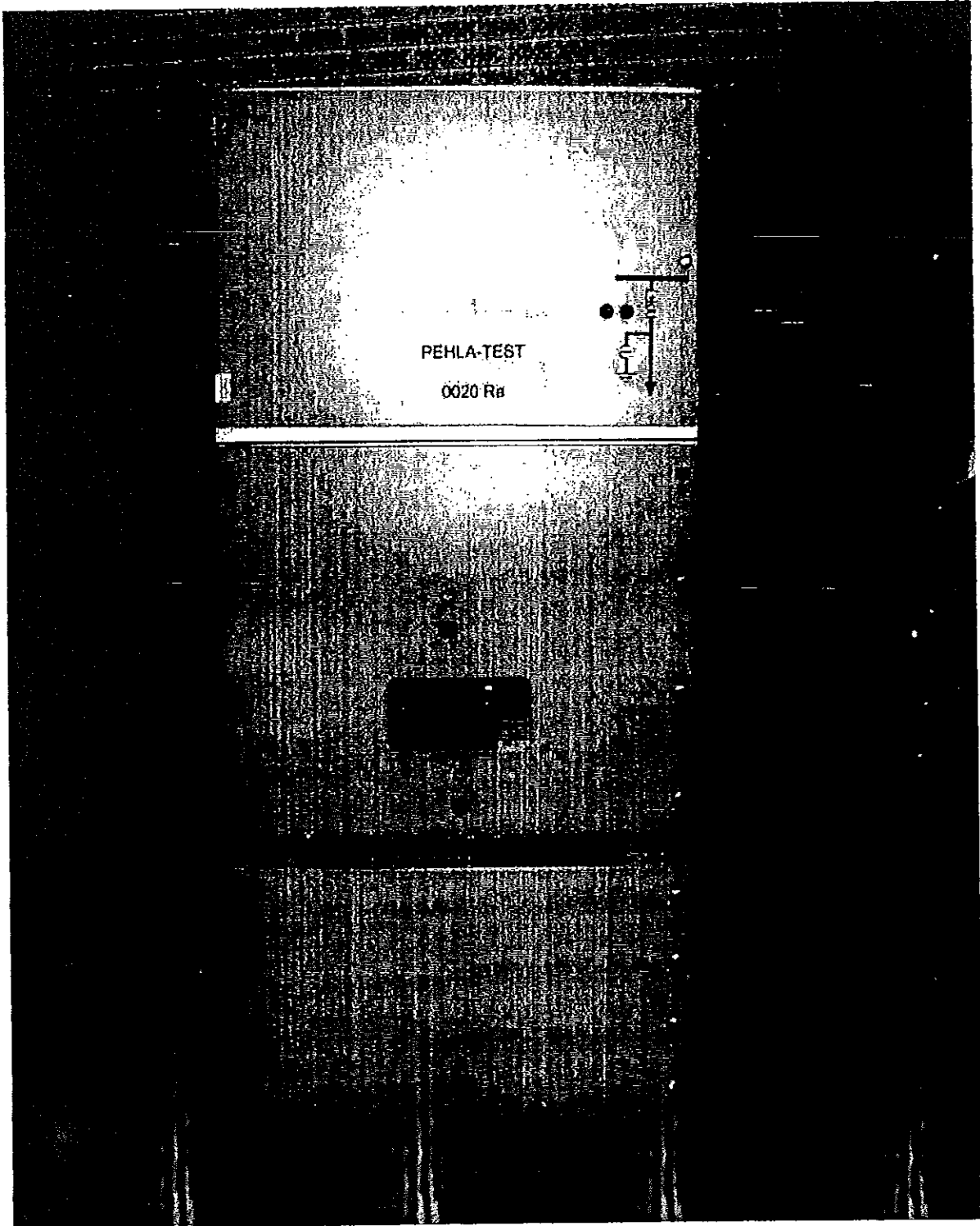
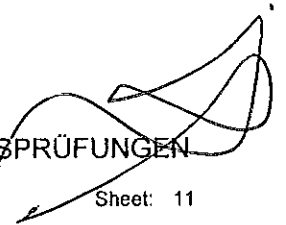
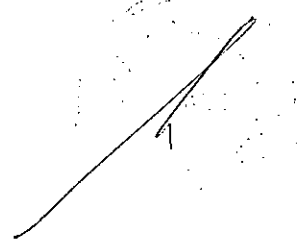


Fig. 1: Test object



PEHLA

GESELLSCHAFT FÜR ELEKTRISCHE HOCHLEISTUNGSPRÜFUNGEN
Member of the Short-Circuit-Testing Liaison (STL)

Test Report

Report No.: 0016 Ra Copy No.: 0 Contents: 19 Sheets

Equipment under test: Metal-clad air-insulated switchgear panel type ZS1.2, rated voltage 12 kV (width = 1000 mm), drawing-no. GCE 8010452 R0112, with vacuum circuit-breaker type VD4P 1225-31.

Manufacturer: ABB Calor Emag Mittelspannung GmbH, D-40472 Ratingen, Germany

Client: ABB Calor Emag Mittelspannung GmbH, D-40472 Ratingen, Germany

Testing station: PEHLA - Testing Station Ratingen

Date of test: 8th May 2000

Applied test specifications: IEC 60298: 1990-12, clauses 6.1.1, 6.1.3, 6.1.4 a), 6.1.5 - 6.1.7, IEC 60694: 1996-05, clauses 6.2.1, 6.2.3 - 6.2.6.

Tests performed: Dielectric type test.

- Standard lightning impulse withstand voltage test at 75 kV and power-frequency withstand voltage test at 28 kV to earth, between phases and across open switching device.
- 2-kV-AC Voltage test on auxiliary and control circuits.

Test results: The above ZS1.2-type panel with VD4P 1225-31 passed the dielectric type test successfully. The respective requirements are met.



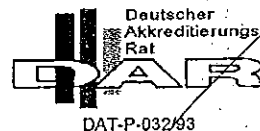
GESELLSCHAFT FÜR ELEKTRISCHE HOCHLEISTUNGSPRÜFUNGEN

Technical Committee

Mannheim, 04th July 2001

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Addresses:

Office: PEHLA-Geschäftsstelle
Hallenweg 40
D-68219 Mannheim

Testing Station: PEHLA-Testing Station Ratingen
Oberhausener Str. 33
D-40472 Ratingen

Manufacturer: ABB Calor Emag Mittelspannung GmbH
Oberhausener Str. 33
D-40472 Ratingen

Client: ABB Calor Emag Mittelspannung GmbH
Oberhausener Str. 33
D-40472 Ratingen




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List of Test Participants

Representatives of the Test Committee:

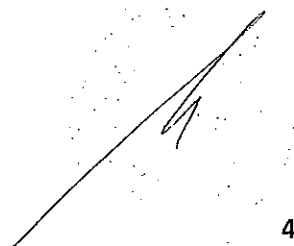
Mr. A. Meier	PEHLA - Testing Station Ratingen
Mr. W. Stolz	PEHLA - Testing Station Mannheim

Test Engineer:

Mr. U. Lisseck	PEHLA - Testing Station Ratingen
----------------	----------------------------------

Other Participants:

-



Technical Data of Test Object**Switchgear**

Ratings assigned by the manufacturer

Test Object: Metal-clad air-insulated switchgear panel
Type: ZS1.2
Manufacturer: ABB Calor Emag Mittelspannung GmbH, D-40472 Ratingen, Germany
Serial-No.: 07550027/2010/00 **Year of manufacture:** 2000
Drawing No.: GCE 8010452 R0112 Index 00

Rated voltage	12 kV
Rated lightning impulse withstand voltage	75 kV
Rated switching impulse withstand voltage	- kV
Rated power frequency withstand voltage	28 kV
Rated frequency	50/60 Hz
Rated normal current of busbar	2500 A
Rated normal current of tee-off	2500 A
Rated peak withstand current	80 kA
Rated short-time withstand current	31.5 kA
Rated duration of short-circuit	3 s
Insulating medium	air
Rated functional pressure (abs./20 °C)	- kPa
Minimum functional pressure (abs./20 °C)	- kPa
Permissible values for internal arc faults:	
Peak current	80 kA
Short-time current	31.5 kA
Duration of short-circuit	1 s
Max. ambient air temperature	40 °C

The above switchgear panel is fully described in the mentioned drawings.

Essential characteristics and installed devices:

The above switchgear panel is fully described in the mentioned drawings.
Essential details are:

- Busbar 2 x 80 mm x 10 mm / R 5 mm, Cu, bare, with bushing plate.
- Busbar tee-off conductor 2 x 100 mm x 10 mm / R 5 mm, Cu, bare.
- tulip insulator with contact pin $\varnothing = 109$ mm.
- Current transformer type ASS 12 -- 20, manufacturer: WTW, Serial-No. L1: 00/166476; L2: 00/166477; L3: 00/166478.
- Voltage transformer type VES 12 -- 02, manufacturer: WTW, Serial-No. L1: 00/166610; L2: 00/166611; L3: 00/166612.
- Earthing switch type EK6-1208-275, Serial-No. 02/032/00.
- Cable conductor 2 x 100 mm x 10 mm / R 5 mm, Cu, bare.

Date of receipt of test object: 8th May 2000



Technical Data of Test Object

Switching Device – Circuit-Breaker

Ratings assigned by the manufacturer

Test Object: Vacuum circuit-breaker
Type: VD4P 1225-31
Manufacturer: ABB Calor Emag Mittelspannung GmbH; D-40472 Ratingen, Germany
Serial-No.: 7007054/4001/00 **Year of manufacture:** 2000
Drawing No.: GCE 7000162 R1178 Index 00 (circuit-breaker)
Vacuum interrupter: Type VG4S, L1: No. 00G4S01115, L2: No. 00G4S01116, L3: No. 00G4S01117
Drawing No.: GCE 7005535 R0101 index 02 (interrupter)

Rated voltage	12 kV
Rated lightning impulse withstand voltage	75 kV
Rated switching impulse withstand voltage	- kV
Rated power frequency withstand voltage	28 kV
Rated frequency	50/60 Hz
Rated normal current	2500 A
Rated peak withstand current	80 kA
Rated short-time withstand current	31.5 kA
Rated duration of short-circuit	3 s
Rated short-circuit breaking current	
... Rated short-circuit current	31.5 kA
D.C. component	30 %
Rated short-circuit making current	80 kA
Rated transient recovery voltage:	
Peak value	20.6 kV
Rate of rise	0.34 kV/ μ s
First-pole-to-clear-factor	1.5
Rated operating sequence	O-0.3 s -CO-3 min-CO
Arc extinguishing medium	Vacuum
Number of poles	3
Number of units per pole	1
Rated opening time	\leq 45 ms
Rated closing time	approx. 60 ms
Rated voltage of trip coil	230 V-DC
Rated voltage of closing coil	230 V-DC
Rated supply voltage	230 V-DC
Rated frequency of supply voltage	- Hz
Max. ambient air temperature	40 °C
Further specifications:	-

Essential characteristics: -

Date of receipt of test object: 8th May 2000

List of Drawings

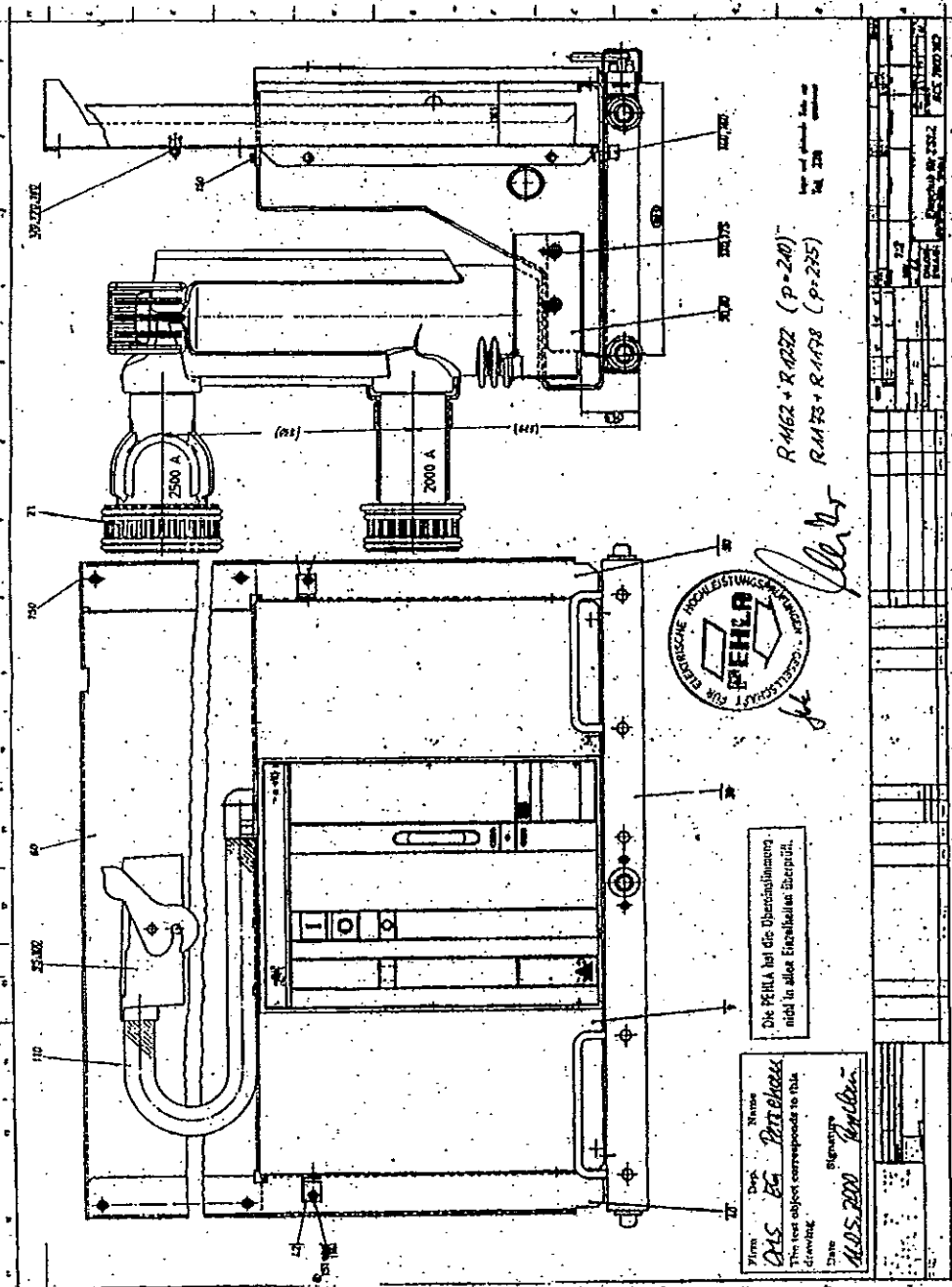
The manufacturer has guaranteed, that the equipment submitted for test has been manufactured in full accordance with the following drawings. PEHLA has verified that these drawings adequately represent the equipment tested. These drawings have been stamped and signed by PEHLA representatives and are kept

- with the test documents at the test laboratory.
- at the client.

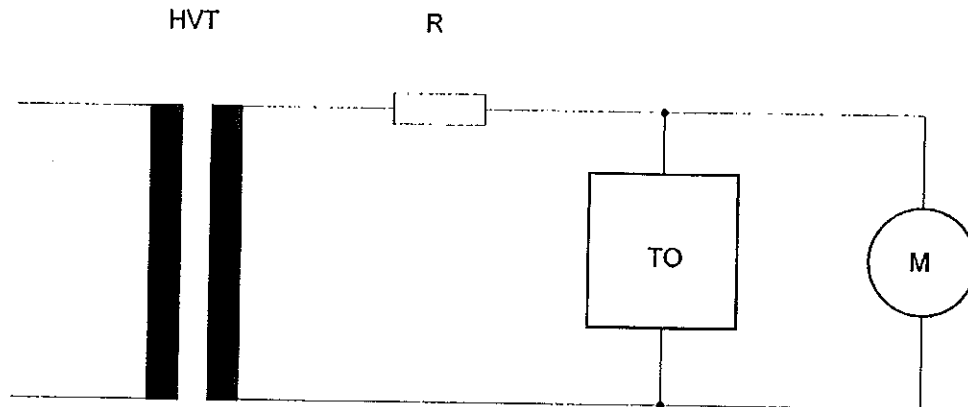
Drawing-No.	Index	Title	Additional remarks
GCE 8010452 R0112	00	SWITCHGEAR 12kV; PW1000	A copy is included in this Test Report
GCE 8001304 P0101	03	CONTACT PIN	--
GCE 7000162 R1178	00	Einschub für ZS1.2	A copy is included in this Test Report
GCE 7005535 R0101	00	Interrupter	--




Drawing No. 7000162R1178



Technical Data of Test Circuit Power Frequency Voltage



Technical Data

HVT - High Voltage Test Transformer, Type TEO 250/20, Serial-No. 268 734,
manufacturer: Meßwandler-Bau GmbH, Bamberg

Rated Voltage 260 kV

Rated Capacity 50 kVA

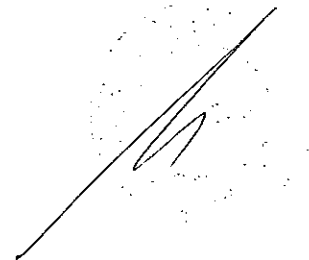
Short Circuit Impedance 14.6 %

TO - Test Object: ZS1.2/12kV -type panel, 2500 A

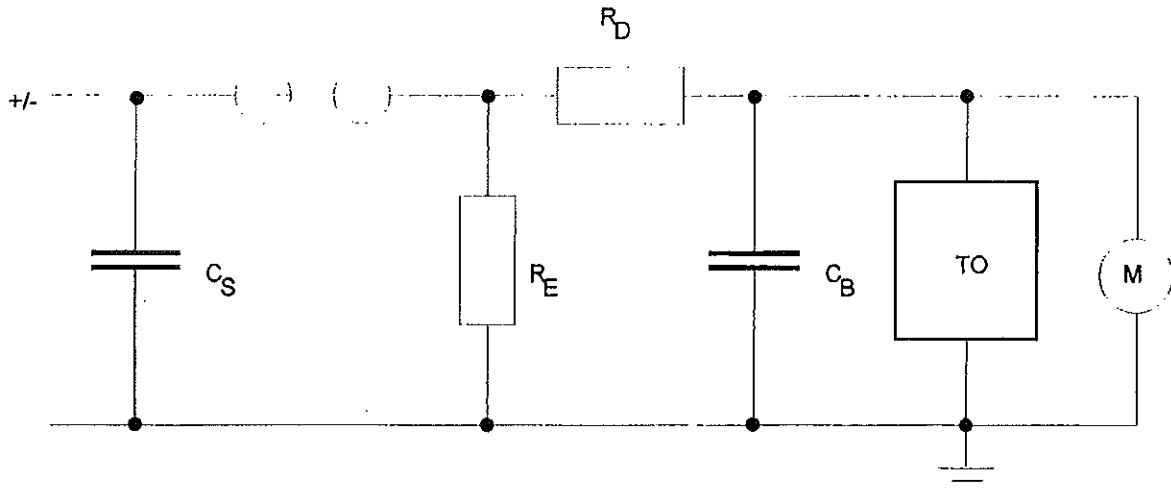
M - Voltage Measurement: Capacitive Divider Type CM 300 (Ident-No. ELK-000994) in
connection with a Peak Voltmeter Type DMI 551/Haefely
(Ident-No. ELK-000989)

Verification of Calibration:

- Capacitive Divider (Ident-No. ELK-000994, ELK-000990, ELK-000992):
calibrated on April 1998 at DEACE/LH,
Calibration Report-No. 9800086.
- Peak Voltmeter Typ DMI 551 (Ident-No. ELK-000989):
calibrated on April 2000 at DECMS/LK,
Calibration Report No. 2000353.



Technical Data of Test Circuit
Lightning Impulse Voltage 1.2/50



Technical Data

Impulse Generator Type SGSA-400-20, WO: 4549-51, manufacturer: Haefely

Maximum Charging Voltage	U_{Σ}	=	400 kV
Number of Stages	n	=	4
Surge Capacity per Stage	C_S	=	600 nF
Load Capacitance	C_B	=	2000 pF
Damping Resistance	R_D	=	R_{SI}
Internal Front Resistance per Stage	R_{SI}	=	52 Ω
Discharge Resistance	R_E	=	4 R_P
Tail Resistance per Stage	R_P	=	115 Ω

TO - Test Object: ZS1.2/12kV -type panel, 2500 A

M - Voltage Measurement: Resistance divider RT400 (ident-no.: ELK-000937) in connection with a peak voltmeter type SV 642/Haefely (ident-no. ELK-000064) and oscilloscope type TDS520/ Tektronix (ident-no. ELK-000545).

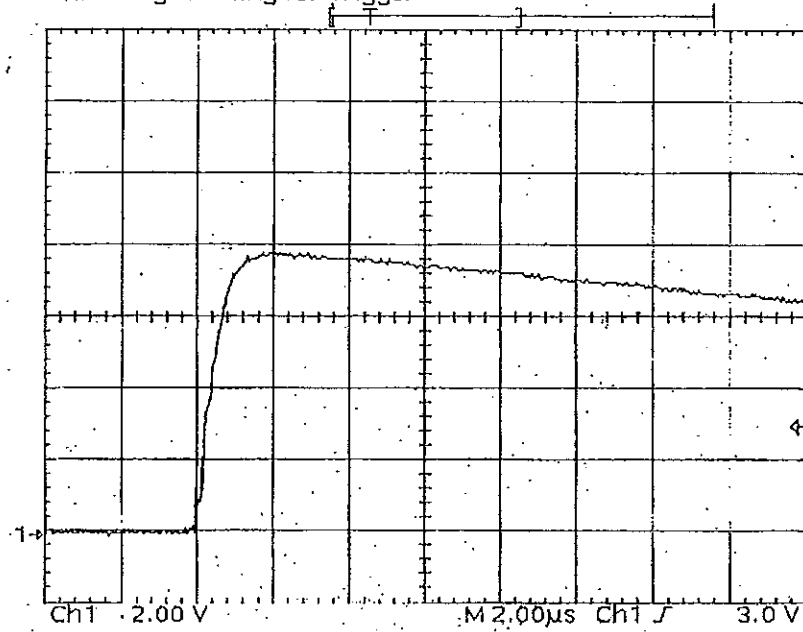
Verification of Calibration:

- Resistance divider RT400 (ident-no. ELK-000937, ELK-000940, ELK-000942): calibrated in April 1996 at FGH-Mannheim, FGH-Calibration-Report-No. 012 DKD-K-15901 96-04.
- Peak voltmeter type SV 642 (ident-no. ELK-000064): calibrated in December 1999 at DECMS/LK, Calibration-Report-No. 9900279.
- Oscilloscope Type TDS520 (Ident-No. ELK-000545): calibrated in March 2000 at DECMS/LK, Calibration-Report-No. 2000297.

Lightning Impulse Voltage with the Test Object connected

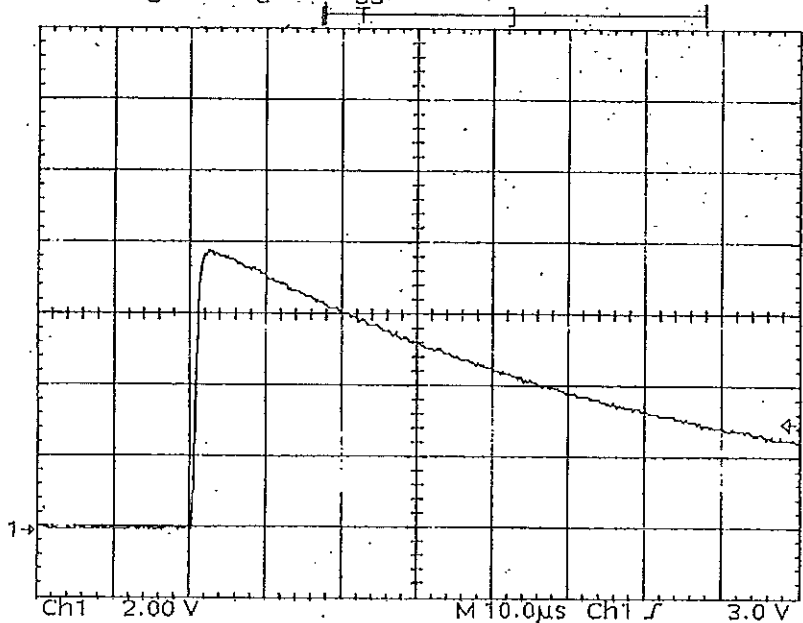
(Standard Value: $1.2 \pm 30\%$ / $50 \pm 20\%$ / peak $\pm 3\%$)

Tek Running: waiting for Trigger



T₁ = 1.23 μs

Tek Running: waiting for Trigger



T₂ = 49.0 μs

Atmospheric Conditions during Tests

Date of test: 8th May 2000

IEC 17A/567/Q: Corrigendum to subclause 6.2.1 of IEC60694, 2000-01					
(Indices: ~ power frequency voltage; + positive lightning impulse voltage; - negative lightning impulse voltage)					
Input data		Correction factors		calculated	applied
air temperature t:	24.5 °C	air density	k _{1~} :	0.994	-
air pressure b:	1022 hPa	correction factors	k ₁₊ :	0.994	-
air humidity h:	10.955 g/m ³		k ₁₋ :	0.994	-
50% disruptive-discharge voltages	U _{B~} :		air humidity	k _{2~} :	1.000
	U _{B+} :	correction factors	k ₂₊ :	1.000	-
	U _{B-} :		k ₂₋ :	1.000	-
minimum discharge path L:	m	atmospheric	K _{t~} :	0.994	0.994
		correction factors	K _{t+} :	0.994	0.994
			K _{t-} :	0.994	0.994

Lightning Impulse Voltage Test Power Frequency Voltage Test

Test performed: Test of insulation phase-to-phase, phase-to-ground and against shutter.

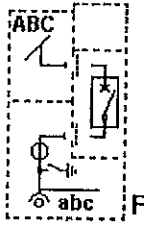
Date of test: 8th May 2000

Condition of test object before test: Factory new, clean and dry.

Connections to test object: Infeed of the test voltage at the led-out busbar right hand resp. at the cable connecting bar in the cable compartment.

Front time T_1 : 1.23 μ s Time to half-value T_2 : 49.0 μ s Test frequency f: 150 Hz

All voltage values are corrected with the applied atmospheric correction factor.
The applied test voltages refer to the standard atmosphere of 20 °C, 1013 hPa and 11 g/m³.

Test Arrangement 1:			Applied power frequency voltage ~ kV	Result
Condition	Voltage applied to	Earthed		
				
Vacuum circuit-breaker in test position, shutters closed.	Aa	BCbcF	28 +75 -75	1 minute/0 ¹⁾ 15/0 15/0
	Bb	ACacF	28 +75 -75	1 minute/0 ¹⁾ 15/0 15/0
	Cc	ABabF	28 +75 -75	1 minute/0 ¹⁾ 15/0 15/0

Remarks: A,a = Phase L1, B,b = Phase L2, C,c = Phase L3, F = Frame

¹⁾ Due to the voltage transformers the test frequency was increased upto 150 Hz.

Lightning Impulse Voltage Test Power Frequency Voltage Test

Test performed: Test of insulation phase-to-phase, phase-to-ground and across open switching device.

Date of test: 8th May 2000

Condition of test object before test: Factory new, clean and dry.

Connections to test object: Infeed of the test voltage at the led-out busbar right hand resp. at the cable connecting bar in cable compartment.

Front time T_f : 1.23 μ s

Time to half-value T_2 : 49.0 μ s

Test frequency f: 50/150 Hz

All voltage values are corrected with the applied atmospheric correction factor.

The applied test voltages refer to the standard atmosphere of 20 °C, 1013 hPa and 11 g/m³.

Test Arrangement 2:			Applied power frequency voltage ~ kV	Result
Condition	Voltage applied to	Earthed		
Vacuum circuit-breaker in service position and open.	A	BCabcF	28 +75 -75	1 minute/0 15/0 15/0
	B	ACabcF	28 +75 -75	1 minute/0 15/0 15/0
	C	ABabcF	28 +75 -75	1 minute/0 15/0 15/0
Vacuum circuit-breaker in service position and open.	a	bcABC F	28 +75 -75	1 minute/0 ¹⁾ 15/0 15/0
	b	acABC F	28 +75 -75	1 minute/0 ¹⁾ 15/1 15/0
	c	abABC F	28 +75 -75	1 minute/0 ¹⁾ 15/0 15/0

Remarks: A,a = Phase L1, B,b = Phase L2, C,c = Phase L3, F = Frame

¹⁾ Due to the voltage transformers the test frequency was increased upto 150 Hz.

Lightning Impulse Voltage Test Power Frequency Voltage Test

Test performed: Test of insulation phase-to-phase and phase-to-ground.

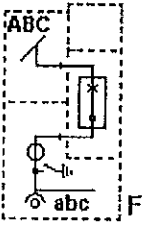
Date of test: 8th May 2000

Condition of test object before test: Factory new, clean and dry.

Connections to test object: Infeed of the test voltage at the led-out busbar right hand.

Front time T_1 : 1.23 μ s Time to half-value T_2 : 49.0 μ s Test frequency f: 150 Hz

All voltage values are corrected with the applied atmospheric correction factor.
The applied test voltages refer to the standard atmosphere of 20 °C, 1013 hPa and 11 g/m³.

Test Arrangement 3:			Applied power frequency voltage ~ kV	Result
Condition	Voltage applied to	Earthed		
			Applied lightning impulse voltage + kV	Test duration or number of impulses / breakdowns
Vacuum circuit-breaker in service position and closed.	Aa	BCbcF	28 +75 -75	1 minute/0 ¹⁾ 15/0 15/0
	Bb	ACacF	28 +75 -75	1 minute/0 ¹⁾ 15/0 15/0
	Cc	ABabF	28 +75 -75	1 minute/0 ¹⁾ 15/1 15/0

Remarks: A,a = Phase L1, B,b = Phase L2, C,c = Phase L3, F = Frame

¹⁾ Due to the voltage transformers the test frequency was increased upto 150 Hz.

2 kV Power Frequency Voltage Test at auxiliary and Control Circuits

Technical Data of Test Equipment:

High Voltage Test Equipment

Manufacturer: HCK Essen
Type: WP-500-4
Serial-No. G170-9402002
Rated Voltage: 0 - 4 kV
Ident-No.: ELK-000807/806/805

Verification of Calibration:

Calibrated in August 1999 at DECMS-LK,
Calibration-Report-No. 9900180

Test Procedure:

The auxiliary and control circuits of the switchgear and of the circuit-breaker were subjected to the AC voltage withstand test between the auxiliary and control circuits connected together as a whole and the frame of the switchgear panel (see IEC60694:1996-05 clause 6.2.10).

The AC Test voltage is 2000 V, Test duration = 1 minute.

Test Result:

Date of Test: 8th May 2000

The 2 kV AC voltage test at 2000 V - 1 minute was passed successfully.

No disruptive discharges occurred during test.



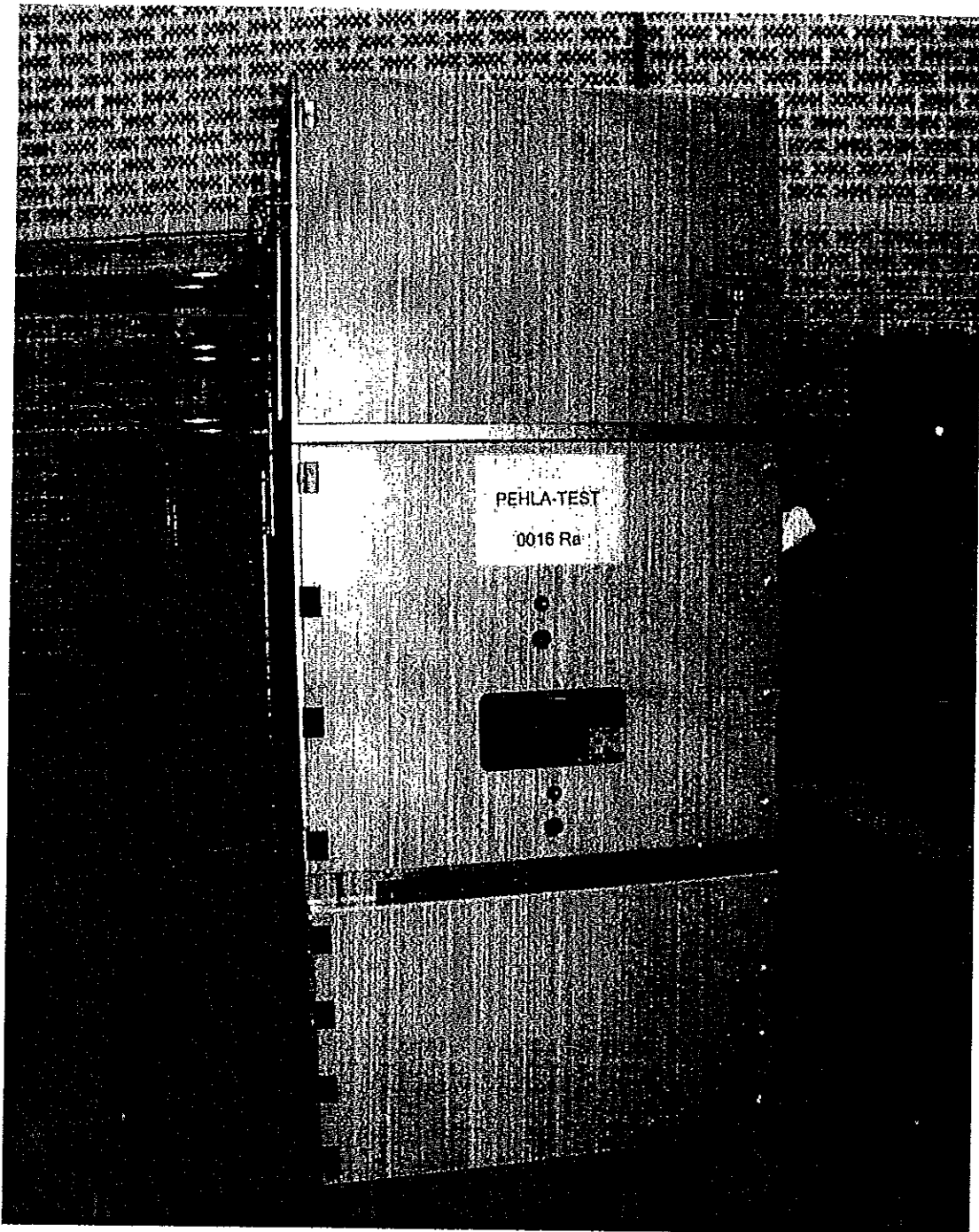


Fig. 1: ZS1.2/12 kV panel

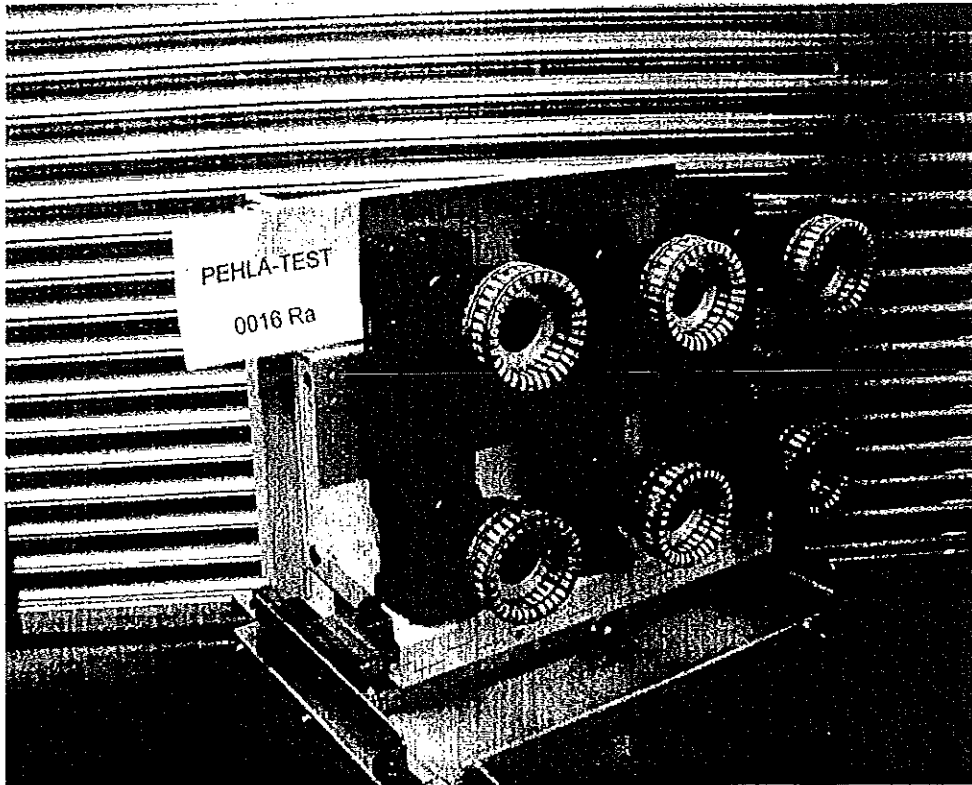


Fig. 2: Vacuum circuit-breaker type VD4P 1225-31

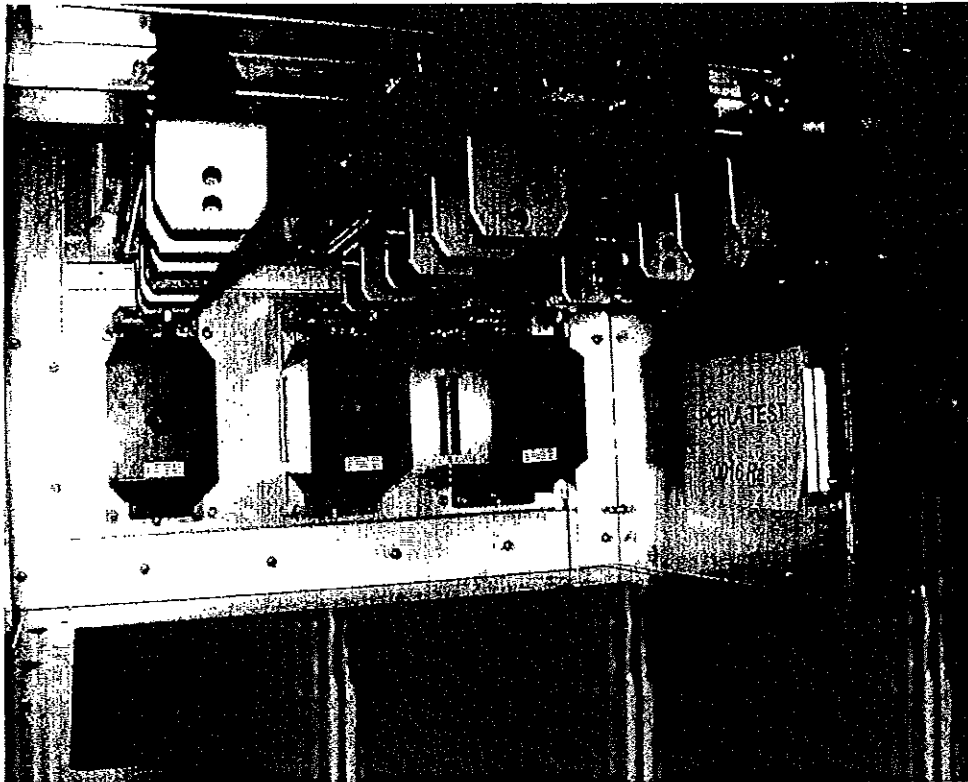
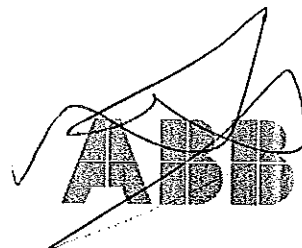


Fig. 3: Cable compartement

АББ Трансмисионе & Дистрибуционе С.п.А.
Унита Оператива Саче Т.М.С.

Виа Фриули 4
 I 24044 – Далмине (BG)
 Италия

тел.: 0039.035.395111
 факс: 0039.035.395874
 E – mail : sacetms.tipm@it.abb.com
 интернет : www.abb.com



ПРОТОКОЛ ЗА ТИПОВИ ИЗПИТАНИЯ No. 100087_С СТРАНЦИ 1/1

Apparatus: КРУ тип ZS1 изд. 1.2 с вакуумнен прекъсвач тип VD4/P
 12.25.32 p=210

Идентификация: 1VCP0000138-Rev.-,en-Технически каталог-2003-04

Параметри:

Номинално напрежение:	12	kV
Ном. Издържано импулсно напрежение:	75	kV
Ном. Издържано напрежение с 50Hz:	28	kV
Номинална честота:	50-60	Hz
Номинален ток на шината:	2500	A
Номинален ток на ошиновката:	2500	A
Ном. Издържан ток, пикова стойност:	63	kA
Ном. Издържан кратковременен ток на к.с.:	31.5	kA
Ном. Продължителност на к.с.:	3	s

Test reports verifying rating assigned by the manufacturer:

Изпитания	Тест съгласно стандарт	Тестов протокол	
		No.	Издаден от
Диелектричени изпитания	IEC 60298 Subclause 6.1	0016 Ra	ПЕХЛА Високо-мощностни лаборатории
Тест с повишаване на температурата	IEC 60298 Subclause 6.3/6.4	HZ 147 E 10	АББ Калор Емаг Лаборатории
Тест за кратковременен т.к.с. и пиков т.к.с.	IEC 60298 Subclause 6.5	MP— A4/010735	АББ Калор Емаг Лаборатории в лаборатория CESI Лаб.
Механична работа и тест за блокировки	IEC 60298 Subclause 6.102	0020 Ra	ПЕХЛА Високо-мощностни лаборатории
Тест за вътрешна дъга	IEC 60298 Annex AA	HZ 146 L02	АББ Калор Емаг Лаборатории
Тест за механична работа	IEC 62271-100 subclause 6.101.2	0317_2 Ra	ПЕХЛА Високо-мощностни лаборатории
Тест за способност за изкл. на т.к.с. и вкл. върху т.к.с.	IEC 62271-100 subclause 6.106	0303 Ra	ПЕХЛА Високо-мощностни лаборатории

Лабораторията на АБВ ТИД Унита Оператива Саче Т.М.С. в гр. Далмине е акредитирана съгласно UNI CEI EN ISO/IEC 17025 от SINAL с регистрационен номер Reg. No. 0253

Лабораторията на АБВ Калор Емаг в гр. Ратинген, Германия е акредитирана съгласно UNI CEI EN ISO/IEC 17025 от DATech под регистрационен номер No. DAT-P-032/93

Високо-мощностните лаборатории ПЕХЛА са акредитирани съгласно UNI CEI EN ISO/IEC 17025 от DATech с регистрационен номер No. DAT-P-032/93 и сертификат Д-ПЛ-12072-06-01

ЧЕЗИ Лаборатории Милано са акредитирани съгласно UNI CEI EN ISO/IEC 17025 от SINAL с регистрационен номер Reg. No. 0030

Дата на издаване:
 2004/07/05

Отдел за Развойна дейност

Г.М. Граванзола

PEHLA

GESELLSCHAFT FÜR ELEKTRISCHE HOCHLEISTUNGSPRÜFUNGEN
Member of the Short-Circuit-Testing Liaison (STL)

Test Report

Report No.: 0317-2 Ra Copy No.: 1 Contents: 24 Sheets

Equipment under test: Vacuum circuit-breaker type VD4 17.20.32

Manufacturer:

Circuit-breaker: ABB T&D S.p.A. - Unità operativa Sace TMS, Via Friuli, 4 - 24044 Dalmine (BG), Italy

Pole parts inclusive vacuum interrupter: ABB Calor Emag Mittelspannung GmbH, 40472 Ratingen, Germany

Client: ABB T&D S.p.A. - Unità operativa Sace TMS, Via Friuli, 4 - 24044 Dalmine (BG), Italy

Testing station: PEHLA - Testing Laboratory Ratingen

Date of test: 29th April 2003 - 23rd May 2003

Applied test specifications:

The tests have been carried out in accordance with the client's instructions.

Test procedure and test parameters were guided by:

IEC 62271-100, 1st Ed, 2001-05, clause 6.101.1 and 6.101.2

IEC 60694, Ed.2.2, 2002-01

Tests performed:

In accordance with the requirements of class M2, 10 000 mechanical operating cycles without voltage on or current in the main circuit were carried out with the vacuum circuit-breaker of type VD4 17.20.32 to demonstrate the mechanical reliability.

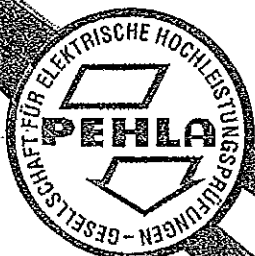
Test results:

10 000 mechanical operating cycles were carried out.

After 6 400 operating cycles, the opening hook assembly was replaced.

Except for this maintenance, no changes impairing the function of the circuit-breaker were noted after the endurance test.

GESELLSCHAFT FÜR ELEKTRISCHE
HOCHLEISTUNGSPRÜFUNGEN



Technical Committee

Mannheim, 25th July 2003

The test results relate only to the items tested.

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DAT-P-032/93

03PE0001

Accreditation

The PEHLA-Testing Laboratory Ratingen has been approved by the DATech (German accreditation body for technology) according to DIN EN ISO/IEC 17025 for tests in the field of high-voltage switchgear and controlgear and power engineering equipment (Registration-No. DAT-P-032/93).

Under reference to DIN EN ISO/IEC 17025 PEHLA states the following:

- The accreditation of the PEHLA-Testing Laboratory or any of its test reports by themselves in no way constitute or imply product approval by DATech or any other body.
- If someone refers to a test in an accredited PEHLA-Testing Laboratory this reference shall include the accreditation body, i.e. DATech, the relevant scope of the accreditation and the appropriate registration number.

STL-Member

PEHLA is foundation-member of the Short-Circuit Testing Liaison (STL) which has been founded in March 1969. STL is a forum for the international co-operation of the testing organisations with the further full members ASTA (GB), CESI (I), ESEF (F), KEMA (NL), SATS (N, S, AIR) and STLNA (USA). In the Framework of EC, STL has been recognised in 1992 by EOTC as agreement group.

PEHLA-Documents**A Certificate**

is issued for type tests which have successfully been carried out in full compliance with the relevant specifications or standards and STL Guides valid at the time of the test.

For these tests the equipment under test must be clearly identified by technical description, drawings and additional specifications.

A Test Document

is issued for parts of type tests which have successfully been carried out in full compliance with the relevant specifications or standards and STL Guides valid at the time of test.

For these tests the equipment under test must be clearly identified by technical description, drawings and additional specifications.

A Test Report

is issued for all other tests which have been carried out according to specifications, standards or "PEHLA-Richtlinien" (PEHLA Guides) and/or clients instructions.

Similarly, this test report contains all test results, details of the conditions under which the tests were carried out, also details relating to the behaviour of the equipment during test, and its condition after the tests.

Addresses:

Office: PEHLA-Geschäftsstelle
Hallenweg 40
68219 Mannheim; Germany

Testing Station: PEHLA-Testing Laboratory Ratingen
Oberhausener Str. 33
40472 Ratingen; Germany

Manufacturer: ABB T&D S.p.A - Unità Operativa Sace TMS
Via Friuli, 4
24044 Dalmine (BG), Italy

ABB Calor Emag Mittelspannung GmbH
Oberhausener Str. 33
40472 Ratingen, Germany

Client: ABB T&D S.p.A - Unità Operativa Sace TMS
Via Friuli, 4
24044 Dalmine (BG), Italy

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List of Test Participants

Representatives of the Test Committee:

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Mr. K.-H. Koch
Mr. M. Schöttler
Mr. U. Köster

PEHLA-Testing Laboratory Mannheim
PEHLA-Testing Laboratory Mannheim
PEHLA-Testing Laboratory Ratingen
PEHLA-Testing Laboratory Ratingen

Test Operator:

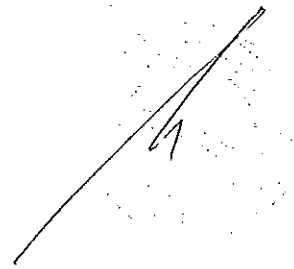
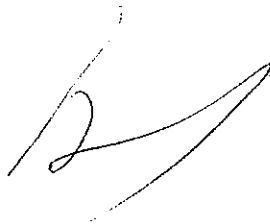
Mr. M. Schöttler
Mr. H.-W. Ott
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Representatives of the Client:

Mr. S. Magoni
Mr. L. Cavenati

ABB T&D S.p.A. - Unità operativa Sace TMS, Italy
ABB T&D S.p.A. - Unità operativa Sace TMS, Italy



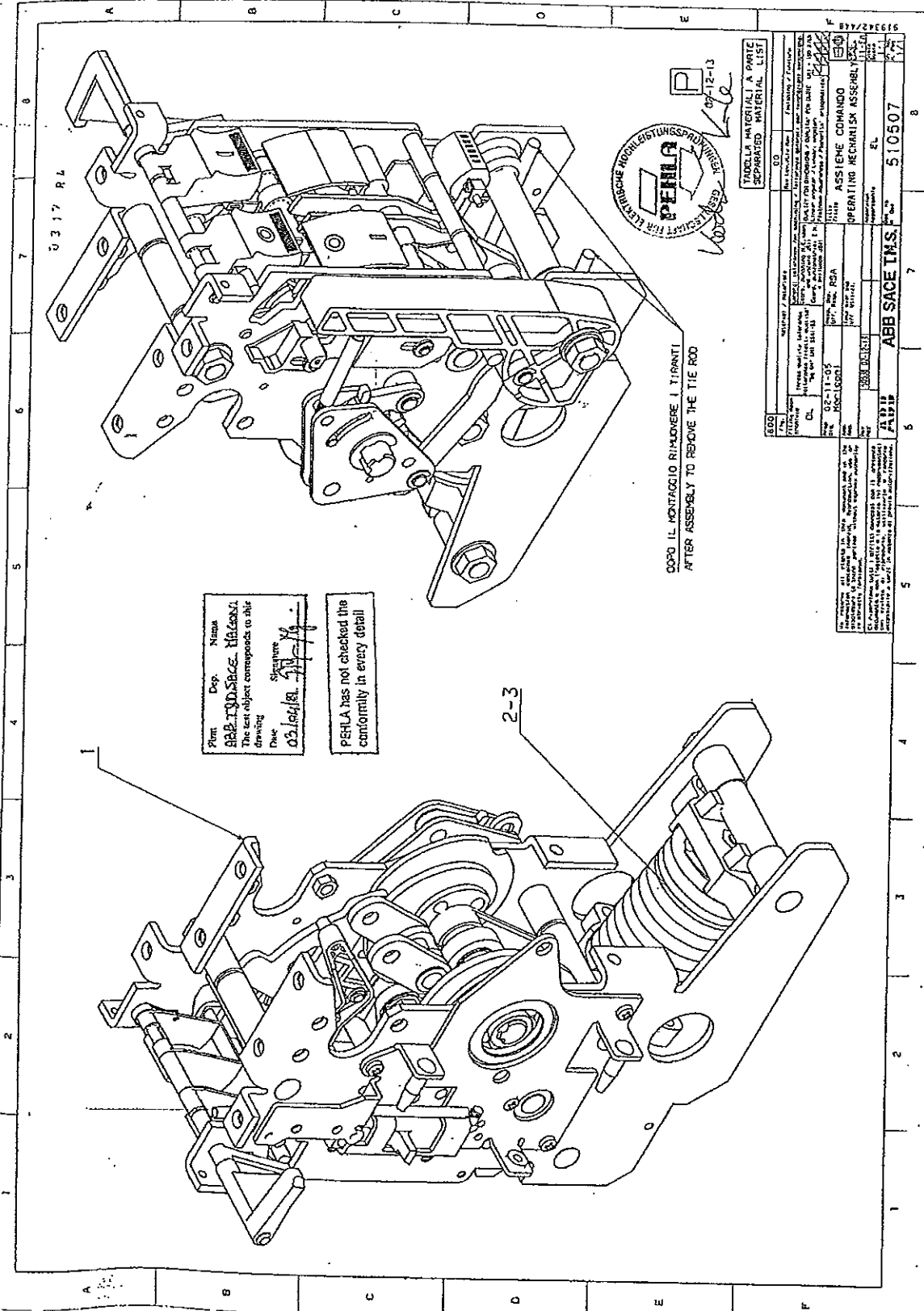
List of Drawings

The manufacturer has guaranteed, that the equipment submitted for test has been manufactured in full accordance with the following drawings. PEHLA has verified that these drawings adequately represent the equipment tested. These drawings have been stamped and signed by PEHLA representatives and are kept

- with the test documents at the test laboratory.
- at the client.

The drawings contained in this document are identical with the checked, stamped and signed drawings.

Drawing-No.	Revision	Title	Additional remarks
TN. 7408	M5234	VACUUM CIRCUIT BREAKER TYPE VD4 12-17.5kV 1600-2000-2500A	Included in test report
510507	50538	OPERATING MECHANISM ASSEMBLY	Included in test report
GCE7005745R0152	00	pole VD4p 12kV 2000A 31,5kA H=310	Included in test report
510804	50538	COMPRESSION SPRING	—
510805	50538	COMPRESSION SPRING	—
GCE7005535R0101	03	Montagegruppe	—
Parts list			
510564		Ass. molle di ch. com. EL2	—
510507		Assieme comando EL2	—
GCE7005745R0152		Pol VD4P 12kV 2000A 31,5kA H=310	—



Firm: **ABB TDS SACE** Nome
 Dep.: **ABB TDS SACE** Il test object corresponds to this drawing
 Date: **03.10.1981** Signature
PERLA has not checked the conformity in every detail!



Dopo il montaggio rimovere i tiranti
AFTER ASSEMBLY TO REMOVE THE TIE ROD

TABELLA MATERIALI A PARTE SEPARATED MATERIAL LIST	
QTY	DESCRIPTION
1	ASSIEME COMANDO OPERATING MECHANISM ASSEMBLY
1	ABB SACE I.M.S. 510507

Details on Performance of the Test

Prior to the endurance test, the following electrical and mechanical data were determined by measurements on the circuit-breaker and its auxiliary systems:

- a) closing time (5 times *)
- b) opening time (5 times *)
- c) time spread between units of one pole - not applicable
- d) time spread between poles (5 times *)
- e) charging time of the motorized operating mechanism (5 times *)
- f) consumption of the motorized operating mechanism (5 times *)
- g) consumption of the tripping devices (5 times *)
- h) duration of opening and closing command impulse
- i) tightness
- j) gas densities or pressures - not applicable
- k) resistance of the main circuit (5 times *)
- l) time-travel chart (5 times *)
- m) other important characteristics
 - contact travel
 - check of vacuum of interrupters
 - verification of the rated operating sequence (refer to clause 6.101.2.5 a))
 - ambient atmospheric conditions

*) 5 times at rated, minimum and maximum supply voltage.

The subsequent endurance test comprising 10 000 mechanical operating cycles was structured as follows and carried out five times:

500 operating cycles with operating sequence C - 30 s - O - 30 s at the minimum supply voltage of closing and opening devices and motorized operating mechanism and the minimum pressure for operation

500 operating cycles with operating sequence C - 30 s - O - 30 s at the rated supply voltage of closing and opening devices and motorized operating mechanism and the rated pressure for operation

500 operating cycles with operating sequence C - 30 s - O - 30 s at the maximum supply voltage of closing and opening devices and motorized operating mechanism and at the maximum pressure for operation

250 operating cycles with operating sequence C - 30 s - O - 300 ms - CO - 90 s at the rated supply voltage of closing and opening devices and motorized operating mechanism and at the rated pressure for operation

For faster operation, the recharging motor was cooled by air pressure.

After each series of 2 000 operating sequences the operating characteristics: a), b), d), e), and l) as listed above have been recorded.

Following the endurance test, the measurements carried out before the mechanical endurance test were measured again for comparison. Check, whether the travel characteristics fell within the envelope curves, taken before the endurance test.

Results of measurements before the mechanical endurance test

Number of operations: counter: 99923

a/b) Opening and closing time:

U_a = 220 V DC

Operating time [ms]

- measured during the 5 x CO operations
- at the minimum supply voltage
- at the rated supply voltage
- at the maximum supply voltage

U [V]	t _o (opening)			t _c (closing)		
	0.7 x U _a	1.0 x U _a	1.1 x U _a	0.85 x U _a	1.0 x U _a	1.1 x U _a
t [ms]	66.9	46.5	44.4	69.6	64.8	62.7
	66.9	47.1	44.4	69.0	64.5	62.7
	66.9	48.8	44.4	69.6	65.1	62.4
	67.8	46.8	44.4	69.3	64.8	62.4
	66.3	46.8	44.4	69.6	64.8	62.7

d) Time spread between the breaker poles:

The time spread between the breaker poles on closing and on opening of the circuit-breaker was measured to < 2 ms.

e/f) Charging time and power consumption of the motorized operating mechanism:

Rated voltage: U_a = 220 V DC

Measured values:

- Measured during the 5 x CO operations
- at the minimum supply voltage
- at the rated supply voltage
- at the maximum supply voltage

motor voltage	charging time after O-C operation [s]					current consumption [A]					power consumption [W]				
U = 0.85 x U _a = 187 V DC	3.99	4.08	4.20	4.25	4.20	0.98	0.96	1.02	1.02	1.00	183	180	191	191	187
U = 1.0 x U _a = 220 V DC	3.47	3.44	3.36	3.36	3.37	1.01	1.00	0.98	0.99	0.99	222	220	216	218	218
U = 1.1 x U _a = 242 V DC	2.77	2.99	2.97	3.00	3.00	1.02	1.02	1.02	1.03	1.03	247	247	247	249	249

g) Consumption of the tripping devices:

- Measured during the 5 x CO operations
- at the minimum supply voltage
 - at the rated supply voltage
 - at the maximum supply voltage

Rated operating voltage U_a	Shunt-release ON -MC					Shunt-release OFF -MO1				
	220 V DC									
Current at minimum supply voltage [A]	0.72	0.72	0.72	0.72	0.72	0.52	0.52	0.52	0.52	0.52
Current at rated supply voltage [A]	0.88	0.84	0.88	0.88	0.88	0.68	0.64	0.68	0.64	0.68
Current at maximum supply voltage [A]	0.96	0.96	0.96	0.96	0.96	0.76	0.76	0.72	0.72	0.72

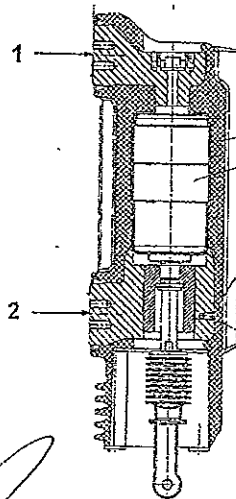
h) Duration of closing and opening command impulse:

- Measured during the 5 x CO operations
- at the minimum supply voltage
 - at the rated supply voltage
 - at the maximum supply voltage

Duration of command impulse at	Shunt-release ON -MC					Shunt-release OFF -MO1				
	[ms]									
at minimum supply voltage [ms]	69.3	73.8	74.1	72.3	70.8	67.2	68.1	69.0	70.2	69.6
at rated supply voltage [ms]	67.2	64.8	67.2	67.8	69.0	46.2	47.1	48.3	47.1	48.3
at maximum supply voltage [ms]	62.7	63.0	63.0	62.4	66.6	47.1	47.7	48.	47.1	48.0

k) Resistance of the main conductors:

Measuring points:



Report No.: 0317-2 Ra

Contact resistance measured during the 5 x CO operations at the minimum supply voltage of the coils:

Measuring points	L1 μΩ	L2 μΩ	L3 μΩ
1 - 2	12.4	11.4	11.8

Contact resistance measured during the 5 x CO operations at the rated supply voltage of the coils:

Measuring points	L1 μΩ	L2 μΩ	L3 μΩ
1 - 2	12.3	11.5	12.1

Contact resistance measured during the 5 x CO operations at the maximum supply voltage of the coils:

Measuring points	L1 μΩ	L2 μΩ	L3 μΩ
1 - 2	12.4	11.6	12.1

l) Time-travel chart with opening and closing speed: See diagram 1.1 and 1.2

Speed in [m/s]; $U_a = 220 \text{ V DC}$
at $U = 1.0 \times U_a$

	V_{O1}	V_{O2}	V_C
L2	1.18	1.30	0.91

The deviations from the measured mechanical time travel charts are in the allowable limits of the reference mechanical travel characteristics.

- V_{O1} : opening speed considered 8.25 mm after the separation in the main contacts of phase L2.
- V_{O2} : opening speed considered between 1.65 and 8.25 mm after the separation in the main contacts of phase L2.
- V_C : closing speed considered 3.3 mm before the touching in the main contacts of phase L2.

m) Other important characteristics:

▪ **Contact travel:**

	L1	L2	L3
Total Travel [mm]	14.8	14.9	14.9
Cont.-travel [mm]	11.2	11.3	11.2
Contact-spring travel [mm]	3.6	3.6	3.7

▪ **Check of vacuum of interrupters:**

60 kV DC ok

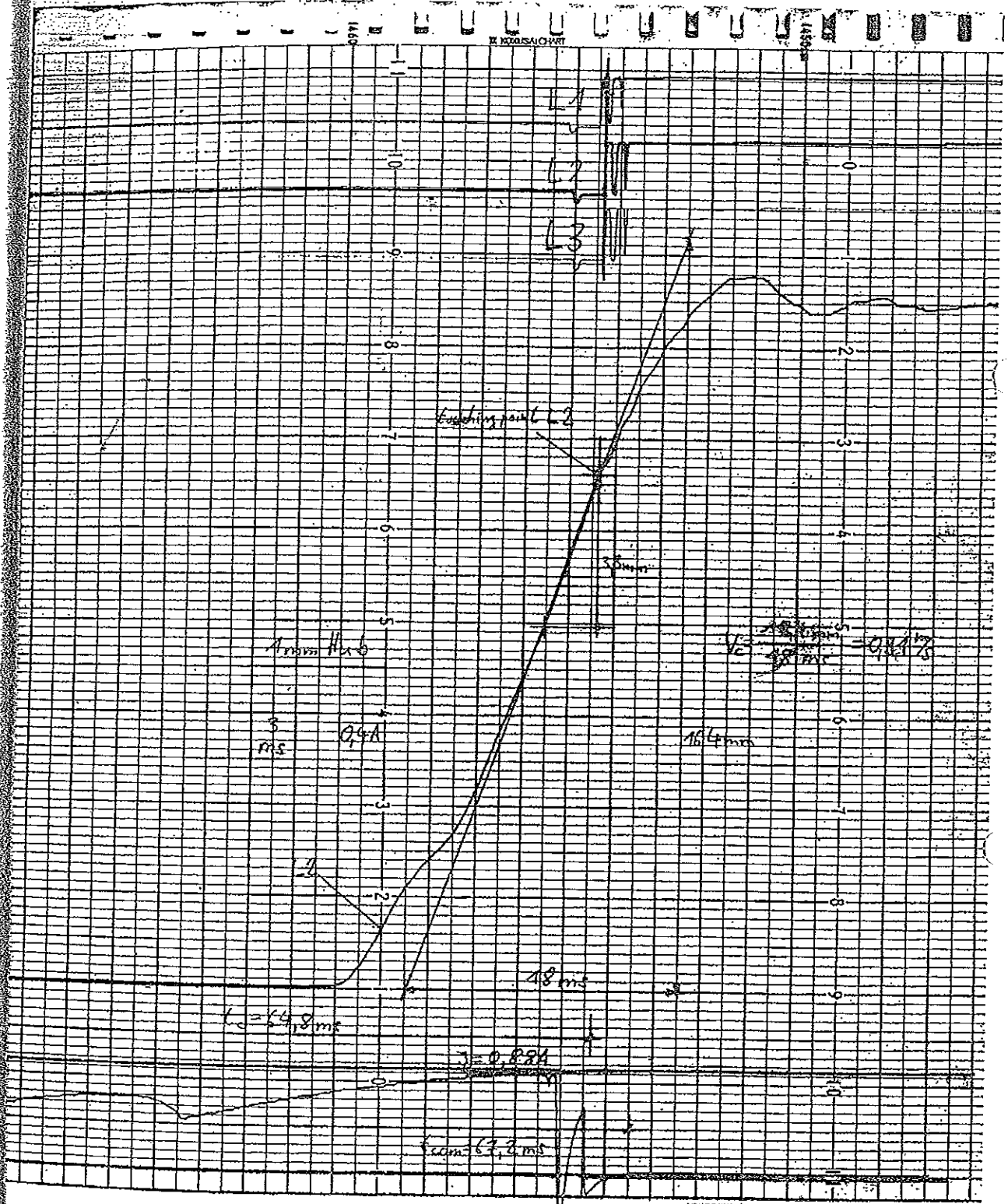
▪ **Verification of the rated operating sequence:**

O-0.3s-CO-3min-CO at rated voltage ok

▪ **Ambient atmospheric conditions:**

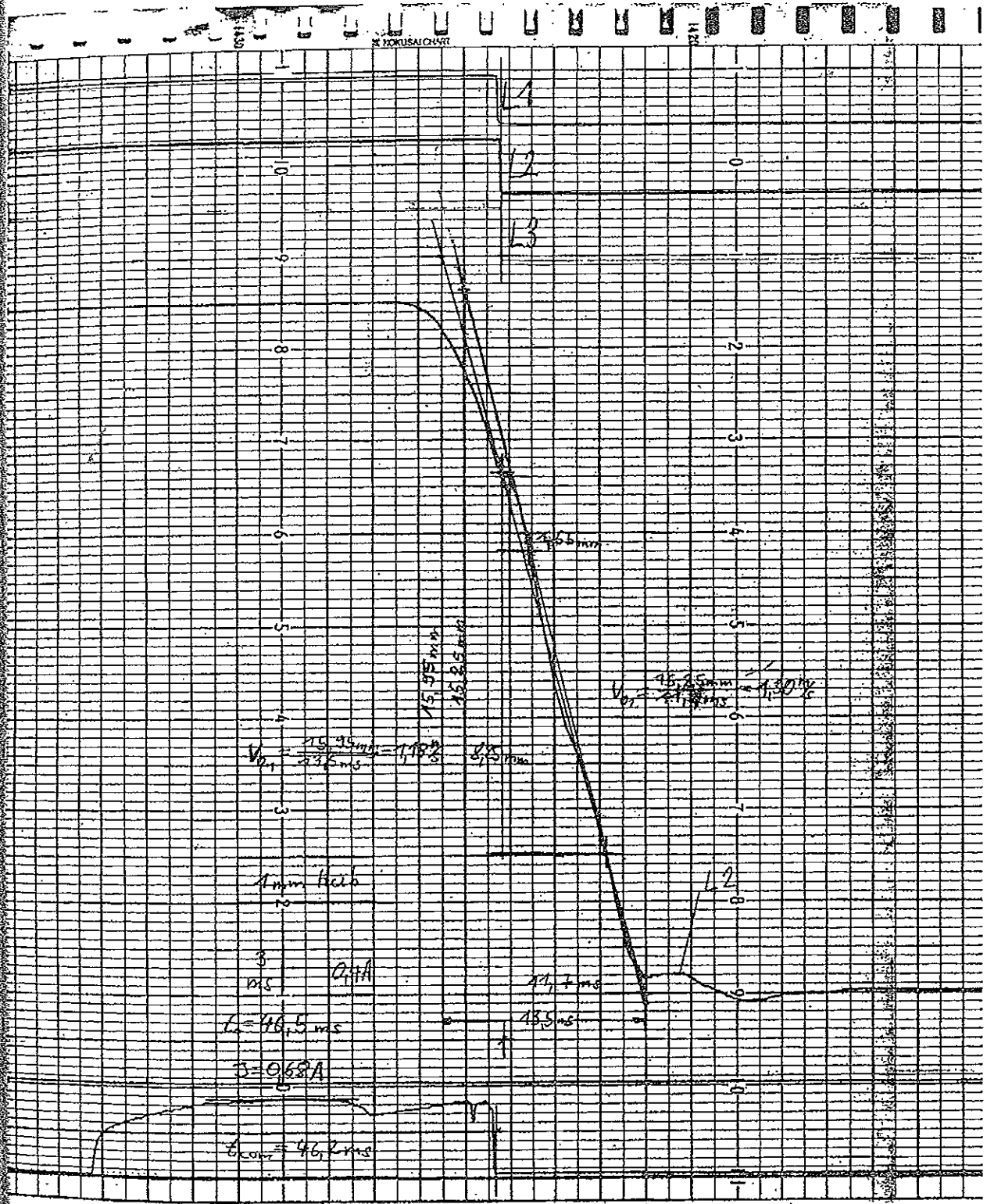
Date: 29th April 2003, ambient air temperature: approx. 23°C

Diagram 1.1: Measurement of the operating speed before the mechanical endurance test



Measuring point: Insulated coupling rod in phase L2
 Operating speed measured: $V_c = 0.91\text{ m/s}$ at $U = 1.0 \times U_a$
 For the speed calculation, an enlarged similar triangle was used in order to increase the accuracy of the travel and time measurement.

Diagram 1.2: Measurement of the operating speed before the mechanical endurance test



Measuring point: Insulated coupling rod in phase L2

Operating speed measured: $V_{01} = 1.18 \text{ m/s}$, $V_{02} = 1.30 \text{ m/s}$ at $U = 1.0 \times U_a$

For the speed calculation, an enlarged similar triangle was used in order to increase the accuracy of the travel and time measurement.

Results of measurements during the mechanical endurance test

a/b) Opening and closing time:

Operating time [ms] U _a = 220 V DC	U [V]	t _{o1} (opening)			t _c (closing)		
		0.7 x U _a	1.0 x U _a	1.1 x U _a	0.85 x U _a	1.0 x U _a	1.1 x U _a
Number of operations: 2 000	t [ms]	66.6	47.4	44.7	68.4	63.6	61.5
Number of operations: 4 000	t [ms]	67.2	45.9	44.7	68.4	64.2	61.8
Number of operations: 6 000	t [ms]	67.5	46.5	44.7	68.1	63.9	62.1
Number of operations: 8 000	t [ms]	67,8	48,0	45,7	67,8	63,6	61,1

d) Time spread between the breaker poles:

The time spread between the breaker poles on closing and on opening of the circuit-breaker was measured to < 2 ms.

e) Charging time of the motorized operating mechanism:

Motor voltage U _a = 220 V DC	charging time after O-C operation [s]		
	U = 0.85 x U _a = 187 V DC	U = 1.0 x U _a = 220 V DC	U = 1.1 x U _a = 242 V DC
Number of operations: 2 000	4.04	3.23	2.80
Number of operations: 4 000	4.23	3.29	2.90
Number of operations: 6 000	4.20	3.23	2.98
Number of operations: 8 000	4.22	3.27	2.93

m) Other important characteristics - contact travel:

Contact travel in L2	Total Travel [mm]
Number of operations: 2 000	14.7
Number of operations: 4 000	14.7
Number of operations: 6 000	14.6
Number of operations: 8 000	14.6

l) Time-travel chart with opening and closing speed:

Speed in [m/s]; at U _a = 220 V DC L2	V _{o1} (8.25 mm)	V _{o2} (6.60 mm)	V _c (3.30 mm)
	Number of operations: 2 000	1.08	1.31
Number of operations: 4 000	1.11	1.27	0.95
Number of operations: 6 000	1.10	1.29	0.91
Number of operations: 8 000	1.12	1.33	0.93

The deviations from the measured mechanical time travel charts are in the allowable limits of the reference mechanical travel characteristics.

Results of measurements after the mechanical endurance test

Number of operations: counter: 10027

a/b) Opening and closing time:

$U_a = 220 \text{ V DC}$

Operating time [ms]

- measured during the 5 x CO operations
- at the minimum supply voltage
- at the rated supply voltage
- at the maximum supply voltage

U [V]	t_o (opening)			t_c (closing)		
	0.7 x U_a	1.0 x U_a	1.1 x U_a	0.85 x U_a	1.0 x U_a	1.1 x U_a
	71.4	48.6	45.9	68.4	63.9	62.1
	71.1	48.6	45.9	68.4	64.5	61.8
t [ms]	70.2	48.3	45.9	68.1	64.2	61.8
	72.9	48.6	45.9	68.7	64.2	61.8
	71.1	48.3	45.6	68.1	64.2	61.8

d) Time spread between the breaker poles:

The time spread between the breaker poles on closing and on opening of the circuit-breaker was measured to < 2 ms.

e/f) Charging time and power consumption of the motorized operating mechanism:

Rated voltage: $U_a = 220 \text{ V DC}$

Measured values:

Measured during the 5 x CO operations

- at the minimum supply voltage
- at the rated supply voltage
- at the maximum supply voltage

motor voltage	charging time after O-C operation [s]					current consumption [A]					power consumption [W]				
$U = 0.85 \times U_a$ $= 187 \text{ V DC}$	4.04	4.12	4.10	4.03	4.06	0.94	0.98	0.98	0.94	0.97	176	183	183	176	181
$U = 1.0 \times U_a$ $= 220 \text{ V DC}$	3.15	3.12	3.12	3.12	3.11	0.97	0.96	0.96	0.96	0.96	213	211	211	211	211
$U = 1.1 \times U_a$ $= 242 \text{ V DC}$	2.71	2.83	2.77	2.77	2.75	0.95	0.98	0.94	0.95	0.94	230	237	228	230	228

g) Consumption of the tripping devices:

Measured during the 5 x CO operations
 - at the minimum supply voltage
 - at the rated supply voltage
 - at the maximum supply voltage

	Shunt-release ON -MC					Shunt-release OFF -MO1				
Rated operating voltage U_a	220 V DC					220 V DC				
Current at minimum supply voltage [A]	0.68	0.72	0.72	0.72	0.72	0.56	0.52	0.52	0.52	0.52
Current at rated supply voltage [A]	0.88	0.88	0.88	0.88	0.88	0.68	0.72	0.68	0.68	0.68
Current at maximum supply voltage [A]	0.96	1.00	0.96	0.96	0.96	0.76	0.76	0.76	0.76	0.76

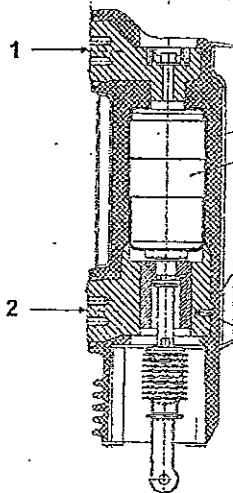
h) Duration of closing and opening command impulse:

Measured during the 5 x CO operations
 - at the minimum supply voltage
 - at the rated supply voltage
 - at the maximum supply voltage

	Shunt-release ON -MC					Shunt-release OFF -MO1				
Duration of command impulse at minimum supply voltage [ms]	69.6	69.6	69.3	69.9	69.3	70.5	72.3	69.9	73.8	72.6
Duration of command impulse at rated supply voltage [ms]	65.7	66.3	66.0	66.0	66.0	50.7	50.4	51.9	51.6	50.7
Duration of command impulse at maximum supply voltage [ms]	64.5	64.2	63.9	64.2	64.2	51.9	50.7	52.2	51.6	50.7

k) Resistance of the main conductors:

Measuring points:



Contact resistance measured during the 5 x CO operations at the minimum supply voltage of the coils:

Measuring points	L1 μΩ	L2 μΩ	L3 μΩ
1 - 2	13.5	13.6	13.2

Contact resistance measured during the 5 x CO operations at the rated supply voltage of the coils:

Measuring points	L1 μΩ	L2 μΩ	L3 μΩ
1 - 2	14.3	14.1	13.3

Contact resistance measured during the 5 x CO operations at the maximum supply voltage of the coils:

Measuring points	L1 μΩ	L2 μΩ	L3 μΩ
1 - 2	13.8	14.0	13.7

) Time-travel chart with opening and closing speed: See diagram 2.1 and 2.2

Speed in [m/s]; U_a = 220 V DC
at U = 1.0 x U_a

	V ₀₁	V ₀₂	V _c
L2	1.22	1.37	0.89

The deviations from the measured mechanical time travel charts are in the allowable limits of the reference mechanical travel characteristics.

- v₀₁: opening speed considered 8.25 mm after the separation in the main contacts of phase L2.
- v₀₂: opening speed considered between 1.65 and 8.25 mm after the separation in the main contacts of phase L2.
- v_c: closing speed considered 3.3 mm before the touching in the main contacts of phase L2.

n) Other important characteristics:

▪ Contact travel:

	L1	L2	L3
Total Travel [mm]	14.6	14.7	14.6
Cont.-travel [mm]	11.0	11.2	11.1
Contact-spring travel [mm]	3.6	3.5	3.5

▪ Check of vacuum of interrupters:

60 kV DC ok

▪ Verification of the rated operating sequence:

O-0.3s-CO-3min-CO at rated voltage ok

▪ Ambient atmospheric conditions:

Date: 23rd May 2003, ambient air temperature: approx. 22°C

Diagram 2.1: Measurement of the operating speed after the mechanical endurance test

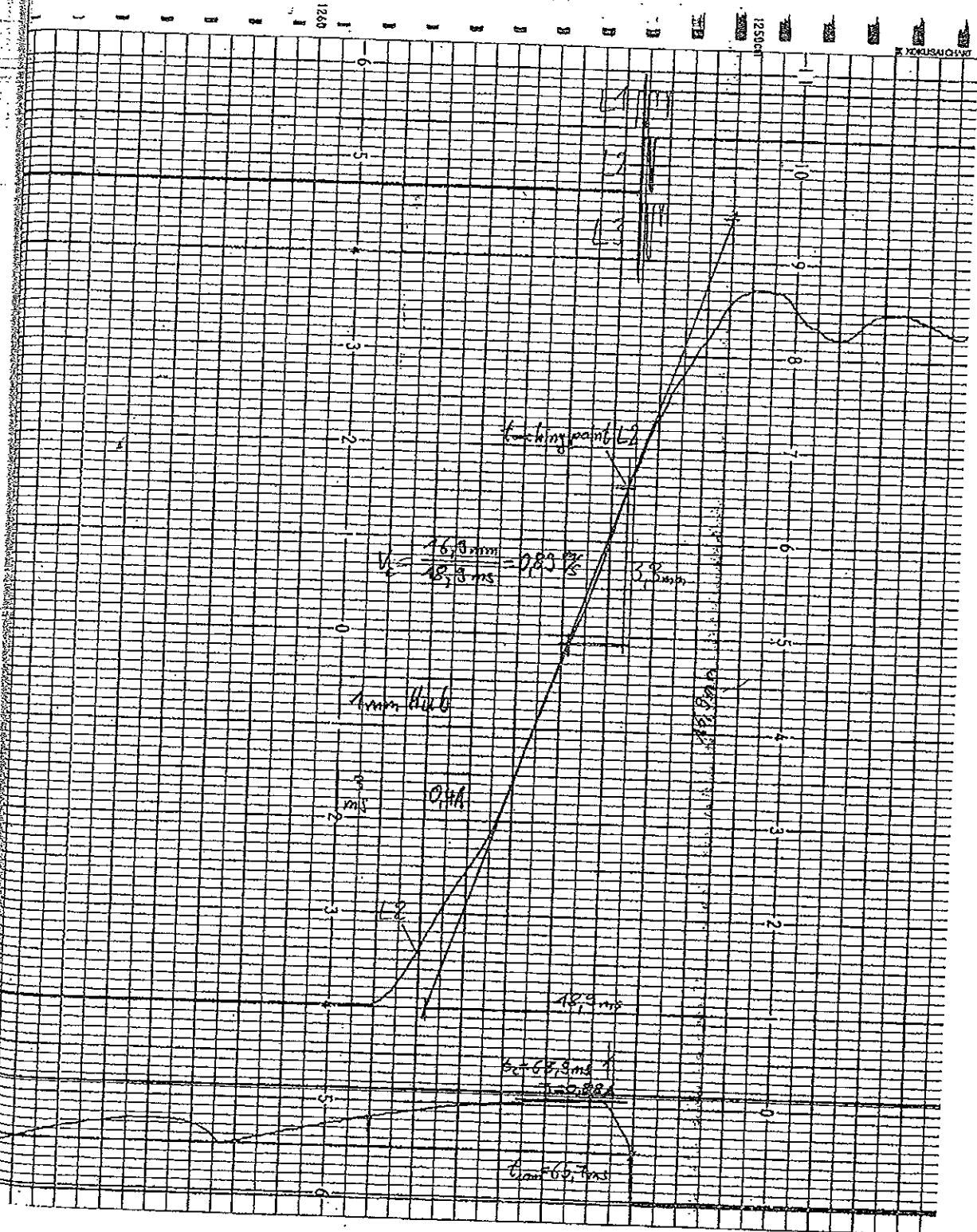
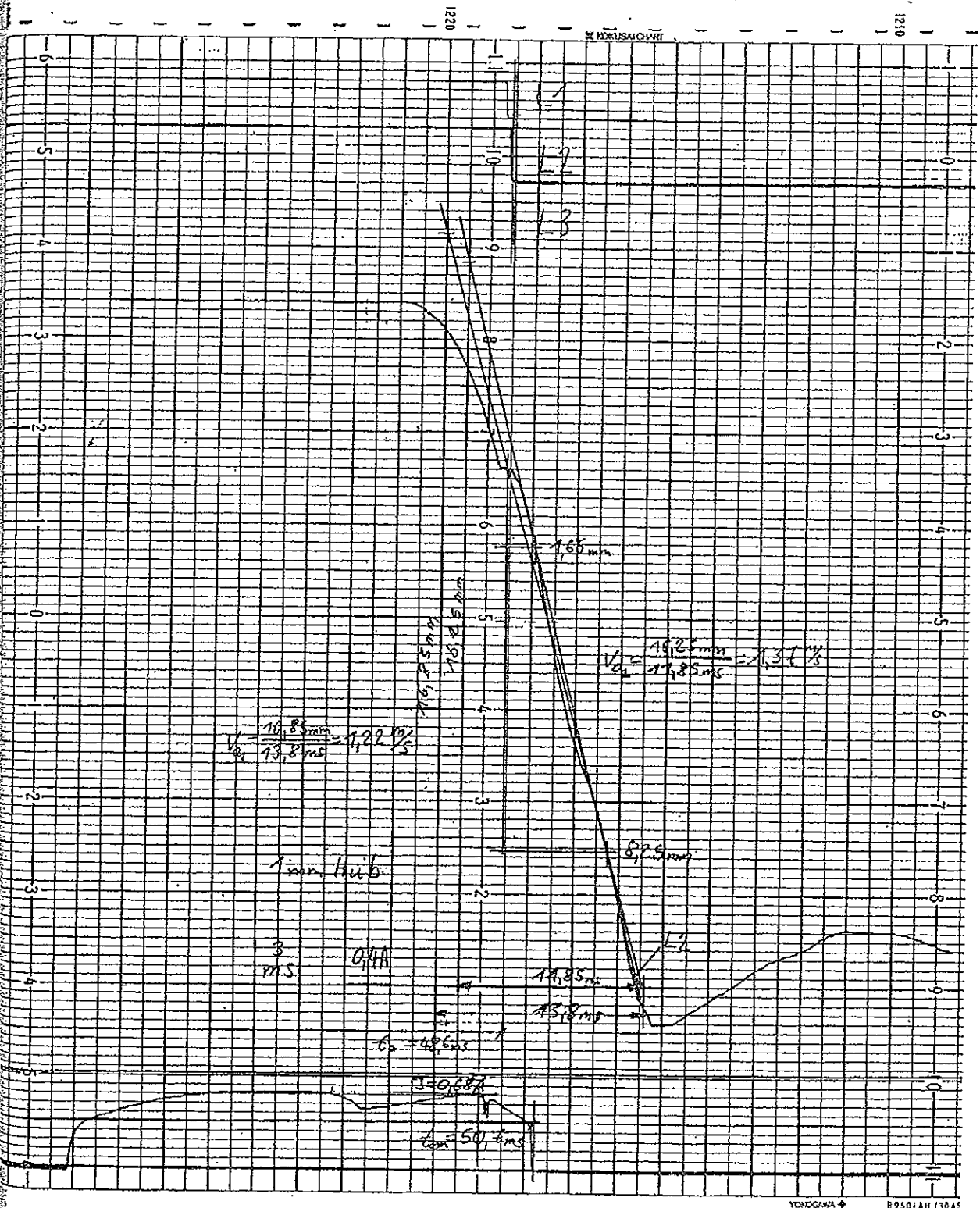


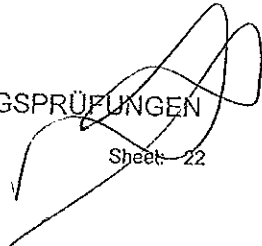
Diagram 2.2: Measurement of the operating speed after the mechanical endurance test



Measuring point: Insulated coupling rod in phase L2

Operating speed measured: $V_{01} = 1.22 \text{ m/s}$, $V_{02} = 1.37 \text{ m/s}$ at $U = 1.0 \times U_a$

For the speed calculation, an enlarged similar triangle was used in order to increase the accuracy of the travel and time measurement.




Evaluation of the measurements before and after the test program

The reference mechanical travel characteristic was recorded at the rated supply voltage before the endurance test. All measured travel-curves fall within the limits of the two envelope curves which characterize the allowable deviations from the reference curve.

All characteristics measured before and after the test program do not show unacceptable variations.

The circuit-breaker operated only on command and did not operate without command.

After 6 400 operating cycles, the opening hook assembly was replaced.



Report No.: 0317-2 Ra

Measuring Instrument Record

Test job no.: 940
 Object tested: VD4 17.20.32
 Date of test: 29th April – 23rd May 2003
 Test report: PEHLA 0317-2Ra
 Test operator: Ott/Schöttler

Instrument	Ident.-no.	Measuring	Remarks
Microohmmeter MO2A 50	ELK 001111	20μΩ / 200μΩ	Resistance measurement
Resistive travel pick-up type lino pot Ts 50 502	ELK 001076	5 kΩ	Travel time measurement
DM 7100 Transient memory	ELK 000466	±2 V / full scale 50μs/word, channel 4 (12 bit)	
VEW-3063 Multi-pen	ELK 000464	0.25 V/cm-vernier 10 cm/min, channel 4	
Slide caliper rule	LAE 002162	0 - 300 mm	
Shunt 1.5A/150mV DM 7100 Transient memory	ELK 001044 ELK 000466	1.5A/150mV ±20/0.2 V/full scale 50 μsec/word/10ms/word channel 1, 2, 3, 8 (8 bit)	Current measurement (MC/MO1) Operating time measurement,
VEW-3063 Multi-pen	ELK 000464	Channel 1, 2, 3, 8, 0.25/1 V/cm-cal/vernier 10 cm/min	
Electronic time clock	ELK 001231	0-100s	Charging time measurement
Unigor 6E	ELK 000389	1 A	Motor current measurement
Vidar-Vacuum-checker-Test device	DRU 000026	40/60kV DC	Vacuum-Checker-Test
BBC M2110	ELK 000359	300 V DC	Voltage measurement
Hygrometer Hygronom	FEU 000022	-30°C - +50°C	temperature measurement

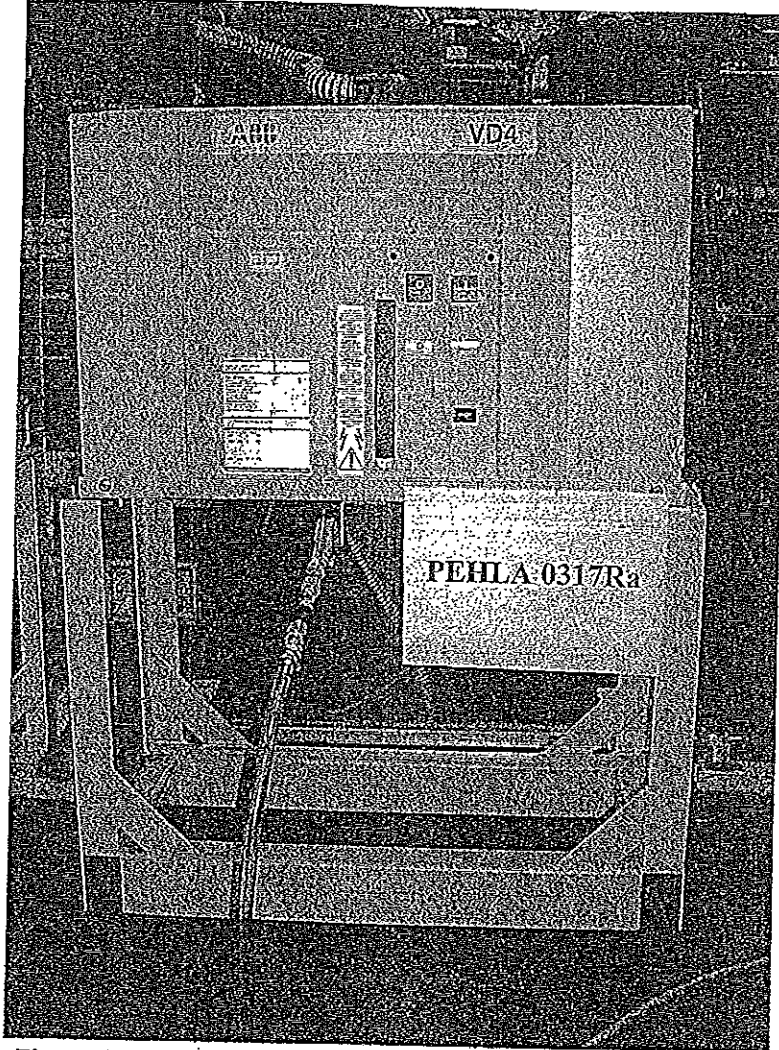


Figure 1: Test object

PEHLA

GESELLSCHAFT FÜR ELEKTRISCHE HOCHLEISTUNGSPRÜFUNGEN
Member of the Short-Circuit-Testing Liaison (STL)

Test Report

Report No.: 0303Ra

Copy No.: 0

Contents: 59 Sheets

Equipment under test: Vacuum circuit-breaker type VD4.17.20.32 (17.5 kV, 2000 A, 31.5 kA) equipped with vacuum interrupters type VG4S.

Manufacturer:

Circuit-breaker: ABB T&D SpA, Divisione Sace T.M.S, Via Friuli, 4 -- 24044 Dalmine (BG), Italy

Pole parts inclusive vacuum interrupters: ABB Calor Emag Mittelspannung GmbH, Oberhausener Str. 33, 40472 Ratingen, Germany

Client: ABB T&D SpA, Divisione Sace T.M.S, Via Friuli, 4 -- 24044 Dalmine (BG), Italy

Testing station: PEHLA-Testing Laboratory Ratingen

Date of test: 9th and 10th January 2003

Applied test specifications:

The tests have been carried out in accordance with the client's instructions.

Test procedure and test parameters were based on:

IEC 62271-100/2001-05, Clauses 6.106.1, 6.106.2, 6.106.3, 6.106.4, 6.106.5, 6.108.3

STL-Guide to IEC 60056: 4th Edition: 1987, Amendment Slip No. 2

Tests performed:

Basic short-circuit test-duties T10 - T100 and double-earth fault breaking test.

No-load operations and measurement of the resistance of the pole parts before and after the tests.

Power-frequency withstand voltage test at 38.0 kV – 1 min before and after the tests.

Measurement of the time-travel characteristic before and after the tests.

For further details see sheet no. 3.

Test results:

The vacuum circuit-breaker passed the mentioned test successfully.

GESELLSCHAFT FÜR ELEKTRISCHE
HOCHLEISTUNGSPRÜFUNGEN



Technical Committee

Mannheim, 31st March 2003

The test results relate only to the items tested.

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DAT-P-032/93

Accreditation

The PEHLA-Testing Laboratory Ratingen has been approved by the DATech (German accreditation body for technology) according to DIN EN ISO/IEC 17025 for tests in the field of high-voltage switchgear and controlgear and power engineering equipment (Registration-No. DAT-P-032/93).

Under reference to DIN EN ISO/IEC 17025 PEHLA states the following:

- The accreditation of the PEHLA-Testing Laboratory or any of its test reports by themselves in no way constitute or imply product approval by DATech or any other body.
- If someone refers to a test in an accredited PEHLA-Testing Laboratory this reference shall include the accreditation body, i.e. DATech, the relevant scope of the accreditation and the appropriate registration number.

STL-Member

PEHLA is foundation-member of the Short-Circuit Testing Liaison (STL) which has been founded in March 1969. STL is a forum for the international co-operation of the testing organisations with the further full members ASTA (GB), CESI (I), ESEF (F), KEMA (NL), SATS (N, S, AIR) and STLNA (USA). In the Framework of EC, STL has been recognised in 1992 by EOTC as agreement group.

PEHLA-Documents

A Certificate

is issued for type tests which have successfully been carried out in full compliance with the relevant specifications or standards and STL Guides valid at the time of the test.

For these tests the equipment under test must be clearly identified by technical description, drawings and additional specifications.

A Test Document

is issued for parts of type tests which have successfully been carried out in full compliance with the relevant specifications or standards and STL Guides valid at the time of test.

For these tests the equipment under test must be clearly identified by technical description, drawings and additional specifications.

A Test Report

is issued for all other tests which have been carried out according to specifications, standards or "PEHLA-Richtlinien" (PEHLA Guides) and/or clients instructions.

Similarly, this test report contains all test results, details of the conditions under which the tests were carried out, also details relating to the behaviour of the equipment during test, and its condition after the tests.

Addresses:


Office: PEHLA-Geschäftsstelle
Hallenweg 40
68219 Mannheim, Germany

Testing Station: PEHLA-Testing Laboratory Ratingen
Oberhausener Str. 33
40472 Ratingen, Germany

Manufacturer: ABB T&D SpA, Divisione SACE T.M.S.
Via Friuli, 4
24044 Dalmine (BG), Italy

ABB Calor Emag Mittelspannung GmbH
Oberhausener Str. 33
40472 Ratingen, Germany

Client: ABB T&D SpA, Divisione SACE T.M.S.
Via Friuli, 4
24044 Dalmine (BG), Italy



Tests performed:

Basic short-circuit test series T10 - T100 and double-earth fault breaking test.

T10: 3.56 kA at 18.9 kV / 3.54 kA at 18.8 kV / 3.56 kA at 18.8 kV
(10 % I_{sc} O-0.3s-CO-3min-CO).

T30: 10.2 kA at 19.1 kV / 10.2 kA at 18.6 kV / 10.1 kA at 18.5 kV
(30 % I_{sc} O-0.3s-CO-3 min-CO).

T60: 19.0 kA at 18.5 kV / 18.5 kA at 17.6 kV / 18.6 kA at 18.1 kV
(60 % I_{sc} O-0.3s-CO-3min-CO).

T100s: 33.2 kA at 20.8 kV / 32.3 kA at 19.3 kV / 32.3 kA at 19.5 kV
(100% I_{sc} O-0.3 s-CO-3min-CO).

T100a: 31.5 kA (24.3% $_{DC-comp.}$) at 19.6 kV / 32.0 kA (32.2% $_{DC-comp.}$) at 19.6 kV /
31.6 kA (26.8% $_{DC-comp.}$) at 19.6 kV
(100% I_{sc} $O_{asym}/O_{asym}/O_{asym}$).

Double-earth fault breaking test: 27.8 kA at 18.7 kV

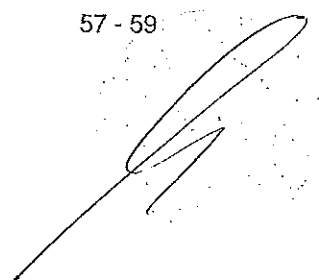
No-load operations and measurement of the resistance of the pole parts before and after the tests.

Power-frequency withstand voltage test at 38.0 kV – 1 min before and after the tests.

Measurement of the time-travel characteristic before and after the tests.

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List of Test Participants

Representatives of the Test Committee:

Mr. G. Heit	PEHLA-Testing Laboratory Mannheim, Germany
Mr. K.-H. Diergardt	PEHLA-Testing Laboratory Ratingen, Germany

Test Engineer:

Mr. K.-H. Diergardt	PEHLA-Testing Laboratory Ratingen, Germany
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Representatives of the Client:

Mr. S. Magoni	ABB T&D SpA, Division SACE T.M.S., Italy
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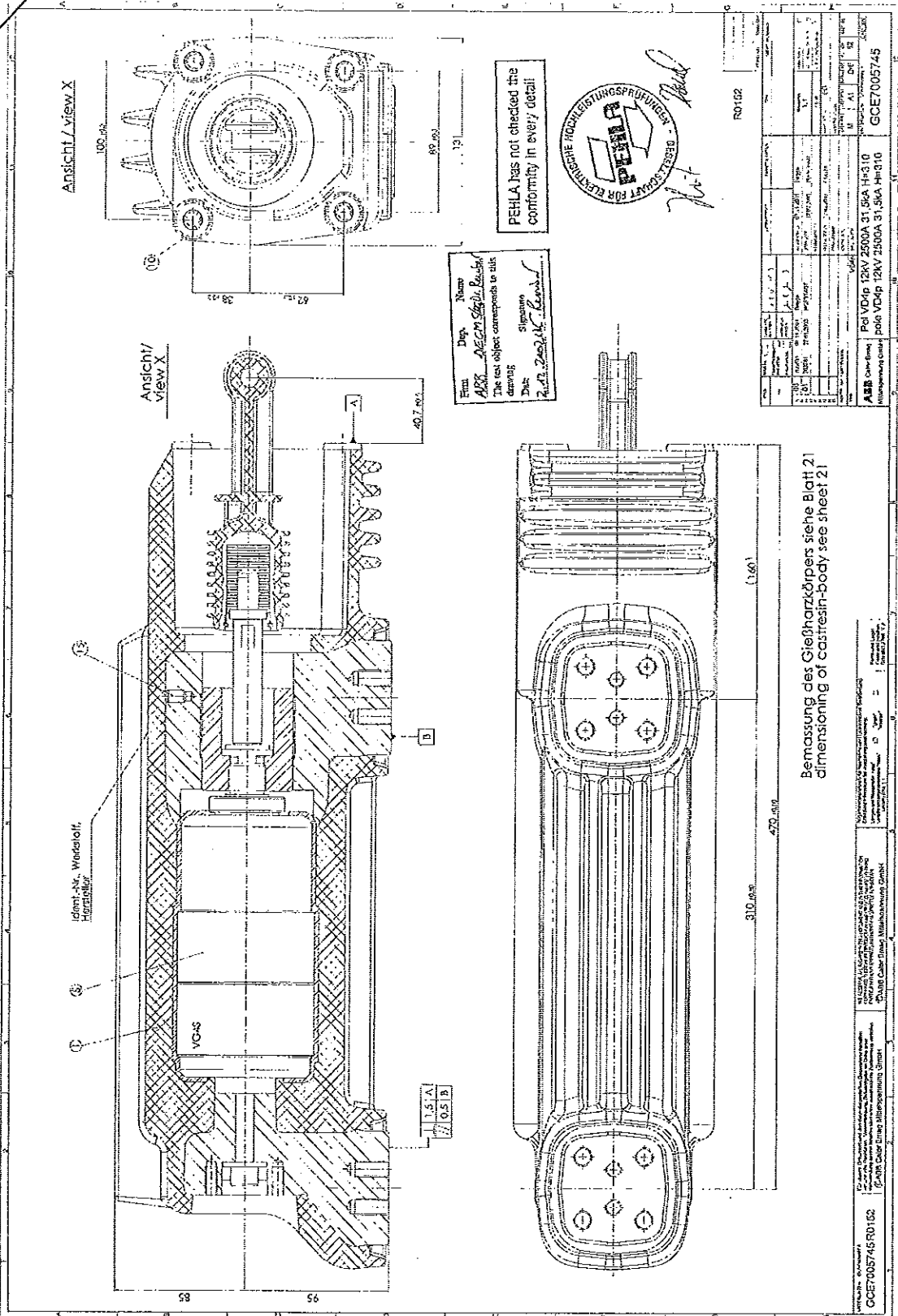
List of Drawings

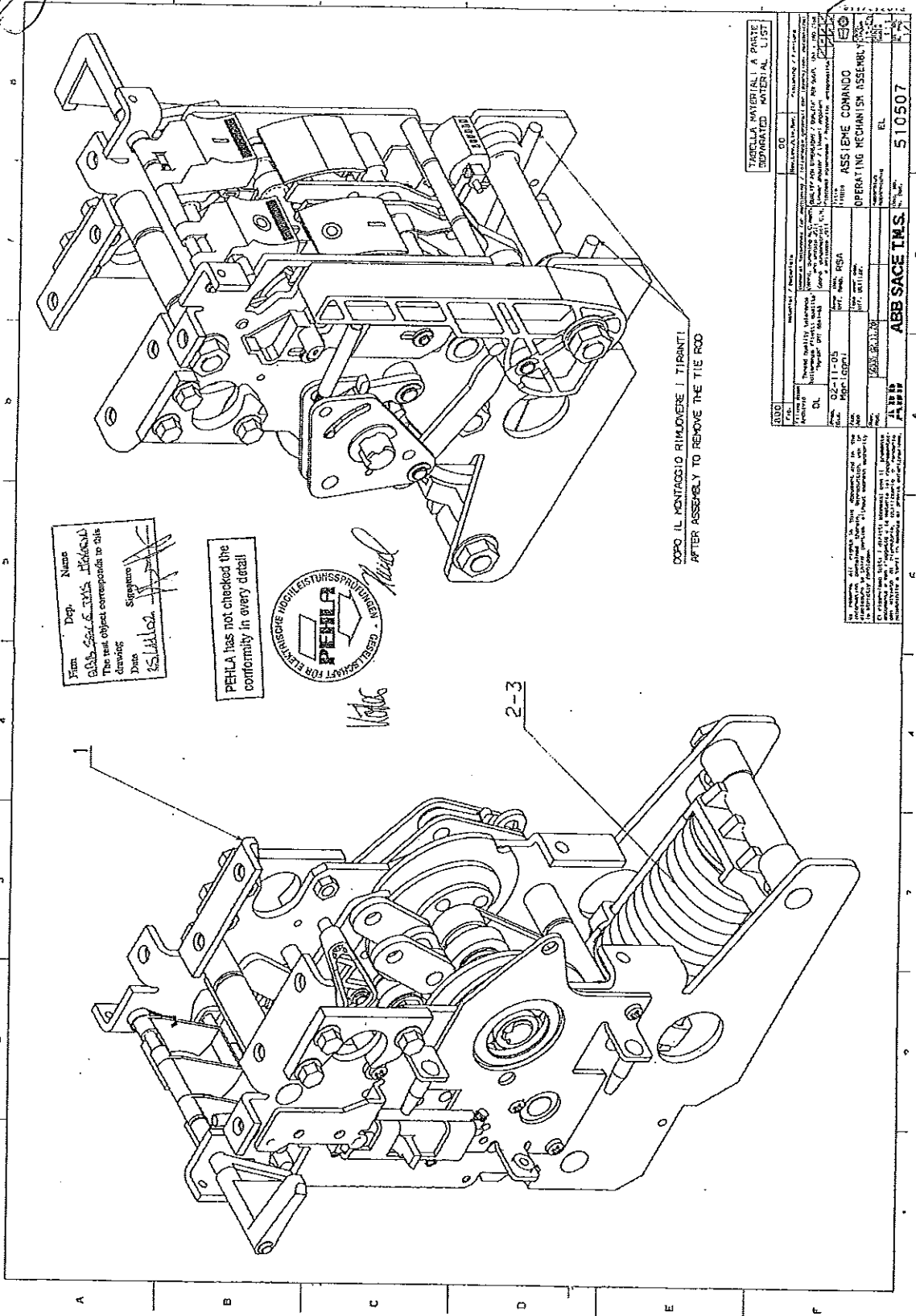
The manufacturer has guaranteed, that the equipment submitted for test has been manufactured in full accordance with the following drawings. PEHLA has verified that these drawings adequately represent the equipment tested. These drawings have been stamped and signed by PEHLA representatives and are kept

- with the test documents at the test laboratory.
- at the client.

The drawings contained in this document are identical with the checked, stamped and signed drawings.

Drawing-No.	Revision	Title	Additional remarks
TN. 7408	M5234	VACUUM CIRCUIT BREAKER TYPE VD4 12-17.5 kV 1600-2000-2500A	Included in this Test Report
GCE7005745R0152	01	pole VD4p 12kV 2500A 31,5kA H=310	Included in this Test Report
510507	50535	OPERATION MECHANISM ASSEMBLY	Included in this Test Report
510564	50535	CLOSING SPRINGS ASSEMBLY	-
Parts list			
510564		Ass. molle di ch. com. EL1	-
510507		Assieme comando EL1	-
GCE7005745R0152		Pol VD4P 12kV 2000A 31,5kA H=310	-





DOPO IL MONTAGGIO RIMOVERE I TIRANTI
AFTER ASSEMBLY TO REMOVE THE TIE ROD

Firm: Dep. Name: *ABB S.p.A. I.T.A.S. ITALIA*
 The test object corresponds to this drawing: *55.141.02*
 Date: *15/11/62* Signature: *[Signature]*

PEHLA has not checked the conformity in every detail



TABELLA MATERIALI A PARTE SEPARATED MATERIAL LIST	
00	ABB S.p.A. I.T.A.S. ITALIA
01	ABB S.p.A. I.T.A.S. ITALIA
02	ABB S.p.A. I.T.A.S. ITALIA
03	ABB S.p.A. I.T.A.S. ITALIA
04	ABB S.p.A. I.T.A.S. ITALIA
05	ABB S.p.A. I.T.A.S. ITALIA
06	ABB S.p.A. I.T.A.S. ITALIA
07	ABB S.p.A. I.T.A.S. ITALIA
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100	ABB S.p.A. I.T.A.S. ITALIA

ABB SACE I.T.A.S. 510507

Technical Data of Test Circuits

Test	Basic Short-Circuit Test-Duty	T60		T100	
Test No.	0303Ra	04 – 07		08 – 19	
Number of phases	(test circuit)	3		3	
Rated voltage	kV	17.5		17.5	
Number of poles or phases	(test object)	3		3	
Voltage distribution	%	-		-	
Power frequency	Hz	50		50	
Power factor	cos φ	≤ 0.15		≤ 0.15	
Earthing conditions	Generator / System	earthed via 5 kΩ		earthed via 5 kΩ	
	Transformer	not earthed		not earthed	
	Short-circuit point	earthed		earthed	
Short-circuit breaking current	kA	18.9		31.5	
Test frequency	Hz	-		-	
Crest value of injected current	kA	-		-	
Corresponding test frequency	Hz	-		-	
Transient Recovery Voltage		required values	actual values	required values	actual values
TRV peak value u_c	kV	32.0	37.3	30.0	29.6
Time t_2 or t_3	μs	31.0	36.0	71.0	64.0
Time delay t_d	μs	-	-	-	-
Rate-of-rise u_1 / t_1 or u_c / t_3	kV/μs	1.04	1.04	0.42	0.46
Voltage u_1	kV	-	-	-	-
Time t_1	μs	-	-	-	-
First peak u_L	kV	-	-	-	-
Time t_L	μs	-	-	-	-
Rate of rise u_L/t_L	kV/μs	-	-	-	-
Surge impedance Z_L	Ω	-	-	-	-
Time Delay t_{dL}	μs	-	-	-	-
Crest value u_T	kV	-	-	-	-
Crest value u_c	kV	-	-	-	-
Voltage measurements		-	Dividers 4.5 MΩ / 10 kΩ	-	Dividers 4.5 MΩ / 10 kΩ
Current measurements		-	Shunts 37.6 μΩ	-	Shunts 37.6 μΩ

Remarks: -

Technical Data of Test Circuits

Test	Basic Short-Circuit Test-Duty	T30		T10	
Test No.	0303Ra	20 – 24		25 – 27	
Number of phases	(test circuit)	3		3	
Rated voltage	kV	17.5		17.5	
Number of poles or phases	(test object)	3		3	
Voltage distribution	%	-		-	
Power frequency	Hz	50		50	
Power factor	cos φ	≤ 0.15		≤ 0.15	
Earthing conditions	Generator / System	earthed via 5 kΩ		earthed via 5 kΩ	
	Transformer	not earthed		not earthed	
	Short-circuit point	earthed		earthed	
Short-circuit breaking current	kA	9.45		3.15	
Test frequency	Hz	-		-	
Crest value of injected current	kA	-		-	
Corresponding test frequency	Hz	-		-	
Transient Recovery Voltage		required values	actual values	required values	actual values
TRV peak value u_c	kV	32.0	35.0	32.0	35.4
Time t_2 or t_3	μs	15.0	56.5 ^{*1}	15.0	49.0 ^{*1}
Time delay t_d	μs	-	-	-	-
Rate-of-rise u_1 / t_1 or u_c / t_3	kV/μs	2.14	0.62	2.14	0.72
Voltage u_1	kV	-	-	-	-
Time t_1	μs	-	-	-	-
First peak u_L	kV	-	-	-	-
Time t_L	μs	-	-	-	-
Rate of rise u_L/t_L	kV/μs	-	-	-	-
Surge impedance Z_L	Ω	-	-	-	-
Time Delay t_{dL}	μs	-	-	-	-
Crest value u_T	kV	-	-	-	-
Crest value u_c	kV	-	-	-	-
Voltage measurements		-	Dividers 4.5 MΩ / 10 kΩ	-	Dividers 4.5 MΩ / 10 kΩ
Current measurements		-	Shunts 37.6 μΩ	-	Shunts 37.6 μΩ

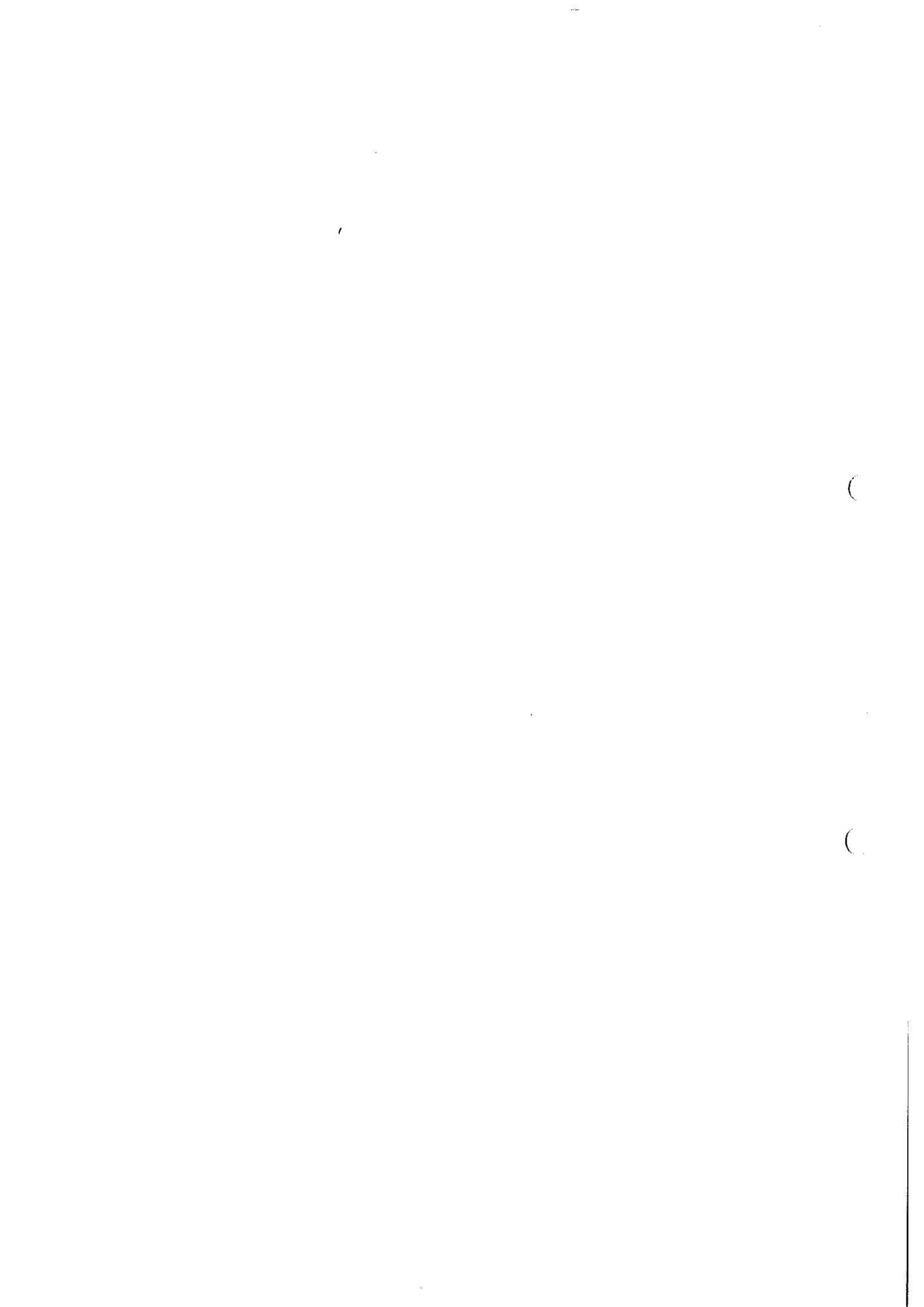
Remarks:

*¹ Due to limitations of the test plant, the length of time t_3 of the TRV is greater than the rated value.

Technical Data of Test Circuits

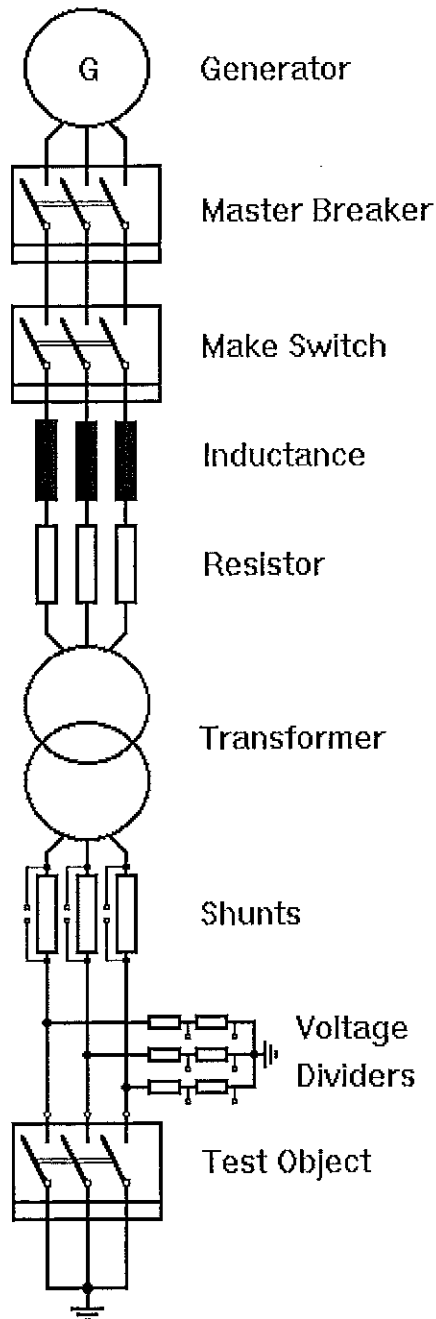
Test		Double-earth fault test			
Test No.	0303Ra	29 – 31			
Number of phases	(test circuit)	2			
Rated voltage	kV	17.5			
Number of poles or phases	(test object)	1			
Voltage distribution	%	-			
Power frequency	Hz	50			
Power factor	cos φ	≤ 0.15			
Earthing conditions	Generator / System	earthed via 5 kΩ			
	Transformer	not earthed			
	Short-circuit point	earthed			
Short-circuit breaking current	kA	27.4			
Test frequency	Hz	-			
Crest value of injected current	kA	-			
Corresponding test frequency	Hz	-			
Transient Recovery Voltage		required values	actual values	required values	actual values
TRV peak value u_c	kV	34.6	34.1	-	-
Time t_2 or t_3	μs	81.9	77.5	-	-
Time delay t_d	μs	-	-	-	-
Rate-of-rise u_1 / t_1 or u_c / t_3	kV/μs	0.42	0.44	-	-
Voltage u_1	kV	-	-	-	-
Time t_1	μs	-	-	-	-
First peak u_L	kV	-	-	-	-
Time t_L	μs	-	-	-	-
Rate of rise u_L/t_L	kV/μs	-	-	-	-
Surge impedance Z_L	Ω	-	-	-	-
Time Delay t_{dL}	μs	-	-	-	-
Crest value u_T	kV	-	-	-	-
Crest value u_c	kV	-	-	-	-
Voltage measurements		-	Dividers 4.5 MΩ / 10 kΩ	-	-
Current measurements		-	Shunts 37.6 μΩ	-	-

Remarks: -

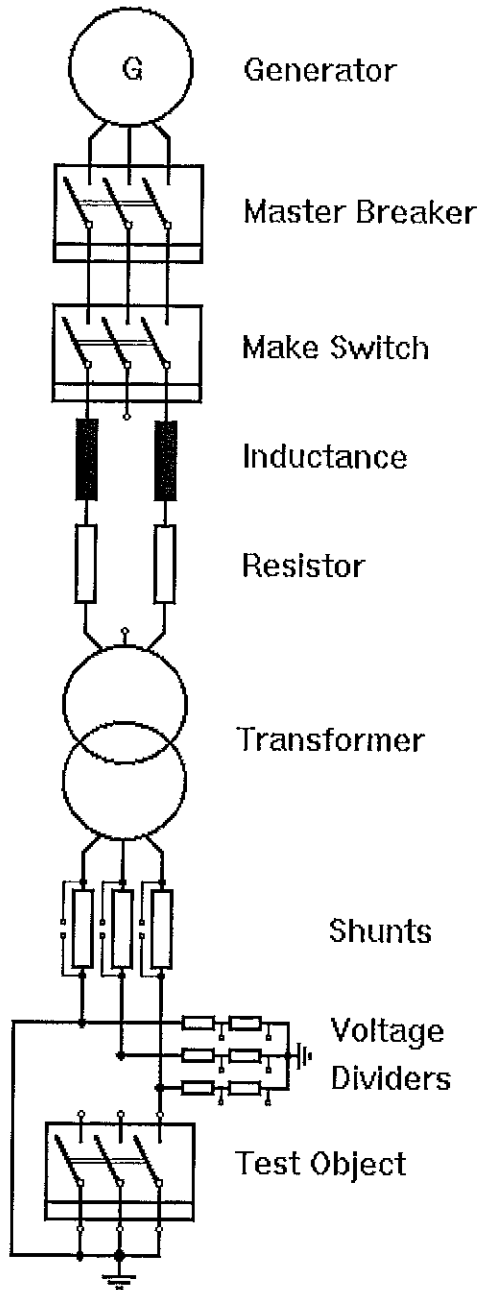


Principle Diagram of Three-phase Test Circuits

Basic Short-circuit Test Duties T10 - T100



Principle Diagram of Single-phase Test Circuit



Short-Circuit Making and Breaking Tests

Circuit-breaker

Test duty: T60
Date of test: 09th January 2003
Condition of test object before test: Factory new.
Connections to test object: By means of copper bars to the upper terminals of the circuit-breaker. Lower terminals of the circuit-breaker short-circuited and earthed.
Arc extinguishing medium: Vacuum

Test No. PEHLA 0303Ra		6		7
Operating sequence		O - 0.3s - CO - 3min - CO		
Applied voltage	kV	-	18.6	17.7
Short-circuit making current	L1	-	44.2	34.7
	kA L2	-	39.2	47.0
	L3	-	51.3	50.7
Short-circuit breaking current	L1	19.6	18.4	18.6
	Short-circuit current kA L2	17.8	18.5	18.5
	L3	19.6	18.7	18.8
	Average value kA	19.0	18.5	18.6
d.c. component	% L1	< 20	< 20	< 20
	L2	< 20	< 20	< 20
	L3	< 20	< 20	< 20
Recovery voltage	L1	10.7	10.1	10.5
	kV L2	10.7	10.1	10.4
	L3	10.7	10.2	10.4
Average value (phase-to-phase)	kV -	18.5	17.6	18.1
Transient Recovery Voltage (TRV), first-pole-to-clear	kV	-	-	-
Arcing time	L1	1.0	2.2	1.4
	ms L2	6.6	7.0	8.2
	L3	7.0	7.8	8.2
Closing time	ms	-	64.6	65.6
Opening time	ms	69.7	70.1	71.6
Result		P	P	P

Legend: P: Positive, breaker cleared or breaker closed and cleared N: Negative, breaker failed

Remarks:

PEHLA 0303Ra / 01: Current calibration
 PEHLA 0303Ra / 02: No-load operations before tests
 PEHLA 0303Ra / 03: Voltage calibration
 PEHLA 0303Ra / 04 and 05: Tests with reduced values
 PEHLA 0303Ra / 06 and 07: The operating devices are supplied at their minimum voltage.

Condition of test object after test: Circuit-breaker without functional or visible change.

Test no.
PEHLA 0303Ra / 06

