Tyco Electronics Energy Division



PPR-1658

Type Test Report for Plug-in Switchgear Termination for U_m = 145 kV **PHVS-1450P**

Tested by:Felten & Guilleaume Kabelwerke GmbHDate:16.9.02Pages:23Appendix:—



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ET6.22 Belz, 16.09.1999

Type Test Report

Plug-in Switchgear Termination for U_m = 145 kV **KSEV 145**

1. Purpose

Tyco Electronics requested Felten & Guilleaume Kabelwerke GmbH to carry out a type test on the Plug-in Switchgear Termination up to Um = 145 kV. The plug-in component is designed to fit an insulator for U_m = 72,5 and 145 kV. Therefore this type test relates to KSEV 72 and KSEV 145 (identical with Tyco: PHVS-1450P-XX/YY).

2. Plug-in Termination

2.1 Description Insulator

The tested dry-type switchgear termination consists of the insulator and the plug-in part, which is fitted to the cable. The insulator is made of epoxy with an embedded electrode. This gas-leak-proof design does not require installation of additional sealing technology. An insulating ring integrated at the insulator base enables the separation of the cable metal screen from earth.

With an adapter on top all requirements of IEC 60859 are met and the insulator can be pre-installed into the switchgear at the manufacturing site. The insulator is factory tested.

2.2 Description Plug-in Part

The plug-in part consists of the conductor connector, the prefabricated and pre-tested stress cone and the appropriate cable gland. The conductor connector is available either in mechanical connection or crimping technology. Multiple contact elements at the top of the connector stud provide the current connection to the embedded electrode of the insulator housing. The rubber electrical stress cone installed onto the cable insulation limits the electrical stress of the cable insulation and the switchgear housing within the design performance.

2.3 Description Cable Gland

A spring loaded compression device including a sealing of the cable oversheath and switchgear housing is part of the cable gland. The compression device exerts forces on the stress cone to provide occurrence perfect electrical interface fit between cone and insulator housing.



The termination is a dry type version of a switchgear termination. The compact dimensions of the maintenance-free design allow multiple connections and disconnections .

3. Test Set-up

For type testing of the 145 kV plug-in termination a test arrangement was installed with a 15 m long 110 kV XLPE cable with copper conductor of 630 mm² conductor cross section (Annex 2), a test termination and the plug-in termination. The switchgear housing was completed with an outdoor/SF₆ bushing. The bushing and the test termination were connected to form a loop and to facilitate conductor heating. The test arrangement and the position of the thermocouples is shown in annex 3.

4. Test Program

The type test was carried out in accordance with VDE 0276, part 632, edition may 1999 and IEC 60840, edition 1988.

Additional tests were carried out following the "Bewag *)-Vorschrift für 110-kV-VPE-Kabel-und deren Garnituren, Ausgabe TKT 04.98": Short duration AC voltage test and a test at the insulating flange at the insulator with DC voltage and impulse voltage. Both versions of the conductor connection (compression and screwing technique) inside the termination were tested with high current following the VDE 0670 T1000, edition 1998.

*) BEWAG = Berliner E- Werke AG

List of type test program:

- Short duration AC voltage test with 275 kV
- Partial test with 1,5 U_o
- Heating cycle voltage test with 2 U_o
- Impulse voltage test with 650 kV
- AC voltage test with 2,5 Uo
- Partial discharge test with 1,5 U_o
- DC voltage test at the insulating flange with 20 kV
- Impulse voltage test at the insulating flange with 37,5 kV
- High current test
- 5. Test Procedure
- 5.1 Short Duration Test

The test was successfully carried out with 275 kV for 1 minute (Annex 4).

5.2 Partial Discharge Test

The partial discharge test was carried out with 1,5 Uo = 114 kV. At a interference level of 1



pC no discharge from the test installation was detected (Annex 5).

5.3 Heating Cycle Voltage Test

The temperature correlation is given in appendix 6 between conductor temperature and temperature at the outer plastic cable sheath.

With a current of 1600 A the conductor temperature of 95 °C was reached after 6 hours. The temperature was maintained within the limits between 95 to 100 °C for 2 hours. A natural cooling period of 16 hours followed the heating period. The temperature of the outer plastic cable sheath is shown in annex 7 to 10.

The cycle of heating and cooling was carried out 20 times. During the whole test a voltage of 2 Uo was applied (annex 11).

No flashover or breakdown did occur.

5.4 Impulse Voltage Test

The test installation was again heated to a temperature 95 to 100 $^{\circ}$ C (Annex 12). The test was carried out with ten positive and ten negative impulses with a peak of 650 kV (Annex 13).

The diagrams are shown in annex 14 and 15.

No breakdown or flashover did occur.

5.5 AC Voltage Test

After the impulse test the test circuit was subjected to an AC voltage of 2,5 U_0 = 190 kV for 15 minutes (annex 16).

5.6 Partial Discharge Test

The partial discharge test was carried out with 1,5 $U_o = 114$ kV. At a interference level of 1 pC no discharge from the test installation was detected (Annex 17).

5.7 DC Voltage Test at the insulating Flange

The insulating flange was tested with a DC voltage of 20 kV for 1 minute (annex 18). The test arrangement passed the test successfully.

5.8 Impulse Voltage Test at the insulating Flange

The impulse voltage test was carried out with ten positive and ten negative impulses with a peak level of each 37,5 kV (annex 19). The test arrangement passed the test successfully.

5.9 High Current Tests

Two complete terminations were installed on a 110 kV cable with a conductor connection in compression and in screwing technique. Both installations were then subjected to a high current test plant. The test were carried out with 50 kA for 1 s , 40 kA for 3 s and with an impulse current of 125 kA for 0,1 s. The test circuit was not damaged dur-



ing this test (annex 20).

6. Result

The plug-in termination type KSEV-C, version 5.1 has successfully passed all tests according to VDE 0276, part 632, edition may 1999 and IEC 840, edition 1988.

Felten & Guilleaume Kabelwerke GmbH Development HV Cable Accessories

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Enclosures



1	conductor size, copper	630	mm ²
	diameter over conductor	30.0	mm
2	conductor screen approx.	1.4	mm
3	XLPE insulation triple extruded	18.0	mm
4	insulation screen approx.	1.0	mm
5	semi-conducting bedding		
6	cross section of copper screen, wires + tape longitudinally watertight	35	mm²
7	CWF tape (copper woven fabric tape)		
8	APL sheath consisting of : - coated aluminium tape - PE oversheath, thickness	3.4	mm
	diameter over completed cable approx.	83	mm



FELTEN & GUILLEAUME KABELWERKE GMBH Single Core XLPE Cable 2XS(FL)2Y 1 x 630 RM/35 64 / 110 kV

EHP	8	418/2
Scale	ι	1:1
Drawn	1	23.07.97 Al
Checked	1	23.07.97
Revision	:	V

Prüfprotokoll



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FaG			A	C-Voltage	e Tes oltage te	st st			Anne	x 4			
Test :		Туре Те	st Plug-ir	n Switchgear	ear Termination for U _m =145 kV								
Specifica	ation :	IEC 840,	edition 19	988			_						
Cable ty	pe :	N2XS (F	L) 2Y 1	x 630 RM /	35 64	4/110	kV						
Order No	o :				Lengt	h of sa	imple :		15 m				
Outdoor	-Term. :	Test	terminat	ion	Term Draw	Type ing No:	: KSE\ ET5 I	/-C, Ver KEW 10	rsion 5.1 208				
Swite	h on	Swite	h off	Voltage		h-co	unter	Durati	on of test				
Date	Time	Date	Time	kV		On	Off	h	min	Sign			
2.6.98	9.48	2.6.98	9,49	275		0			1	Be			
									1				
							E						
			3										
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	2.1												
										74 1			

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behalten vgültig in on F&G	Test :	Туре Те	est Plug-in Sw	vitchgear Tern	nination for U _m =	:145 kV	2							
ch vor te, gleich igung v	Specification	n : IEC 840,	edition 1988											
usdrückli an Drit Genehm	Cable type :	N2XS (F	FL) 2Y 1 x 6	30 RM / 35 6	64 / 110 kV	10 kV								
schte al eilunger nrittliche	Order No :			Length	of sample :	15 m								
Alle Ro oder Mitt ohne sch	Outdoor Ter	m. : Test te	ermination	Term Drawir	Type : KSEV- ng-No: ET5 Ki	C, Version 5.1 EW 10208								
	Adju	Adjustment and calibration of the test circuit												
	Calil	Calibration impulse: 2 pC												
		- at the cable end remote from the detector $2pC = 10mm$ - at the cable end near the detector												
	Basic interference level <u><1 pC 1 5 mm</u>													
	Partial discharge mearuring													
	Date	Voltage	Interfere	ence level	Partial discha	arge intensity	Sign							
		kV	mm	рС	mm	pC								
	2.6.98	114	<5	<1	< 5	<1	Be							
nitted														
on or iss not perr		-												
eproduct itever is F&G.														
erved. R form whe ority from														
trictly res in any ten autho														
rights st d parties rout writ	Datei: E145TE1.DOC													

FaG	Correlation of	the temperature	Annex 6					
Test :	Type Test Plug-in Swite	chgear Termination for U _m =14	45 kV					
Specification :	IEC 840, edition 1988							
Cable type :	N2XS (FL) 2Y 1 x 630	RM/35 64/110 kV						
Order No :		Length of sample :	15 m					
Outdoor Term. :	Test termination	Term-Type : KSEV-C Drawing-No: ET5 KEV	, Version 5.1 N 10208					

Temperature drop between conductor and sheath dependent on the heating current



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FaG			He	ating Heatin	Cyc ng prot		st		Annex	Annex 7	
Test :		Type Tes	t Plug-	in Swit	tchge	ar Term	inatior	for U _m =145	kV		
Specificat	ion :	IEC 840, e	dition 1	1988							
Cable typ	e :	N2XS (FL	.) 2Y	1 x 63	0 RM	/ 35 6	4 / 110) kV		COLL PERS	
Order No	:					Length	of sar	nple :	15 m		
Outdoor T	erm. :	Test ter	minatio	on		TermType : KSEV-C, V Drawing-No: ET5 KEW			ersion 5.1 10208		
				Sheat at the	h temj therm	perature ocouple		Ambient- temperature			
		Current	1	2	3	4		6	Heating cycle		
Date	Time	А	°C	°C	°C	°C	°C	°C	No	Sign	
5.6.98	7.00	0	21	21	21	21		21	1.	ze	
5.6.98	13.00	1600	55	43	52	34		23		Se	
5.6.98	15.00	1600	57	45	54	35		24		Se	
6.6.98	7.00	0	23	23	23	23		23	2.	3	
6.6.98	13.00	1600	54	43	52	34		23		Be	
6.6.98	15.00	1600	56	44	53	35		23		Se	
7.6.98	7.00	0	23	23	23	23		23	3.	Be	
7.6.98	13.00	1600	54	42	51	31		22		Be	
7.6.98	15.00	1600	56	43	52	33		21		3e	
8.6.98	7.00	0	22	22	22	22		22	4.	Je	
8.6.98	13.00	1600	52	42	S٨	31		21		Fe	
8.6.98	15.00	1600	53	43	52	32		21		Be	
9.6.98	7.00	0	22	22	22	22		22	S.	Ze	
9.6.98	13.00	1600	52	42	SO	31		22		3e	
9.6.98	15.00	1600	53	43	51	32		22		k	
10.6,98	7.00	0	22	22	22	22		22,	6.	3e	
10.6.98	13.00	1600	53	42	50	31		22		3e	
10.6.98	15.00	1600	54	43	51	32		22		k	

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Heating Cycle Test

Annex 8

Test :		Type Test	t Plug-i	in Swit	chgea	ar Term	inatior	for U _m =145	kV		
Specificat	ion :	IEC 840, e	dition 1	988		6					
Cable typ	e:	N2XS (FL) 2Y	1 x 630	RM	/ 35 64	4/110) kV			
Order No	:					Length of sample :			15 m		
Outdoor T	erm. :	Test terr	minatio	n		Term1	Type :	KSEV-C, V	ersion 5.1		
						Drawing	g-No:	ET5 KEW	10208		
				Sheath at the	h temp thermo	perature locouple		Ambient- temperature			
		Current	1	2	3	4		6	Heating cycle		
Date	Time	А	°C	°C	°C	°C	°C	°C	No	Sigr	
11.6.98	7.00	0	21	21	21	21		21	7.	Be	
11.6.98	13.00	1600	54	43	51	32		22		Be	
11.6.98	15.00	1600	55	44	52	33		22		Be	
12.6.98	7.00	0	20	20	20	20		20	8.	Be	
12.6.98	13.00	1600	52	41	50	30		20		Be	
12.6.98	15.00	1600	54	42	51	31		20		Be	
13.6.98	7.00	0	19	19	19	19		19	9,	R	
13.6.98	13.00	1600	53	41	SO	31		20		Be	
13.6.98	15.00	1600	54	42	50	32		20		Be	
14.6.98	7.00	0	19	19	19	19		19	10.	Ze	
14.6.98	13.00	1600	52	40	50	31		19		30	
14.6.98	15.00	1600	53	41	50	32		19		Be	
15.6.98	7.00	0	20	20	20	20		20	11.	Be	
15.6.98	13.00	1600	52	41	50	31		20		Be	
15.6.98	15.00	1600	53	42	S1	32		20		Be	
16.6.98	7.00	0	20	20	20	20		20	12.	Re	
16.6.98	13.00	1600	52	41	50	30		20		Be	
16.6.98	15.00	1600	53	42	51	31		20		Be	

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FaG			Неа	ating _{Heatin}	Cyc g prote		st		Annex	9
Test :		Type Test	Plug-i	in Swit	chgea	ar Termi	inatior	for U _m =145	kV	
Specificat	ion :	IEC 840, e	dition 1	988						
Cable type	е:	N2XS (FL) 2Y	1 x 630	RM	/ 35 64	4 / 110) kV		
Order No	:					Length	of san	nple :	15 m	
Outdoor T	erm. :	Test terr	minatio	n		Term1 Drawin	Гуре : g-No:	KSEV-C, V ET5 KEW 1	ersion 5.1 10208	
				Sheath at the t	n temp therm	oerature ocouple		Ambient- temperature		
		Current	1	2	3	4		6	Heating cycle	
Date	Time	А	°C	°C	°C	°C	°C	°C	No	Sign
17.6.98	7.00	0	20	20	20	20		20	13,	le
17.6.98	13.00	1600	52	41	50	29		20		Be
17.6.98	15.00	1600	53	42	50	30		20		Je
18.6.98	7.00	0	20	20	20	20		20	14.	Re
18.6.98	13.00	1600	51	40	48	29		19		Be
18.6.38	15.00	1600	52	41	49	30		19		B
19.6.98	7.00	0	20	20	20	20		20	15.	R
19.6.98	13.00	1600	54	42	50	31		21		Be
19.6.98	15.00	1600	55	43	51	32		22		Be
20.6.98	7.00	0	21	21	21	21		20	16.	Be
20.6.98	13.00	1600	55	42	52	34		23		Be
20.6.98	15.00	1600	57	44	53	35		23		Be
21.6.98	7.00	0	23	23	23	23		23	17.	Re
21.6.98	13.00	1600	54	43	51	32		23		Be
21.6.98	15.00	1600	56	44	52	33		23		R
22.6.98	7.00	0	23	23	23	23		22	18.	Be
22.6.98	13.00	1600	54	43	SI	33		22		Be
22.6.98	15.00	1600	55	44	S2	34		22		Be

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FaG			He	eating Cyc Voltage prot	cle Test			Annex	: 11			
Test :		Type Tes	st Plug-ir	n Switchgear	igear Termination for U _m =145 kV							
Specifica	ation :	IEC 840, e	edition 19	988								
Cable ty	pe:	N2XS (FI	L) 2Y 1	x 630 RM /	35 64 / 110							
Order No	o :				Length of s	ample :		15 m				
Outdoor-	Term. :	Test t	erminati	on	TermType Drawing No	9 : KSE\ 9: ET5	/-C, Vers KEW 102	ion 5.1 08				
Swite	h on	Switcl	h off	Voltage	h-co	ounter	Duratio	n of test				
Date	Time	Date	Time	kV	On	Off	h	min	Sign			
5,6,98	7.00	25.6.98	8.00	152	0	481	481		Be			
				-								
				- P22								
								1 - S M				
		- Concerne										

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FaG			Impu	llse ∖ _{Heatin}	/olta		est		Annex	12
Test :		Type Test	t Plug-i	in Swit	chge	ar Term	inatior	n for U _m =145	kV	
Specificat	ion :	IEC 840, e	dition 1	988		1				
Cable type	e :	N2XS (FL	.) 2Y	1 x 630	RM	/ 35 6	4 / 110) kV		
Order No	:					Length	of san	nple :	15 m	
Outdoor T	erm. :	Test terr	minatic	on		Term Drawin	Type : g-No:	KSEV-C, V ET5 KEW 1	ersion 5.1 10208	
				Sheath at the	n tem therm	perature locouple		Ambient- temperature		
		Current	1	2	3	4		6	Heating cycle	
Date	Time	А	°C	°C	°C	°C	°C	°C	No	Sign
17.7.98	2.00	0	21	21	21	21		21		Be
17.7.98	8.00	1600	55	43	52	33		21		se
17.7.98	10.00	1600	57	45	53	3 34		22		Be
						-				
	_									1

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Datei: E145HEIZ2.DOC

Fal	G	1	Impulse	Volta	age Te	st		Anne>	¢ 13		
Test :	Т	ype Test	Plug-in Sv	vitchge	ar Termi	nation for l	J _m =145	kV			
Specifi	cation : I	EC 840, ed	lition 1988				_				
Cable	type : N	2XS (FL)	2Y 1x6	30 RM	/ 35 64	/ 110 kV					
Order I	No :				Length of sample : 15 m						
Outdoo	or Term. :	Test term	iination		TermT Drawing	ype: KSI I-No: ET{	EV-C, Ve 5 KEW 1	ersion 5.1 0208			
Condu	actor temperati	ure :	95	°C	2						
Date	Charge voltage kV	Impulses number	Impulses counted	Impul	se voltage kV	Polarity	Re	emarks	Sign		
17.7.98	30	Λ	35-1	3	25	+			Be		
	39	2		4	23	+					
	48	3		S	21	+					
	60	4-13	10	68	52	+	Ann	ex 14			
	30	14		3:	24	-					
	39	15		4:	21	-					
_	48,2	16		5	20	-		0			
	60,3	17-26	10	64	-8	-	Ann	ex 15			
					List						
	A										
				-				_			
		_					8	-			
				8.1							
							E				

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F&G			A	AC-Voltage	e Test Itage test			Anney	x 16
Test :		Туре Те	st Plug-i	n Switchgear	Terminatio	on for U _m =	145 kV		
Specifica	ation :	IEC 840,	edition 1	988					
Cable ty	pe :	N2XS (F	FL) 2Y 1	1 x 630 RM /	35 64 / 11	10 kV			
Order N	o :				Length of	sample :		15 m	
Outdoor	-Term. :	Test	terminat	lion	TermTyp Drawing N	be∶KSE\ lo:ET5l	/-C, Ver KEW 10	sion 5.1 208	
Swite	h on	Swite	h off	Voltage	h-e	counter	Duratio	on of test	
Date	Time	Date	Time	kV	On	Off	h	min	Sign
17.7.98	12.00	17.7.98	12.15	190	0	D.25		15	Be
-									
			_						
	_								
				-					
				3	-				
							8	-	
			_						
							0		

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FaG	Partial Discharge Test After Impulse voltage test					Annex 17			
Test :	Type Test Plug-in Switchgear Termination for U _m =145 kV								
Specification	pecification : IEC 840, edition 1988								
Cable type :	N2XS (F	EL) 2Y 1 x 63	30 RM / 35 6	4 / 110 kV					
Order No :			Length	Length of sample : 15 m					
Outdoor Ten	m. : Test te	ermination	Term Drawin	Type : KSEV- ng-No: ET5 K	C, Version 5.1 EW 10208				
Adju	stment and ca	libration of the	e test circuit						
Basi	- at the cable - at the cable ic interference	e end remote e end near the level	from the dete	<1p	c 1 5mm	<u>n</u>			
Parti	ial discharge n	nearuring							
Date	Voltage	Interfere	ence level	Partial discha	arge intensity	Sigr			
	kV	mm	pC	mm	pC	2			
20.7.98	114	<5	<1	25	<1	Be			
1									
				123.010.0.0	_				

FaG		DC-Voltage Test At the insulating flange							Annex 18	
Test :		Туре Тез	st Plug-ir	n Switchgear	Terminatio	n for U _m =	145 kV			
Specifica	ation :	IEC 840,	edition 19	988						
Cable ty	pe:	N2XS (F	L) 2Y 1	x 630 RM /	35 64/11	0 kV				
Order No :					Length of s	15 m				
Outdoor-Term. : Test termination					TermType: KSEV-C, Version 5.1 Drawing No: ET5 KEW 10208					
Switch on Switch off V			Voltage	h-c	on of test					
Date	Time	Date	Time	kV	On	Off	h	min	Sign	
22.7.98	8.10	22.7.98	8.11	20	0			Λ	Be	
2										
	-									
							2			
	-									
			- 8.1				1 m			

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Datei: E145spgs.DOC

Fa		Impulse Voltage Test At the insulating flange						Annex 19	
Test :	Т	ype Test	Plug-in Sv	vitchge	ar Termir	nation for U _m	=145	kV	
Specifi	cation : IE	EC 840, ed	ition 1988						
Cable t	ype: N	I2XS (FL)	2Y 1x6	30 RM	/ 35 64	/ 110 kV			
Order N	No :				Length o	of sample :		15 m	
Outdoo	or Term. :	Test term	ination		TermT	ype∶KSE\ -No:ET5∤	/-C, Ve KEW 1	ersion 5.1 0208	
Condu	ictor temperati	are :		°C	2				
Date	Charge voltage kV	Impulses number	Impulses counted	Impul	se voltage kV	Polarity	Re	emarks	Sign
22.7.98	20	Λ		22,8		+			Be
	30	2		33,2		+			
	31,6	3		35		+			
	33,6	4-13	10	37,5		+			
	16	14	-	15		-			
	21	15		24.2		-	× ×		
	26	16		30,5		-		-	
	33,9	17-26	10	37.5		-			
	3								
								-	
								115	

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Datei: E145stiso.doc





Annex 20

Prüfbericht

PB- 8000--068-001

Auftrag Nr.:

9900224

Auftraggeber:

Hersteller:

Prüfgegenstand:

Typbezeichnung:

Herstelldatum:

Prüfspezifikation:

Durchgeführte Prüfungen: Felten & Guilleaume Kabelwerke GmbH Schanzenstr.24 D-51063 Köln

siehe Auftraggeber

Kompaktendverschluß

1. Prüfling: Zeichnung 3.7 6501-01 2. Prüfling: Zeichnung 3.7 6501-02

. .1999

in Anlehnung an VDE0670T1000:1998

Hochstromprüfungen 1) Icw=40kA, 1sek; Ipk=100kA, 100msek 2) Icw=50kA, 1sek; Ipk=125kA, 100msek 3) Icw=40kA, 3sek

Prüfergebnis:

Seitenzahl gesamt:

Ausstelldatum:

bestanden

89 (1 Deckblatt, 86 Dokumentationsseiten, 2 Anlagen)

16.03.1999

Leiter Prüflaboratorium Bonn



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Klöckner-Moeller ist Mitglied der Gesellschaft zur Prüfung und Zertifizierung von Niederspannungsgeräten.



Das Prüflaboratorium Bonn der Klöckner Moeller GmbH ist in das ALPHA und LOVAG Register zugelassener Prüflaboratorien aufgenommen. (ID-Nr.: D01)

Prüflaboratorium Bonn, Klöckner-Moeller GmbH, Hein-Moeller-Straße 7-11, D-53115 Bonn (FO-101-043-199809;1/1)