9. Evaluation

Type	Energy		Free travel	Further travel during which energy must be delivered	Actual travel			Minimum travel force	
	Actual value	Specified value	$\overline{OA}$	$\overline{AB}$	Actual value	Specified value Min. $\overline{OB}$	Specified value Max. $\overline{OC}$	Actual value	Specified value
	J		mm	mm	mm			N	
Medium	0,83	1±0,5	4	16	30	20	40	35,6	20

I. Measured duration of travel < maximum duration of travel (100ms)
II. striker energy is Medium 1J +-0,5 J
III. Verification of the withstand force proofed that the striker has the necessary force.

The striker full fills all Requirements of striker Type medium according to:
IEC 60282-1 2002-01; VDE 0670 Teil 4 Abs. 12 02/98

370 / 65

2004-03-29

Test engineer

EFEN GmbH Prüflabor Test Laboratory Eltville

Head of Laboratory

EFEN WICKMANN GRUPPE

Type Test Report

Lab.-No. 01167

1. Object

Current-limiting high-voltage fuse-links
Class: Back-up
Striker: "medium"
Type: HH-SI 10/24kV 80A / 100A FC TB ÜLA 442/65 / 442/78
Ident-No.: 67240.0809 / 67240.1009

Rated voltage	10/24 kV	
Rated current	80 A	100 A
Rated maximum breaking current	63 kA	
Rated frequency	50 Hz	
Rated minimum breaking current	310 A	430 A

2. Reason for test

Type test according to IEC 60282-1 (VDE 0670 Teil 4): 1998-02

3. Tests performed

3.1 Temperature-rise tests and power-dissipation measurement

Rated current		80 A	100 A
Test laboratory		EFEN Prüflabor Eltville	
Test result: $\Delta\vartheta_{max}$ [1]		67,4 K [2]	91,8 K [3]
Test result: P_a	at 50% I_r	38,4 W	59,0 W
	at 100% i_R	233,6 W	397,0 W
EFEN Lab-No.		01153	01154
Test passed		Yes	Yes

[1] permissible temperature rise: 65 K
[2] derating factor: 0,98
[3] derating factor: 0,84

3.2 Breaking Test: Test Duty 1

Rated current	80 A	100 A
Test Laboratory / Document No	KEMA / 720-00	KEMA 731-98
Test circuit applied voltage: U	21,0 kV	21,2 kV
Test circuit prospective current I	63,2 kA	64,0 kA
EFEN Lab-No.	01072	99099
Test passed	Yes	Yes

EFEN GmbH
Postfach 1254 D-65332 Eltville Tel. 0049 (0) 6129 46-0 Fax 46222 e-Mail: efen@efen.com Internet: www.efen.com

3.3 Breaking Test: Test Duty 2

Rated current	80 A	100 A
Test Laboratory / Document No	FGH / LV 00048 1E	FGH LV 00049 1E
Test circuit applied voltage U	21,06 kV	20,95 kV
Test circuit prospective current I	4,98 kA	5,99 kA
EFEN Lab-No.	00101	00102
Test passed	Yes	Yes

3.4 Breaking Test: Test Duty 3

Rated current	80 A	100 A
Test Laboratory / Document No.	FGH LV 00048	FGH LV 00049
Test circuit applied voltage: U	24,2 kV	24,5 kV
Test circuit prospective current I	307 A	426 A
EFEN Lab-No.	00101	00102
Test passed	Yes	Yes

3.5 Tests for time-current characteristics
Test Laboratory: EFEN Prüflabor Eltville
EFEN Lab-No: 01169
Test passed

3.6 Cut-off characteristics
EFEN Lab-No: 01171

3.7 Test of strikers
Test result: 0,83 J => Type medium
Test Laboratory: EFEN Prüflabor Eltville
EFEN Lab-No: 03088
Test passed

4. Test results

The products passed the type tests according to IEC 60 282-1 and VDE 0670 Teil 4 respectively at KEMA, FGH and EFEN test laboratories.

All requirements are fulfilled (see 3.).

370 / 65

2004-11-18

EFEN GmbH Prüflabor Test Laboratory Eltville

Test Engineer

Head of laboratory

1. Type HH-SI 10/24kV 80A FC TB ÜLA 442/65
Order-No.: 67240.0809

2. Reason for test

Temperature-rise tests and power-dissipation measurement

3. Tests performed / measurements

Measurement of temperatures, of voltage drop across fuse-link and power dissipation at different operating currents.

4. Applied standards

IEC 60282-1 1998-01 VDE 0670 Teil 4 Abs. 12 02/98

5. Test-laboratory, period of time

EFEN Prüflabor Eltville, 10/21/1998

6. Arrangement of the equipment

The high-voltage fuse-link is mounted vertically in a fuse-base, with the striker-pin at the top.
The size of bare copper conductors is 150 mm².
Temperatures are measured at the fuse contacts (top and bottom), in the middle of the fuse with thermocouples and are recorded.
The test currents are recorded.

7. Inspection and test sequence

The fuse-link was loaded with test currents I = 40 A and I = 80 A

Test current I [A]	Comments
40	50% rated current
80	Rated current

Temperatures are measured at the fuse contacts and in the middle of the tube with thermocouples.
Calculation of power dissipation from recorded voltage drop and recorded test current.
Calculation of resistance depending on the currents.

8. Results

Type: HH-SI 10/24kV 80A FC TB ÜLA 442/65
R_{cold}: 19,4 mΩ

8.1 Temperature rise test

		Temperature			Temperature rise			Informative	
I [A]	$\vartheta_{amb.}$ [°C]	ϑ_{top} [°C]	ϑ_{bottom} [°C]	$\vartheta_{perm.}$ [°C]	$\Delta\vartheta_{top}$ [K]	$\Delta\vartheta_{bottom}$ [K]	$\Delta\vartheta_{perm.}$ [K]	ϑ_{center} [°C]	ϑ_{center} [K]
40	19,1	37,8	31,2	105	18,7	12,1	65	59,7	40,6
80	18,0	85,4	63,6	105	67,4	45,6	65	197,3	161,3

8.2 Power dissipation and resistance of the test object at defined currents.

I [A]	P_d [W]	$U_{fuse-link}$ [V]	R [mΩ]
40	38,4	0,96	24,0
80	233,6	2,92	36,5

9. Evaluation

The limits for temperature (105 °C) and temperature-rise (65 K) for components and materials are followed according to the IEC standard up to 78 A. A derating factor of 0,975 has to be applied with reference to rated current.

372 / 23
07/06/2001

EFEN GmbH Prüflabor Test Laboratory Eltville

Test engineer

Head of laboratory

1. Type HH-SI 10/24kV 100A FC TB ÜLA 442/78
Order-No.: 67240.1009

2. Reason for test

Temperature-rise tests and power-dissipation measurement

3. Tests performed / measurements

Measurement of temperatures, of voltage drop across fuse-link and power dissipation at different operating currents.

4. Applied standards

IEC 60282-1 1998-01 VDE 0670 Teil 4 Abs. 12 02/98

5. Test-laboratory, period of time

EFEN Prüflabor Eltville, 12/01/1998

6. Arrangement of the equipment

The high-voltage fuse-link is mounted vertically in a fuse-base, with the striker-pin at the top.
The size of bare copper conductors is 150 mm².
Temperatures are measured at the fuse contacts (top and bottom), in the middle of the fuse with thermocouples and are recorded.
The test currents are recorded.

7. Inspection and test sequence

The fuse-link was loaded with test currents I = 50 A and I = 100 A

Test current I [A]	Comments
50	50% rated current
100	Rated current

Temperatures are measured at the fuse contacts and in the middle of the tube with thermocouples.
Calculation of power dissipation from recorded voltage drop and recorded test current.
Calculation of resistance depending on the currents.

8. Results

Type: HH-SI 10/24kV 100A FC TB ÜLA 442/78
R_{cold}: 17,5 mΩ

8.1 Temperature rise test

		Temperature			Temperature rise			Informative	
I [A]	$\vartheta_{amb.}$ [°C]	ϑ_{top} [°C]	ϑ_{bottom} [°C]	$\vartheta_{perm.}$ [°C]	$\Delta\vartheta_{top}$ [K]	$\Delta\vartheta_{bottom}$ [K]	$\Delta\vartheta_{perm.}$ [K]	ϑ_{center} [°C]	ϑ_{center} [K]
50	22	46,2	38,2	105	24,2	16,2	65	76,2	54,0
100	23,8	115,6	90,3	105	91,8	66,5	65	251,2	227,1

8.2 Power dissipation and resistance of the test object at defined currents.

I [A]	P_d [W]	$U_{fuse-link}$ [V]	R [mΩ]
50	59,0	1,18	23,6
100	397,0	3,97	39,7

9. Evaluation

The limits for temperature (105 °C) and temperature-rise (65 K) for components and materials are followed according to the IEC standard up to 84 A. A derating factor of 0,84 has to be applied with reference to rated current.

372 / 23
07/06/2001

EFEN GmbH Prüflabor Test Laboratory Eltville

Test engineer

Head of laboratory

KEMA

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

720–00

REPORT OF PERFORMANCE

CLIENT	EFEN Elektrotechnische Fabrik GmbH, Eltville am Rhein, Germany
MANUFACTURER	EFEN Elektrotechnische Fabrik GmbH, Eltville am Rhein, Germany
APPARATUS	Current limiting fuses
DESIGNATION	HH–SI 10/24kV FC TB 442/56 1 – 2 – 4 – 6.3 – 10 – 16 – 20 – 25 – 31.5 – 40 – 50 – 63 A – 80 A
SERIAL No.	67240.0010, 67240.0020, 67240.0040, 67240.0060, 67240.0100, 67240.0160, 67240.0200, 67240.0250, 67240.0320, 67240.0400, 67240.0500, 67240.0630 and 67240.0800.

RATINGS ASSIGNED BY THE MANUFACTURER

Voltage	24	kV
Current	1 – 2 – 4 – 6.3 – 10 – 16 – 20 – 25 – 31.5 – 40 – 50 – 63 – 80	A (1)
Frequency	50	Hz
Breaking capacity at 24 kV	63	kA
Series	1	
Class	Back–up	

(1) The fuse–links 20 – 25 – 31.5 A and 40 – 50 – 63 A form a homgeneous series in accordance with Sub–clause 13.3.1 of IEC 60282–1.

The tests have been carried out strictly in accordance with IEC 60282–1, Sub–clause 13 (Test–duty 1).
The apparatus has complied with the relevant requirements.

Date of tests 22nd November 2000 and 13th March 2001

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

THIS REPORT CONSISTS OF:

Pages	15
Circuit diagrams	1
Oscillograms	36
Drawings	19
Photographs	5
Information sheet	B70E

KEMA Nederland B.V.

A.L.J. Janssen
Manager High–Power Laboratory

Arnhem, 27th February 2001

TABLE WITH TEST RESULTS

REPORT 720–00	TYPE OF TESTS REQUESTED: Test duty 1	TEST CIRCUIT S02	PAGE 15

Condition before tests: Fuse–base new. Photograph 1502902.
Before each test new fuse–link.
Fuse–link mounted vertically in free air.
Distance fuse–link to floor 1.5 m.
Supply on top of the fuse–carrier.

Date and test	Fuse–link Type	Fuse–link Rated voltage kV / Rated current A	Resistance before test mΩ / after test MΩ	Test circuit Applied voltage kV	Test circuit Prospective current kA	Commencing of arcing after voltage zero °	Instantaneous current at initiation of arcing peak kA	Cut–off current peak kA	Pre–arcing time ms	Arcing time ms	Total operating time ms	Recovery voltage (1) kV	Switching voltage peak kV	Melt $\int I2t$ A2s x 10^6	Total $\int I2t$ A2s x 10^6	Energy $\int UIt$ kJ	Condition after test: Fuse–link / Striker; Behaviour during test, Remarks
010313 5026				10.6	31.3												Checking of the prospective current.
010313 5027				21.0									44.0				Checking of the applied voltage and TRV.
010313 5029	HH–SI 10/24 FC TB 442/56 67240.0800 2049	24 / 80	19.3 / > 300	21.0	63.2	40	10.0	10.0	0.63	6.90	7.53	20.8	46.5	18.2	44.7	237	hot / 23 mm; Fuse cleared.
010313 5030	HH–SI 10/24 FC TB 442/56 67240.0800 2050	24 / 80	19.0 / > 300	21.0	63.2	85	12.4	12.8	0.41	4.80	5.21	20.8	62.8	18.6	64.9	309	hot / 23 mm; Fuse cleared.
010313 5031	HH–SI 10/24 FC TB 442/56 67240.0800 2052	24 / 80	19.0 / > 300	21.0	63.2	83	12.5	12.7	0.38	4.50	4.88	20.8	66.8	15.0	58.8	260	hot / 23 mm; Fuse cleared.

Remarks: Fuse–base showed no visible change.

(1) Maintained for 15 s.

KEMA

KEMA

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

731–98

REPORT OF PERFORMANCE

CLIENT	EFEN Elektrotechnische Fabrik GmbH, Eltville am Rhein, Germany
MANUFACTURER	EFEN Elektrotechnische Fabrik GmbH, Eltville am Rhein, Germany
APPARATUS	Current limiting fuses
DESIGNATION	HH–SI 10/24 FC TB 2 – 4 – 50 – 100 A
SERIAL No.	67240.0020, 67240.0040 67240.0500, 67240.1000

RATINGS ASSIGNED BY THE MANUFACTURER

Voltage		24	kV
Current		2 – 4 – 50 – 100	A
Frequency		50	Hz
Breaking capacity at	24 kV	63	kA
Series		1	
Class		Back–up	

The tests have been carried out strictly in accordance with IEC 60282–1, Clause 13 (Test duty 1).
The fuses have complied with the relevant requirements.

Date of tests 4th November 1998

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

THIS REPORT CONSISTS OF:

Pages	7
Circuit diagrams	1
Oscillograms	13
wings	30
graphs	2
n sheet	B70E

KEMA Nederland B.V.

QUALIFIED BY STERLAB

A.L.J. Janssen

Arnhem, 15th February 1999

TABLE WITH TEST RESULTS

REPORT 731–98	TYPE OF TESTS REQUESTED: Test duty 1 (100 A)	TEST CIRCUIT S02	PAGE 7

Condition before tests: Fuse carrier in same condition.
Fuse–links mounted vertically in free air by means of clips.
Distance fuse–link to floor 1.20 m.

Date and test	Fuse–link Type	Fuse–link Rated voltage kV / Rated current A	Resistance before test mΩ / after test MΩ	Test circuit Applied voltage kV	Test circuit Prospective current kA	Commencing of arc after voltage zero °	Instantaneous current at initiation of arcing peak kA	Cut–off current peak kA	Pre–arcing time ms	Arcing time ms	Total operating time ms	Recovery voltage (1) kV	Switching voltage peak kV	Melt ∫i2t A2s x 10³	Total ∫i2t A2s x 10³	∫U x i x t kJ	Condition after test: Fuse–link / Striker; Behaviour during test; Remarks
981104 4118	HH–SI 10/24 FC TB 442/78 67240.1000 99046	24 / 100	17.0 / > 300	21.2	64.0	55	12.7	12.7	0.57	6.1	6.7	21.2	60.3	30.8	83.0	368	hot / operated; Fuse cleared.
981104 4119	HH–SI 10/24 FC TB 442/78 67240.1000 99047	24 / 100	17.0 / > 300	21.2	64.0	87	13.6	13.8	0.48	4.3	4.8	21.2	65.5	30.6	86.9	327	hot / operated; Fuse cleared.
981104 4120	HH–SI 10/24 FC TB 442/78 67240.1000 990048	24 / 100	17.0 / > 300	21.2	64.0	81	13.6	13.8	0.48	4.8	5.2	21.2	63.7	29.9	93.6	373	hot / operated; Fuse cleared.

Remarks: Fuse–carrier contacts not damaged.

(1) Maintained for 15 s.

KEMA

FORSCHUNGSGEMEINSCHAFT FÜR
ELEKTRISCHE ANLAGEN UND STROMWIRTSCHAFT E.V.

Mannheim-Rheinau, Hallenweg 40

FGH

Accredited testing laboratory to DIN EN 45001 for subject

Deutscher Akkreditierungs Rat DAR

DAT-P-020/92-01	High-voltage apparatus switchgear and controlgear
DAT-P-020/92-12	High-voltage cables and accessories
DAT-P-020/92-21	Voltage quality flicker

Test Report

No. LV 00048

Duly signed copy 1E

Reference: 114-99/241, 246...248
114-00/034...047

Apparatus: Current-limiting fuse-link
Types: a) HH-SI 10/24kV 50A FC TB 442/65, Ident-No.: 67240.0500
b) HH-SI 10/24kV 80A FC TB 442/78, Ident-No.: 67240.0800

Rated voltage: 24 kV
Rated current: a) 50 A, b) 80 A
Class: Back-up

Manufacturer: EFEN Elektrotechnische Fabrik GmbH,
Postfach 12 54, D-65344 Eltville, Germany

Customer: EFEN Elektrotechnische Fabrik GmbH,
Postfach 12 54, D-65344 Eltville, Germany

Test Specification: IEC 282-1, fourth edition, 1994

Tests performed: Breaking tests:

Test duty 2 with type b):
Verification of the operation with prospective current I2 at which current limiting occurs when a high level of energy is stored in the inductance of the circuit.

Test duty 3 with type a) and b):
Verification of the operation at the rated minimum breaking current
a) I3 = 171 A,
b) I3 = 307 A.

Test Results: During the breaking tests performed, the tested fuse-links fully complied with the standard conditions of behaviour with respect to breaking capacity.

Mannheim, May 9, 2000
Hch

Forschungsgem. für Elektrische Anlagen und Stromwirtschaft e.V. * FGH

FORSCHUNGSGEMEINSCHAFT FÜR
ELEKTRISCHE ANLAGEN UND STROMWIRTSCHAFT E.V.

i.V.
Test Engineer:
(Helt / Schaefer)

Place and date of test: LVF Mannheim-Rheinau, 16/11/1999, 24/01/2000, 25/01/2000

Number of sheets: 24

FUSE-LINKS - BREAKING TESTS

Tested fuse-link	Ur [kV]	Ir [A]	Type
	24	80	HH-SI 10/24kV 80A FC TB 442/78 Ident.-No.: 67240.0800

Test-no. 114-99/			241	246	247	248
Specimen		No.	Adjustment test	991125	991126	991127
Resistance		mΩ	-	20.0	19.9	19.9
Test-duty (according to IEC 282-1)			2			
Power factor of the test circuit	cos φ		0.086			
Prospective breaking current (RMS)		kA	5.00	4.98	4.98	4.98
Making angle after voltage zero		° el	8.5	8.6	9.0	10.6
Pre-arcing / Melting time	t_m	ms		3.71	3.74	3.71
Melting current	i_m	kA		5.11	5.17	5.14
Pre-arcing Joule Integral		kA^2s		24.2	25.0	24.5
Cut-off / Let through current	i_d	kA		5.33	5.36	5.39
Arcing time	t_{LB}	ms		6.86	6.81	6.94
Arcing Joule Integral		kA^2s		65.6	63.7	70.8
Arcing time until breaking by the circuit breaker		ms		-	-	-
Max. switching voltage	u_S	kV		55.6	56.9	54.7
Power frequency recovery voltage	U_W	kV	21.14	21.06	21.06	21.05
Maintaining voltage after breaking		s		> 60	> 60	> 60
Test result:						
Fuse operated correct		y/n		y	y	y
Switching voltage $u_s \leq$ permissive value		y/n		y	y	y
Current limiting:	($I_d \leq$ Let-through characteristic)	y/n		-	-	-
Requirement for I2:	i_m/I = 0.85...1.06	i_m/I		1.03	1.04	1.03
Emission of flames or sand		y/n		n	n	n
Damages (external)		y/n		n	n	n
Operation of striker correct		y/n		y	y	y

No. LV 00048 Sheet 15

FUSE-LINKS - BREAKING TESTS

Tested fuse-link	Ur [kV]	Ir [A]	Type
	24	80	67240.0800 HH-SI 10/24kV 80A FC TB 442/78

Test-no. 114-00/			34	35	36	
Specimen		No.	Adjustment test	991121	991120	
Resistance		mΩ	-	20.0	19.8	
Test-duty (according to IEC 282-1)			3			
Power factor of the test circuit	cos φ		0.51			
Prospective breaking current (RMS)		A	307			
Maintained current with low voltage source at 306...304 A at 311...309 A		s		3.67	3.81	
Time of current-interruption while switching over from low voltage to high voltage circuit		ms		167	151	
Melting time	t_m	s		3.67	3.81	
Pre-arcing Joule Integral		A^2s		-	-	
Arcing time	t_{LB}	ms		40	56	
Arcing Joule Integral		kA^2s		3.67	4.40	
Arcing time until breaking by the circuit breaker		ms		-	-	
Max. switching voltage	u_S	kV		34.8	34.8	
Power frequency recovery voltage	U_W	kV	24.2	24.2	24.2	
Maintaining voltage after breaking		s		60	60	
Test result:						
Fuse operated correct		y/n		y	y	
Switching voltage $u_S \leq$ permissive value		y/n		y	y	
Emission of flames or sand		y/n		n	n	
Damages (external)		y/n		n	n	
Operation of striker correct		y/n		y	y	

FORSCHUNGSGEMEINSCHAFT FÜR
ELEKTRISCHE ANLAGEN UND STROMWIRTSCHAFT E.V.

Mannheim-Rheinau, Hallenweg 40

FGH

Accredited testing laboratory to DIN EN 45001 for subject

Deutscher Akkreditierungs Rat DAR

DAT-P-020/92-01	High-voltage apparatus switchgear and controlgear
DAT-P-020/92-12	High-voltage cables and accessories
DAT-P-020/92-21	Voltage quality flicker

Test Report

No. LV 00049

Duly signed copy 1E

Reference: 114-98/410...413,
114-00/493...497

Apparatus: **Current-limiting fuse-link**
Type: HH-SI 10/24kV 100A FC TB 442/78, Ident-No.: 67240.1000

Rated voltage: 24 kV
Rated current: 100 A
Class: Back-up

Manufacturer: EFEN Elektrotechnische Fabrik GmbH,
Postfach 12 54, D-65344 Eltville, Germany

Customer: EFEN Elektrotechnische Fabrik GmbH,
Postfach 12 54, D-65344 Eltville, Germany

Test Specification: IEC 282-1, fourth edition, 1994

Tests performed: Breaking tests:

Test duty 2:
Verification of the operation with prospective current I2 at which current limiting occurs when a high level of energy is stored in the inductance of the circuit.

Test duty 3:
Verification of the operation at the rated minimum breaking current
I3 = 426 A.

Test Results: During the breaking tests performed, the tested fuse-links fully complied with the standard conditions of behaviour with respect to breaking capacity.

Mannheim, July 17, 2000
Hch

Forschungsgem. für Elektrische Anlagen und Stromwirtschaft e.V. * FGH

FORSCHUNGSGEMEINSCHAFT FÜR
ELEKTRISCHE ANLAGEN UND STROMWIRTSCHAFT E.V.

i.V. Test Engineer: i.V.

(Schaefer)

Place and date of test: LVF Mannheim-Rheinau, 8/9/1998, 7/6/2000

Number of sheets: 23

No. LV 00049 Sheet 13

FUSE-LINKS - BREAKING TESTS

Tested fuse-link	Ur [kV]	Ir [A]	Type
	24	100	HH-SI 10/24kV 100A FC TB 442/78, Ident.-No. 67240.1000

Test-no. 114-98/			410	411	412	413
Specimen		No.	Adjustment test	98878	98879	98881
Resistance		mΩ	-	16.8	16.9	17.0
Test-duty (according to IEC 282-1)			2			
Power factor of the test circuit	cos φ		0.095			
Prospective breaking current (RMS)		kA	5.99			
Making angle after voltage zero		° el	9			
Pre-arcing / Melting time	t_m	ms		3.5	3.6	3.6
Melting current	i_m	kA		6.17	6.14	6.17
Pre-arcing Joule Integral		kA^2s		35.5	35.0	35.6
Cut-off / Let through current	i_d	kA		6.45	6.46	6.47
Arcing time	t_{LB}	ms		6.4	6.6	6.6
Arcing Joule Integral		A^2s		72.5	85.2	83.9
Arcing time until breaking by the circuit breaker		ms		-	-	-
Max. switching voltage	u_S	kV		61.2	57.1	58.0
Power frequency recovery voltage	U_w	kV	20.9	20.9	20.9	20.9
Maintaining voltage after breaking		s		60	60	60
Test result:						
Fuse operated correct		y/n		y	y	y
Switching voltage $u_s \leq$ permissive value		y/n		y	y	y
Current limiting:	($I_d \leq$ Let-through characteristic)	y/n		-	-	-
Requirement for I2:	i_m/I = 0.85...1.06	i_m/I		1.03	1.03	1.03
Emission of flames or sand		y/n		n	n	n
Damages (external)		y/n		n	n	n
Operation of striker correct		y/n		y	y	y

FUSE-LINKS - BREAKING TESTS

Tested fuse-link	Ur [kV]	Ir [A]	Type
	24	100	67240.1000 HH-SI 10/24kV 100A FC TB 442/78

Test-no.	114-00/		493	496	497	
Specimen		No.	Adjustment test	00707	00707a	
Resistance		mΩ	-	17.7	17.0	
Test-duty (according to IEC 282-1)			3			
Power factor of the test circuit	cos φ		0.51			
Prospective breaking current (RMS)		A	426			
Maintained current with low voltage source	at 432 A at 431 A	s		1.49	1.72	
Time of current-interruption while switching over from low voltage to high voltage circuit		ms		110	151	
Melting time	t_m	s		1.49	1.72	
Pre-arcing Joule Integral		kA^2s		281	320	
Arcing time	t_{LB}	ms		110	57.5	
Arcing Joule Integral		kA^2s		12.2	8.35	
Arcing time until breaking by the circuit breaker		ms		-	-	
Max. switching voltage	u_S	kV		35.4	35.8	
Power frequency recovery voltage	U_W	kV	24.4	24.5	24.6	
Maintaining voltage after breaking		s		60	60	
Test result:						
Fuse operated correct		y/n		y	y	
Switching voltage $u_S \leq$ permissive value		y/n		y	y	
Emission of flames or sand		y/n		n	n	
Damages (external)		y/n		Thin crack in tube	n	
Operation of striker correct		y/n		y	y	

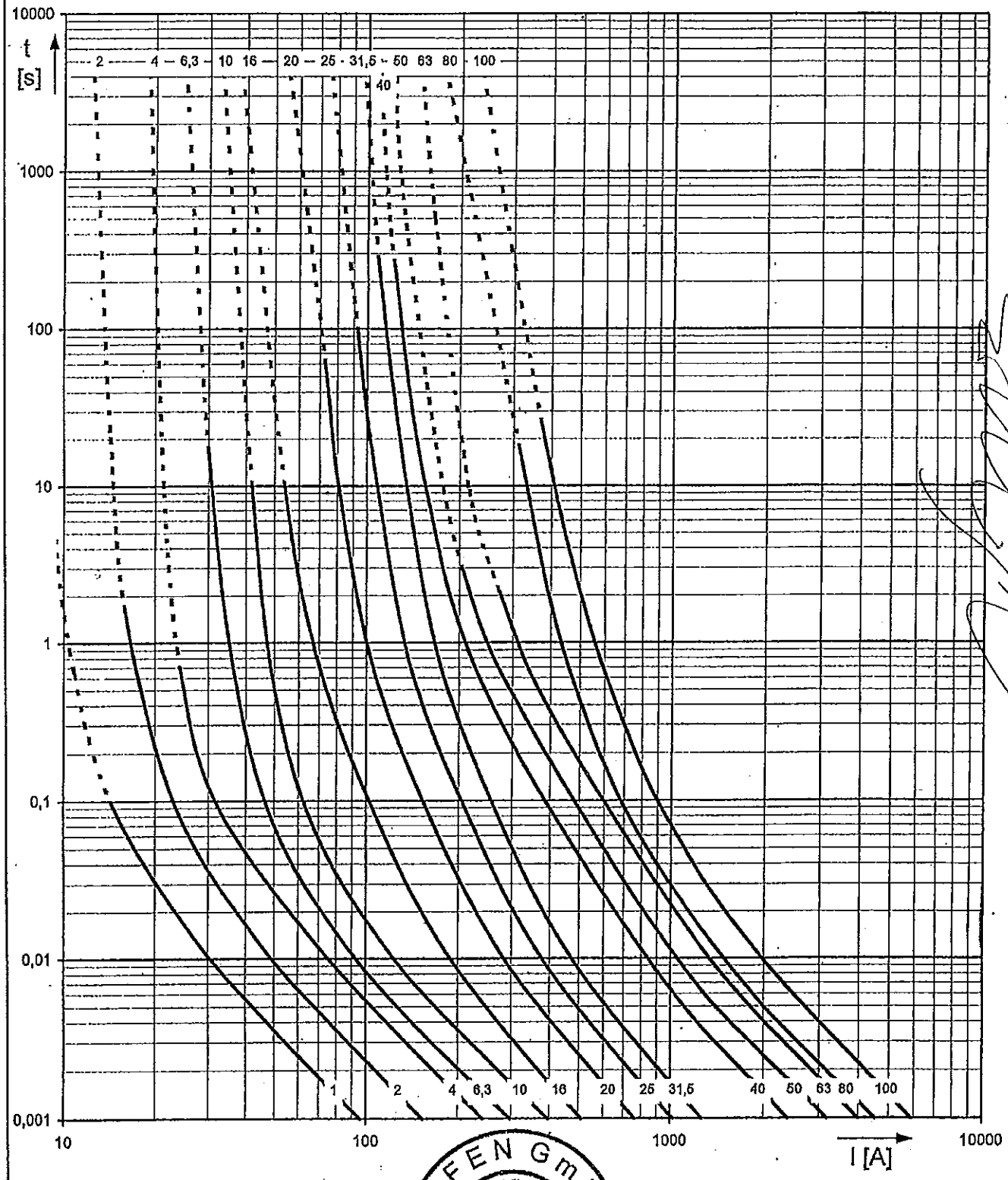
EFEN WICKMANN GRUPPE

Time-current characteristics of H.V. back-up fuse-links with ÜLA (controlled power dissipation)

Lab.-No. 01169

10/24 kV 1 A - 100 A acc. to IEC 60282-1 / VDE 0670 Teil 4

Order-No.: 67240.0019 - 67240.1009



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06.06.2001 / 23

EFEN GmbH

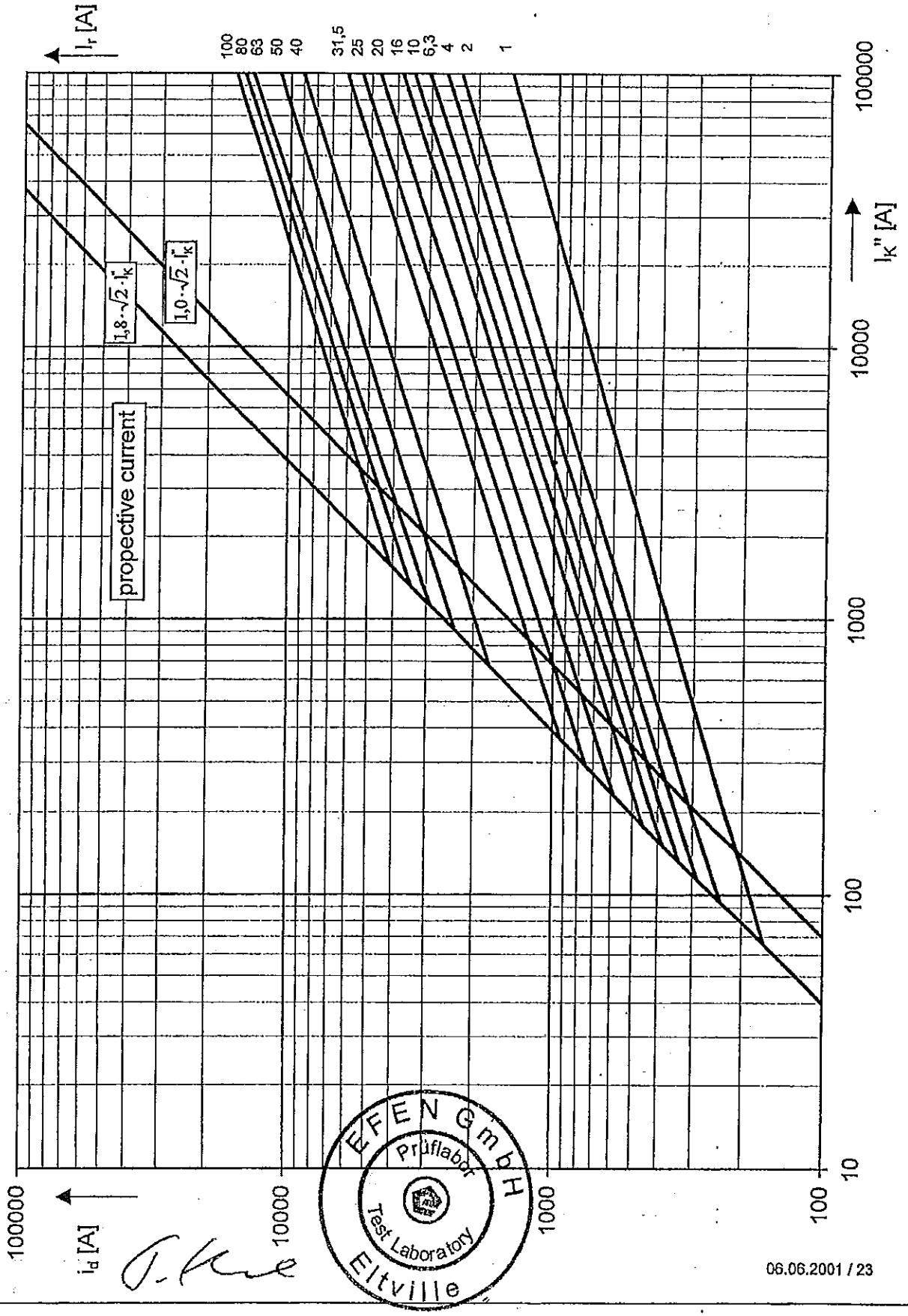
Postfach 1254 · D-65332 Eltville · Tel. 00 49 (0) 61 29 46-0 · Fax 4 62 22 · e-Mail: efen@efen.com · Internet: www.efen.com

EFEN
WICKMANN GRUPPE

Cut-off characteristics of H.V. back-up fuse-links with ÜLA (controlled power dissipation)

Lab.-No. 01171 10/24 kV 1 A - 100 A acc. to IEC 60282-1 / VDE 0670 Teil 4

Order-No.: 67240.0019 to 67240.1009



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1. Type HH – fuse link with striker 81902.0100(3) (duration 30mm)

2. Reason for test

Test of Strikers

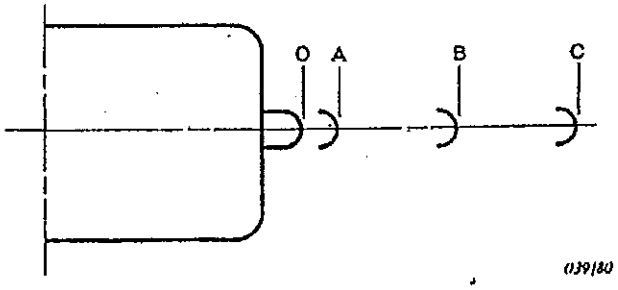
3. Tests performed / measurements

I. measurement of the duration of travel
II. measurement of the force-travel characteristics and calculation of the striker energy actuated by the spring
III. Verification of the withstand force according to applied standard (4)

4. Applied standards

IEC 60282-1 2002-01 VDE 0670 Teil 4 Abs. 12 02/98

4.1 standard in detail regarding strikers



OA – Free travel – No energy output specified.
AB – Further travel during which energy must be delivered.
OB – Minimum actual travel.
OC – Maximum actual travel.
CB – Maximum permitted return travel under withstand force (when applicable).

Type	Energy	Mechanical characteristics					
		Values of		Actual travel		Minimum withstand force	Maximum duration of travel (see note)
		Free travel (OA)*	Further travel during which energy must be delivered (AB)*	Min. (OB)*	Max. (OC)*		
	J	mm	mm	mm	mm	N	ms
Light	0,3 ± 0,25	2	8	10	30	Not applicable	100
Medium	1 ± 0,5	4	16	20	40	20	100
Heavy	2 ± 1	4	6	10	16	40	100

* See figure 12.

NOTE – Duration of travel is defined for actual fuse-links as the time from commencement of arcing to the time when travel OB is reached. For dummy fuses it is the time from application of voltage until travel OB is reached.

5. Test-laboratory, period of time

EFEN laboratory Eltville, 4.12.2003

6. Arrangement of the equipment

I. The tested fuse link is fixed in a fuse-base. An NC (normally closed) switch will be opened if the striker has travelled 30mm. Current, Voltage and the NC switch are recorded by an digital oscilloscope.

II. & III. The force-travel characteristics will be measured by an approved force meter*. For this measurement the striker will be prepared with an scale indicator for measuring the travelled way in mm.

*Zwick Z2.5 / TN1S Material testing device

7. Inspection and test sequence

I. Intact striker circuit is tested with current < 10A and voltage < 15V.
II. Current, voltage and the NC switch are recorded.
III. Force of striker is measured at Positions: 0, 10, und 20mm.
The Position of the Striker is measured at the minimum withstand force of 20N.

8. Results

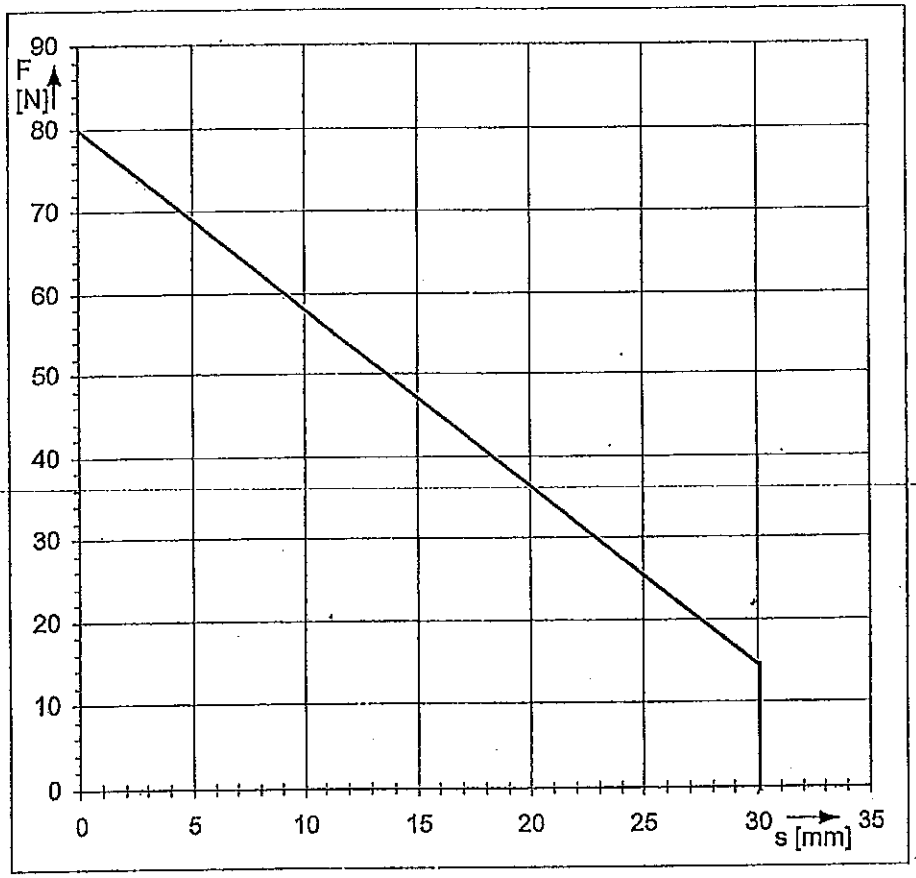
I. measurement of the duration of travel

	duration of travel	Current	Voltage
Sample 1	5 ms	9,9 A	< 15 V
Sample 2	2 ms	11,7 A	< 15 V
Sample 3	4 ms	10 A	< 15 V
Sample 4	6 ms	9,9 A	< 15 V

II. measurement of the force-travel characteristics and calculation of the striker energy

		Sample 1		Sample 2		Sample 3		
Position	Length / mm	Measurem. 1	Measurem. 2	Measurem. 1	Measurem. 2	Measurem. 1	Measurem. 2	Average:
O	0	77	76,8	85,5	81,7	78	78	79,5
A	4	66,5	66,4	67,5	67,4	71,7	69,7	68,2
B	20	37,7	36,1	33,7	33,1	36,2	36,5	35,6
	Energy / J:	0,83	0,82	0,81	0,80	0,86	0,85	0,83

$$Energy = \frac{(F_A + F_B) \times \overline{AB}}{2000} \qquad Energy[J];\ F_A[N];\ F_B[N];\ \overline{AB}[mm];$$



III. Verification of the withstand force of 20N at Position ≥ 20mm

	Measurement	Force / N	Length / mm
Sample 1	1	20	27,4
Sample 1	2	20	27,7
Sample 2	1	20	27,3
Sample 2	2	20	26,9
Sample 3	1	20	28,4
Sample 3	2	20	28,4

9. Evaluation

Type	Energy		Free travel	Further travel during which energy must be delivered	Actual travel			Minimum travel force	
	Actual value	Specified value	$\overline{OA}$	$\overline{AB}$	Actual value	Specified value Min. $\overline{OB}$	Specified value Max. $\overline{OC}$	Actual value	Specified value
	J		mm	mm	mm			N	
Medium	0,83	1±0,5	4	16	30	20	40	35,6	≥20

I. Measured duration of travel < maximum duration of travel (100ms)
II. striker energy is Medium 1J +-0,5 J
III. Verification of the withstand force proofed that the striker has the necessary force.

The striker full fills all Requirements of striker Type medium according to:
IEC 60282-1 2002-01; VDE 0670 Teil 4 Abs. 12 02/98

370 / 65

2004-03-29

Test engineer

EFEN GmbH Prüflabor Test Laboratory Eltville

Head of Laboratory

Приложение № 6

DAkkS
Deutsche
Akkreditierungsstelle

Deutsche Akkreditierungsstelle GmbH *Превод от английски език*

Немски орган по акредитация

Поверен съгласно Раздел 8 подраздел 1 AkkStelleG във връзка с Раздел 1 подраздел 1 AkkStelleGBV
Подписала Многостранните споразумения
на EA. ILAC и IAF за Взаимно признаване

АКРЕДИТАЦИЯ

Немския орган по акредитация
(Deutsche Akkreditierungsstelle GmbH) удостоверява,че лабораторията за изпитване

FGH Engineeering & Test GmbH
Hallenweg 40, 68219 Mannheim

е компетентна съгласно условията на DIN EN ISO/IEC 17025:2005 за извършване на изпитания в следните области:

Високоволтови устройства и системи и техни елементи

Захранващи кабели и комплекти за захранващи кабели

Сертификатът за акредитация би трябвало да се прилага само във връзка с уведомлението за акредитация на 11.01.2012 с акредитационен номер D-PL-12110-01 и е валиден до 10.01.2017.Той се състои от настоящия лист, обратната страна на настоящия лист и следващо приложение с общо 22 страници.

Регистрационен номер на сертификата: **D-PL-12110-01**

On behalf of Dipl.-Ing. (FH) Ralf Egner
Head of Division 2

Франкфурт на Майн, 11.01.2012

Този документ е превод. Окончателната версия е оригиналния Немски сертификат за акредитация.

Виж бележките на гърба

Deutsche Akkreditierungsstelle GmbH
Немски орган по акредитация

Офис Берлин
Spittelmarkt 10
10117 Berlin

Офис Франфуркт на Майн
GartenstraRe 6
60594 Frankfurt am Main

Офис Брауншвайг
Bundesallee 100
38116 Braunschweig

Публикуването на екстракти от сертификата за акредитация е предмет напредварително писмено одобрение от Немския орган по акредитация((Deutsche Akkreditierungsstelle GmbH (DAkkS)).Изключение е непроменената форма of отделни разпространявания на настоящият лист от съответният орган за оценяване споменат на обратната страна на документа.

Да не се има предвид ,че акредитацията се отнася и за области извън обхвата на акредитация, удостоверено с DAkkS.

Акредитацията е издадена по реда на Закона за Органи по Акредитация (AkkStelleG) от 31 юли 2009 (Федерален закон ДВ I стр. 2625) и на Регламент (ЕС) No 765/2008 на Европейския парламент и на Съвета от 9 юли 2008 за определяне на изискванията за акредитация и надзор на пазара във връзка с предлагането на пазара на продукти (Официален вестник на Европейския съюз L 218 от 9 юли 2008 г., стр. 30).DAkkS е подписала Многостранни споразумения за взаимно признаване на Европейската организация за акредитация (EA), Международния акредитационен форум (IAF) и Меджународно Лабораторно сътрудничество за акредитация (ILAC.Подписалите тези споразумения взаимно признават акредитациите.

Актуалното състояние на членството може да бъде изтеглена от следните уебсайтове:

EA: www.european-accreditation.org

ILAC: www.ilac.org

IAF: www.iaf.nu

DAkkS
Deutsche
Akkreditierungsstelle

Deutsche Akkreditierungsstelle GmbH
German Accreditation Body

Entrusted according to Section 8 subsection1 AkkStelleG in connection with Section 1 subsection 1 AkkStelleGBV
Signatory to the Multilateral Agreements of
EA, ILAC and IAF for Mutual Recognition

Accreditation

The Deutsche Akkreditierungsstelle GmbH (German Accreditation Body) attests that the testing laboratory

FGH Engineeering & Test GmbH
Hallenweg 40, 68219 Mannheim

is competent under the terms of DIN EN ISO/IEC 17025:2005 to carry out tests in the following fields:

High voltage devices and systems and their components
Power cable and power cable sets

The accreditation certificate shall only apply in connection with the notice of accreditation of 11.01.2012 with the accreditation number D-PL-12110-01 and is valid until 10.01.2017. It comprises the cover sheet, the reverse side of the cover sheet and the following annex with a total of 22 pages.

Registration number of the certificate: **D-PL-12110-01**

Frankfurt am Main, 11.01.2012

On behalf of Dipl.-Ing. (FH) Ralf Egner
Head of Division 2

This document is a translation. The definitive version is the original German accreditation certificate.

See notes overleaf.

Deutsche Akkreditierungsstelle GmbH

Office Berlin
Spittelmarkt 10
10117 Berlin

Office Frankfurt am Main
Gartenstraße 6
60594 Frankfurt am Main

Office Braunschweig
Bundesallee 100
38116 Braunschweig

The accreditation was granted pursuant to the Act on the Accreditation Body (AkkStelleG) of 31 July 2009 (Federal Law Gazette I p. 2625) and the Regulation (EC) No 765/2008 of the European Parliament and of the Council of 9 July 2008 setting out the requirements for accreditation and market surveillance relating to the marketing of products (Official Journal of the European Union L 218 of 9 July 2008, p. 30). DAkkS is a signatory to the Multilateral Agreements for Mutual Recognition of the European co-operation for Accreditation (EA), International Accreditation Forum (IAF) and International Laboratory Accreditation Cooperation (ILAC). The signatories to these agreements recognise each other's accreditations.

The up-to-date state of membership can be retrieved from the following websites:
EA: www.european-accreditation.org
ILAC: www.ilac.org
IAF: www.iaf.nu

Приложение № 6

Превод от английски език

Приложение към ISO/IEC 17025:2005 Декларация
за акредитация за регистрационен номер: **L 020**

на **KEMA Nederland B.V.**
High-Power Laboratory

Това приложение е валидно:от **19-03-2015** до**01-04-2018** Заменя приложение с дата: **26-01-2015**

Масто където се извършват дейности по акредитация

Главен офис

Utrechtseweg 310, Building no. R11
6812 AR
Arnhem
The Netherlands

No.	Материал или продукт	Вид дейност[1]	Вътрешен референтен номер
	Силови Трансформатори	Изпитания на късо съединение	IEC 60076-5 IEC 60076-11 EN 50464-1 IEEE Std C57.12.90 IEEE Std. C57.12.00
2	Токови Трансформатори	Изпитания на късо съединение Измерване на преходната моментна грешка	IEC 61869-2 IEEE Std C57.13 IEC 61869-1
3	Реактори	Изпитания на късо съединение	IEC 60076-6 IEEE Std C57.21
4	Високо честотни бобини за А.С. захранващи системи	Изпитания на късо съединение	IEC 60353
5	Метални А.С. КРУ1 - 52 kV съотв. > 1 kV и сглобяеми подстанции	Изпитания на късо съединение Проверка на вклюващи и изключващи мощности Механични работни изпитания Дъгов разряд поради вътрешна повреда	IEC 62271-200 IEC 62271-202 IEEE C37.74 IEEE Std C37.20.2 IEEE Std C37.20.7 ANSI C37.54 ANSI C37.55
6	Метални А.С. КРУ> 52 kV съотв.	Изпитания на късо съединение Проверка на вклюващи и изключващи мощности Механични работни изпитания Дъгов разряд поради вътрешнаповреда	IEC 62271-203 IEEE Std C37.122

Това приложение беше одобрено от:
Ir. J.C. van der Poel
Главен Изпълнителен Директор

[1] Ако има препращане към поле (SXXX), това представлява приетата от собствениха схема. Приетата версия е упоменато във връзка с обхвата на схемата на собственика.

Приложение към ISO/IEC 17025:2005 Декларация
за акредитация за регистрационен номер: **L 020**

на **KEMA Nederland B.V.**
High-Power Laboratory

Това приложение е валидно:от **19-03-2015** до**01-04-2018** Заменя приложение с дата: **26-01-2015**

No.	Материал или продукт	Вид дейност[1]	Вътрешен референтен номер
7	Комутационни апарати А.С. Ниско напрежение и контролни Предавателни сглобки	Изпитания на късо съединение	IEC 61439-1 IEC 61439-2 IEC 60439-2
8	Изолирани А,С КРУ 1-52kV	Изпитания на късо съединение Проверка на вклюващи и изключващи мощности Механични работни тестове Дъгов разряд поради вътрешнаповреда	IEC 62271-201
9	Високоволтови АС прекъсвачи	Изпитания на късо съединение Изпитания на включване и изключване Тест на включване Механични изпитания и изпитанания на влияние върху околната среда	IEC 62271-100 IEC 62271-110 IEC 62271-101 IEEE Std C37.09 IEEE Std C37.09a IEEE Std C37.09b IEEE
10	Високоволтови генератори Прекъсвачи	Изпитания на късо съединение	IEEE Std C37.013 IEEE Std C37.013a
11	АС прекъсвачи за Железопътни приложения	Изпитания на включване и изключване	EN 50152-1 IEC 60077-4
12	Високоволтови А.С. Комутатори за номинални Напрежения над 1 kVUp Включително 52 kV	Изпитания на късо съединение Изпитания на включване и изключване Механични изпитвания за издържливост	IEC 62271-103
13	Променливотокови Комутатори за номинални Напрежения от 52 kV и нагоре	Изпитания на късо съединение Изпитания на включване и изключване Механични изпитвания за издържливост	IEC 62271-104 IEEE Std C37.247
14	Високоволтови А.С. Разединители и заземителни комутатори	Изпитания на късо съединение Тест на включване Работа при късо съединение Изпитания на оперативна и механична издържливост Операции при тежки условия на лед Операции при температурните граници Изпитания на контактната зона	IEC 62271-102 IEEE Std C37.34
15	Променивотокови контактори и пускатели	Включващи и изключващи мощности Координация с устройството със защита От късо съединение	IEC 62271-106
16	Автоматични Реклозери и прекъсвания при повреда	Тестове на прекъсвания Работни изпитвания за издържливост	IEC 62271-111 / IEEE Std C37.60