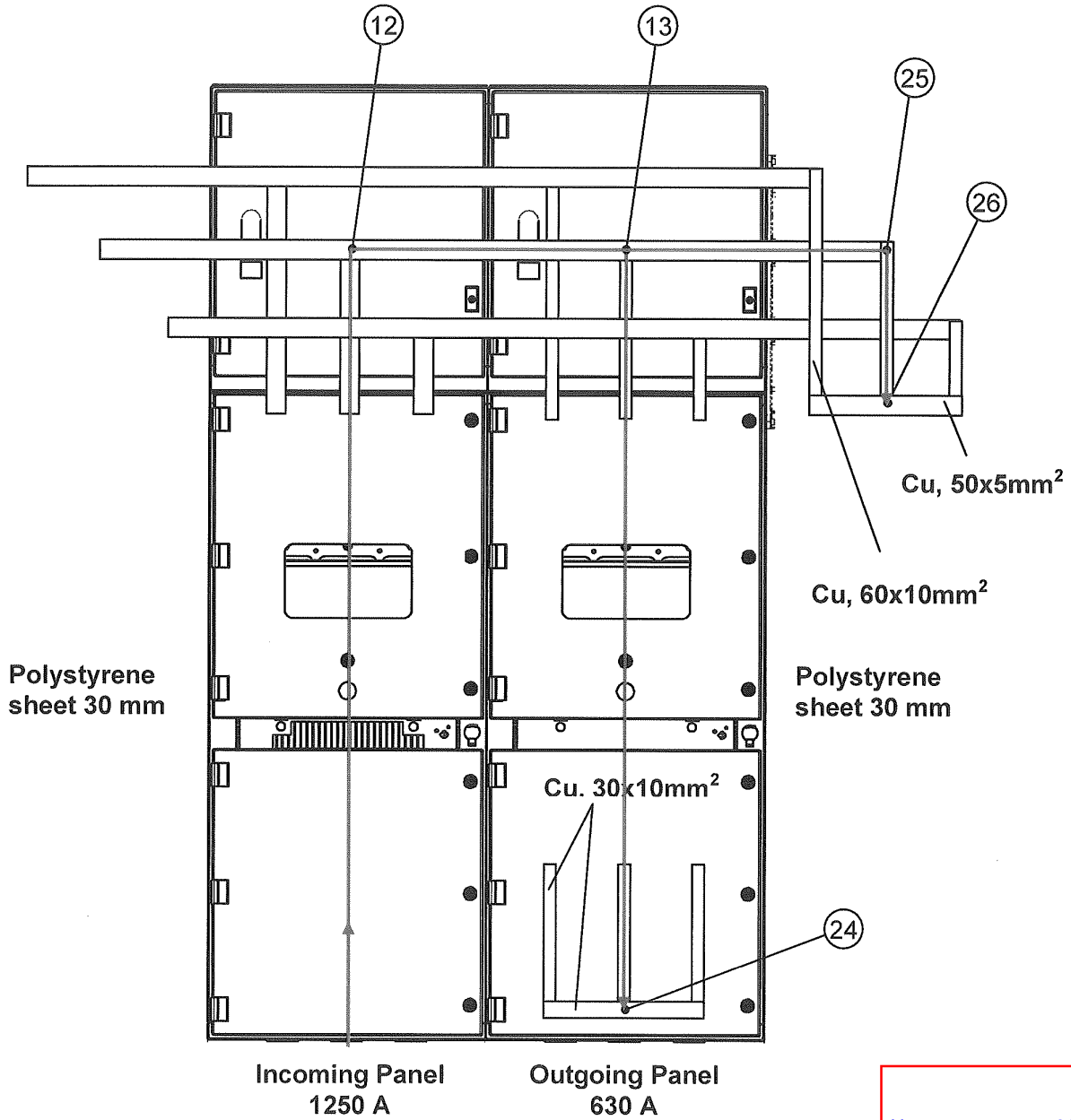


Test Arrangement and Measuring Points for Temperatures and Resistances of Panels and Busbar

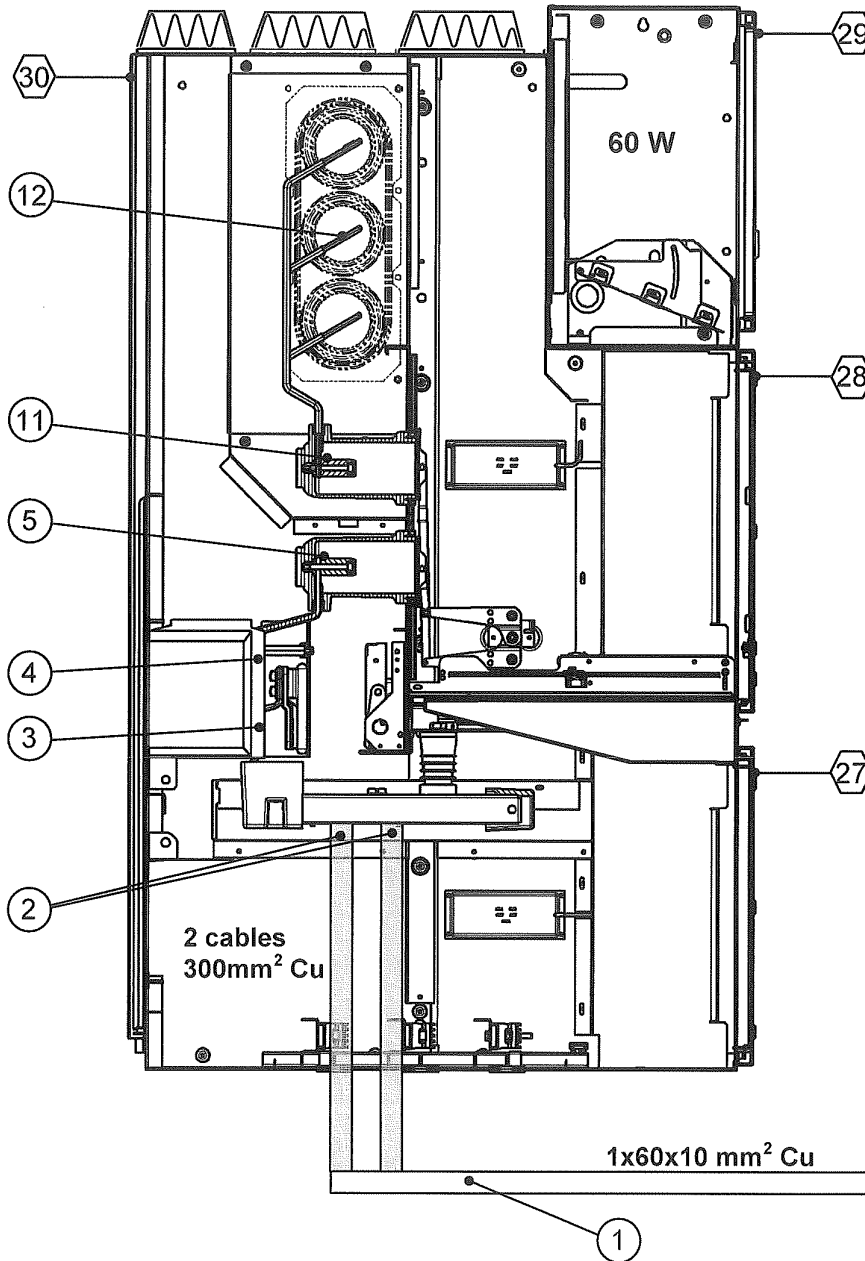


○ Measuring points (L1, L2, L3)

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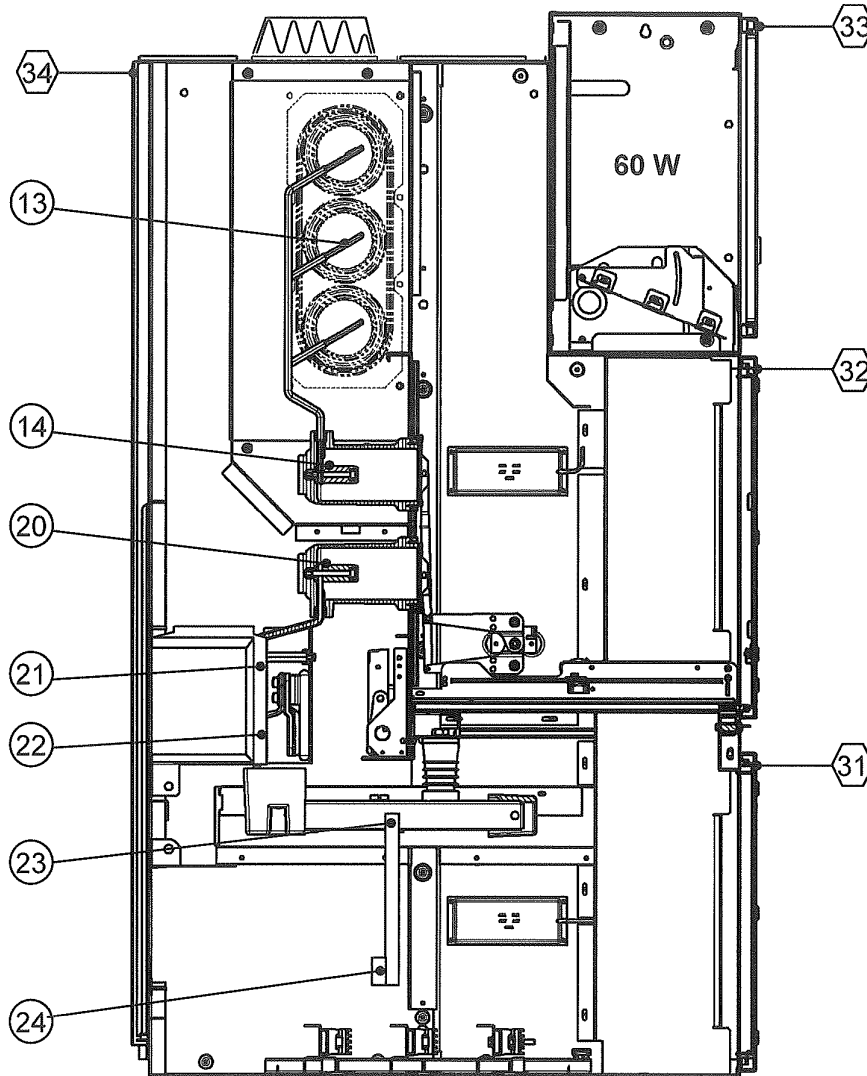
Measuring Points for Temperatures and Resistances of Incoming Panel 1250 A



- Measuring points (L1, L2, L3)
- ⬡ Measuring points (accessible parts)

000302

Measuring Points for Temperatures and Resistances of
Outgoing Panel 630 A

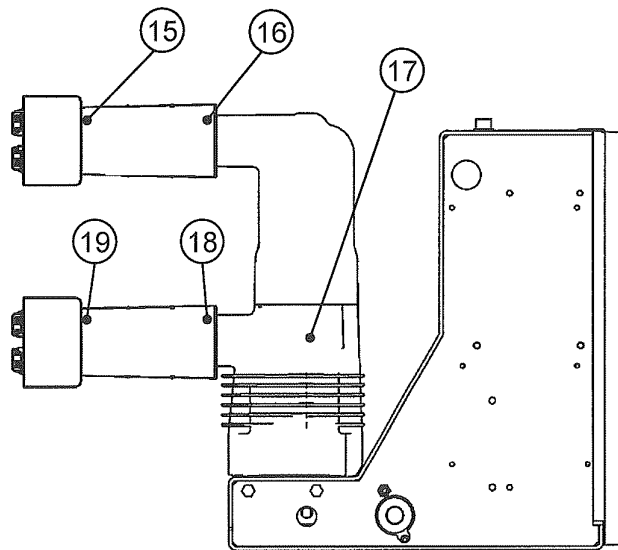
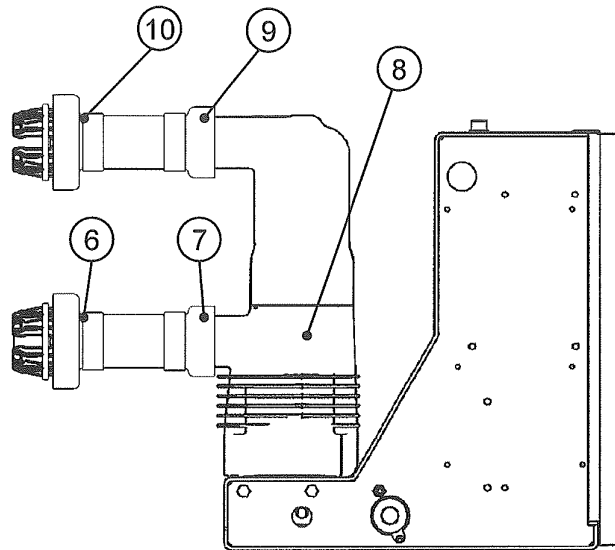


- Measuring points (L1, L2, L3)
- ⬡ Measuring points (accessible parts)

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Measuring Points for Temperatures and Resistances of Circuit-Breakers of both Panels / 1250 A and 630 A



○ Measuring points (L1, L2, L3)

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000604

Measurement of the Resistance of the Main Circuit

Test performed: Measurement of the resistance of the main circuit before and after temperature-rise test
Date of test: 27th November 2009
Condition of test object: Test object was pre-stressed by dielectric and temperature-rise type tests

Measurement before test No. HZ 134 E 47			
Ambient air temperature:		22.1 °C	
Resistance measurement at direct current of:		100 A	
Measurement between points (see sheets 13 to 16)	Resistance of the main circuit $\mu\Omega$		
	L1	L2	L3
2 - 12	91.1	84.0	81.4
6 - 10	22.8	22.5	22.1
12 - 13	14.9	14.8	15.1
13 - 23	129	120	116
15 - 19	39.4	36.4	40.6
2 - 23	228	213	206

Remarks: The measurement of the resistances is carried out by using the thermocouples at the named measurement points.

Date of test: 28th November 2009
Condition of test object: As after temperature-rise test HZ 134 E 47.

Measurement after test No. HZ 134 E 47			
Ambient air temperature:		22.8 °C	
Resistance measurement at direct current of:		100 A	
Measurement between points (see sheets 13 to 16)	Resistance of the main circuit $\mu\Omega$		
	L1	L2	L3
2 - 12	86.6	80.8	78.8
6 - 10	21.6	21.9	21.7
12 - 13	14.9	14.9	15.0
13 - 23	122	114	109
15 - 19	37.2	34.9	38.1
2 - 23	224	210	203

Remarks: The measurement of the resistances is carried out by using the thermocouples at the named measurement points.

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Test Results

Temperature-Rise Test

Test performed: Three phase temperature-rise test
Date of test: 27th – 28th November 2009
Condition of test object: Test object was pre-stressed by dielectric and temperature-rise type tests
Connections to test object: Infeed of current:

At the cable terminal of the incoming panel via 2 cables 300 mm², length about 0.8 m, extended outside the panel by one bar 60 x 10 mm² Cu, length about 2.0 m

Neutral points:

- At the terminal of the outgoing panel via a short link by one bar 30 x 10 mm² Cu
- At the extended busbar of the outgoing panel via tee-off bar 60 x 10 mm² Cu and a short-link by one bar 5 x 50 mm² Cu

Duration of test: 21 h
Average of ambient air temperature: 25.4 °C
Test frequency: 50 Hz

Test current:

Description	Measuring points (see sheets 13 to 16)	Current A			
		Phase L1	Phase L2	Phase L3	Average value
Incoming Panel	1 - 12	1252	1252	1254	1253
Incoming - Outgoing Panel	12 - 13	1252	1252	1254	1253
Outgoing Panel	13 - 24	650	650	651	650

Measuring point (see sheets 13 to 16)	Description of the measuring point	Nature of the measuring point	Final temperature rise K	Permissible temperature rise K
1	L1	feeder bar 1m before point 2	Bare Cu in air	-
	L2			
	L3			
2	L1	Rear cable at cable terminal incoming panel	Expanded polyethylene cable	50
	L2			
	L3			
3	L1	Lower c.t. terminal incoming panel	Connection, bolted, Cu, one part silver coated in air	75
	L2			
	L3			
4	L1	Upper c.t. terminal incoming panel	Connection, bolted, Cu, one part silver coated in air	46.9
	L2			
	L3			
5	L1	Lower disconnecting contact panel incoming panel	Contact, Cu silver-coated in air	54.3
	L2			
	L3			
6	L1	Lower disconnecting contact c.b. incoming panel	Contact, Cu silver-coated in air	57.8
	L2			
	L3			

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Test Results

Temperature-Rise Test (2)

Measuring point (see sheets 13 to 16)		Description of the measuring point	Nature of the measuring point	Final temperature rise K	Permissible temperature rise K
7	L1	Lower pole terminal incoming panel	Connection, bolted, Cu, silver coated in air	58.1	75
	L2			59.8	
	L3			58.8	
8	L1	Current lead / contact stem c.b. incoming panel	Connection, bolted, Cu, one part silver coated in air	63.4	75
	L2			63.9	
	L3			63.1	
9	L1	Upper pole terminal incoming panel	Connection, bolted, Cu, silver coated in	57.0	75
	L2			56.6	
	L3			56.6	
10	L1	Upper disconnecting contact c.b. incoming panel	Contact, Cu silver-coated in air	59.0	65
	L2			58.7	
	L3			58.1	
11	L1	Upper disconnecting contact panel incoming panel	Contact, Cu silver-coated in air	59.0	65
	L2			58.8	
	L3			57.1	
12	L1	Tee-off / busbar incoming panel	Connection, bolted, Cu, one part silver coated in air	42.4	75
	L2			45.5	
	L3			46.8	
13	L1	Busbar / tee-off outgoing pane	Connection, bolted, Cu, one part silver coated in air	40.4	75
	L2			39.9	
	L3			37.7	
14	L1	Upper disconnecting contact panel outgoing panel	Contact, Cu silver-coated in air	38.8	65
	L2			38.7	
	L3			38.3	
15	L1	Upper disconnecting contact c.b. outgoing panel	Contact, Cu silver-coated in air	39.2	65
	L2			38.7	
	L3			39.0	
16	L1	Upper pole terminal outgoing panel	Connection, bolted, Cu, silver coated in air	36.8	75
	L2			37.1	
	L3			37.6	
17	L1	Contact stem / current lead c.b. outgoing panel	Connection, bolted, Cu, one part silver coated in air	38.2	75
	L2			38.1	
	L3			38.6	
18	L1	Lower pole terminal outgoing panel	Connection, bolted, Cu, silver coated in air	36.3	75
	L2			36.6	
	L3			36.9	
19	L1	Lower disconnecting contact c.b. outgoing panel	Contact, Cu silver-coated in air	35.3	75
	L2			35.3	
	L3			35.0	
20	L1	Lower disconnecting contact panel outgoing panel	Contact, Cu silver-coated in air	30.6	75
	L2			31.3	
	L3			30.6	

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Test Results

Temperature-Rise Test (3)

Measuring point (see sheets 13 to 16)		Description of the measuring point	Nature of the measuring point	Final temperature rise K	Permissible temperature rise K
21	L1	Front c.t. terminal outgoing panel	Connection, bolted, Cu, one part silver coated in air	27.0	75
	L2			27.9 ^{1.)}	
	L3			26.8	
22	L1	Rear c.t. terminal outgoing panel	Connection, bolted, Cu, one part silver coated in air	23.9	75
	L2			24.8	
	L3			23.6	
23	L1	cable terminal outgoing panel	Bare Cu in air	31.6	50
	L2			31.3	
	L3			30.4	
24	L1	Neutral point inside outgoing panel / 630 A	-	37.8	50
	L2			39.2	
	L3			36.8	
25	L1	Extended busbar left side outside panel	-	29.8	75
	L2			26.8	
	L3			25.5	
26	L1	Neutral point outside outgoing panel	-	26.7	-
	L2			26.7	
	L3			26.0	
27	-	Front door cable compartment incoming panel	Accessible part which need not to be touched in normal operation	3.6	40
28	-	Front door c.b. compartment top incoming panel	Accessible part expected to be touched in normal operation	4.8	30
29	-	Front door button of c.b. incoming panel	Accessible part expected to be touched in normal operation	2.9	30
30	-	Front door low voltage compartment top incoming panel	Accessible part expected to be touched in normal operation	7.9	30
31	-	Rear wall top incoming panel	Accessible part which need not to be touched in normal operation	9.9	40
32	-	Front door cable compartment outgoing panel	Accessible part which need not to be touched in normal operation	3.2	40
33	-	Front door c.b. compartment top outgoing panel	Accessible part expected to be touched in normal operation	5.3	На основании чл.36а ал.3 от ЗОП
34	-	Front door low voltage compartment top outgoing panel	Accessible part expected to be touched in normal operation	10.5	

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Test Results
Temperature-Rise Test (4)

Measuring point (see sheets 13 to 16)		Description of the measuring point	Nature of the measuring point	Final temperature rise K	Permissible temperature rise K
35	-	Rear wall top outgoing panel	Accessible part which need not to be touched in normal operation	9.1	40

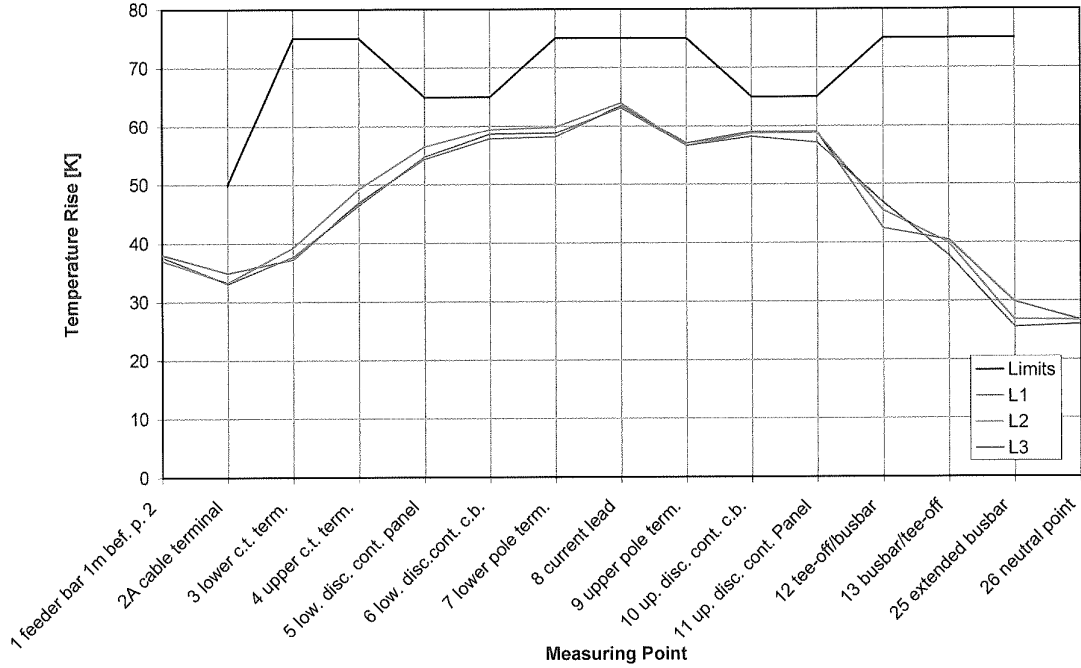
Legend: -

- Remarks:**
- The permitted temperature rises are valid for an ambient air temperature of 40 °C.
 - The sidewalls of the panels were covered by expanded polystyrene sheets of 30 mm thickness.
 - The temperatures were measured by thermocouples type T. For the measuring points of the main circuit the thermocouples were inserted into drilling holes and fixed by peening. For the measuring points of the accessible parts the thermocouples were fixed by a self-adhesive aluminium foil.
 - The measurement system determines the average value of the ambient temperatures calculates the differences to the temperatures of all measuring points and records the temperature rises directly.
 - The measurement interval for currents and temperatures was 10 min.
 - The maximum increase of temperature rise in the last hour was for both panels 0.1 K.
- 1.) The time constant of the incoming panel is 2 h and 20 min (measuring point 4 L2) and of the outgoing panel is 4 h and 10 min (measuring point 21 L2).

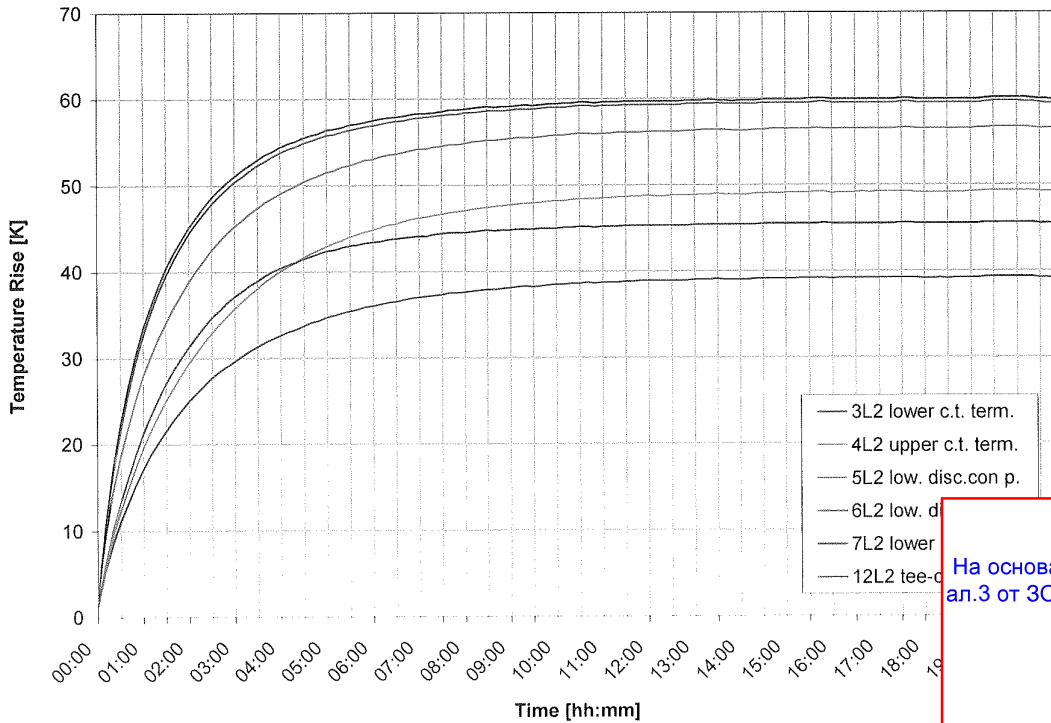
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Temperature Rises and Permitted Temperature Rises of Incoming Panel



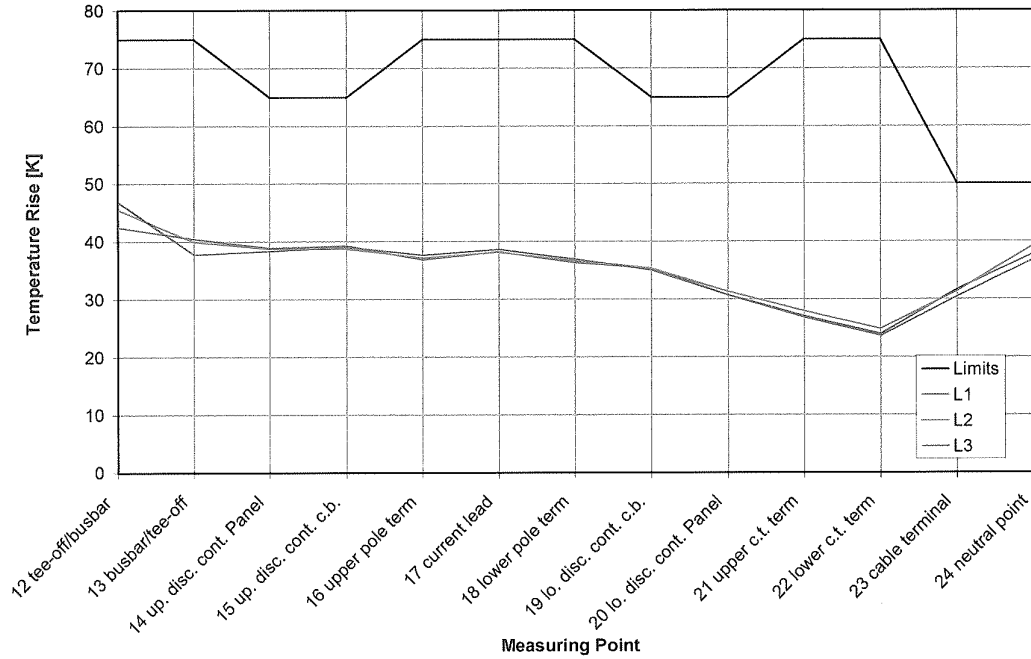
Temperature Rises of Incoming Panel / Phase L2



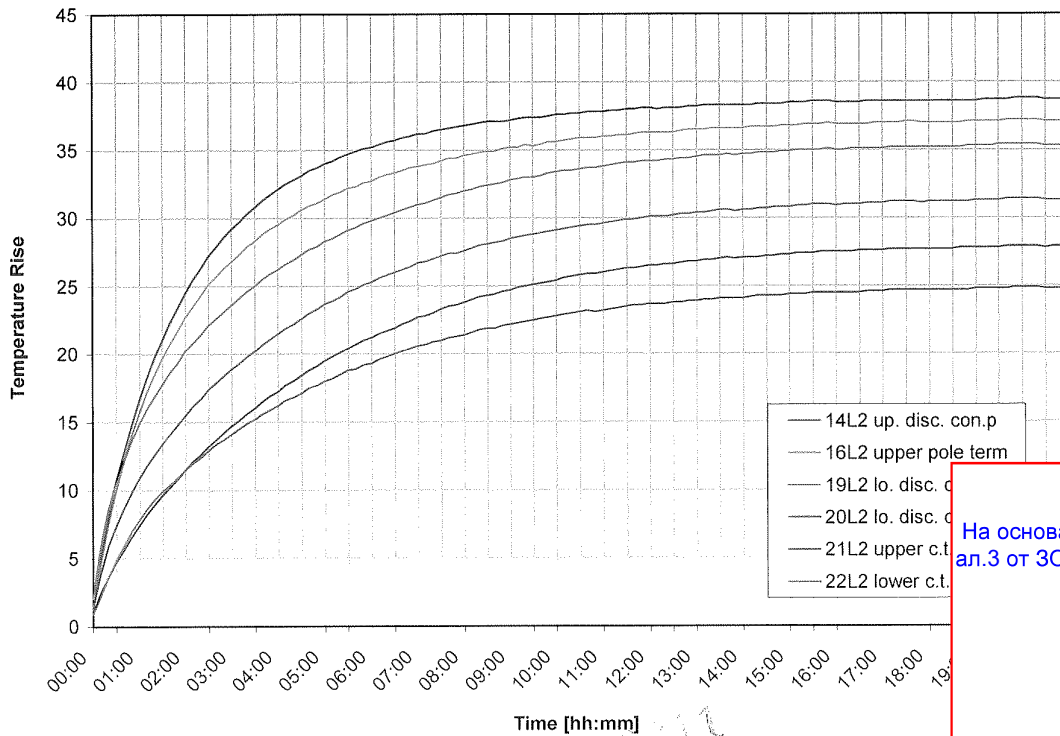
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Temperature Rises and Permitted Temperature Rises of Outgoing Panel



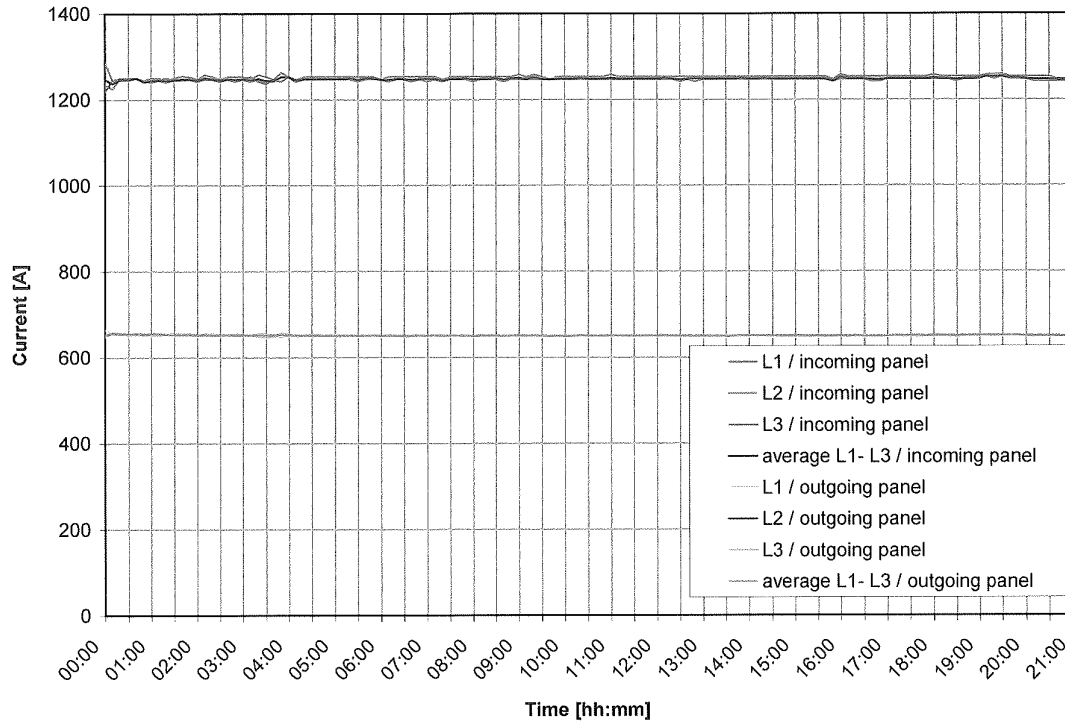
Temperature Rises of Outgoing Panel / Phase L2



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Test Currents



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Photos of Test Object

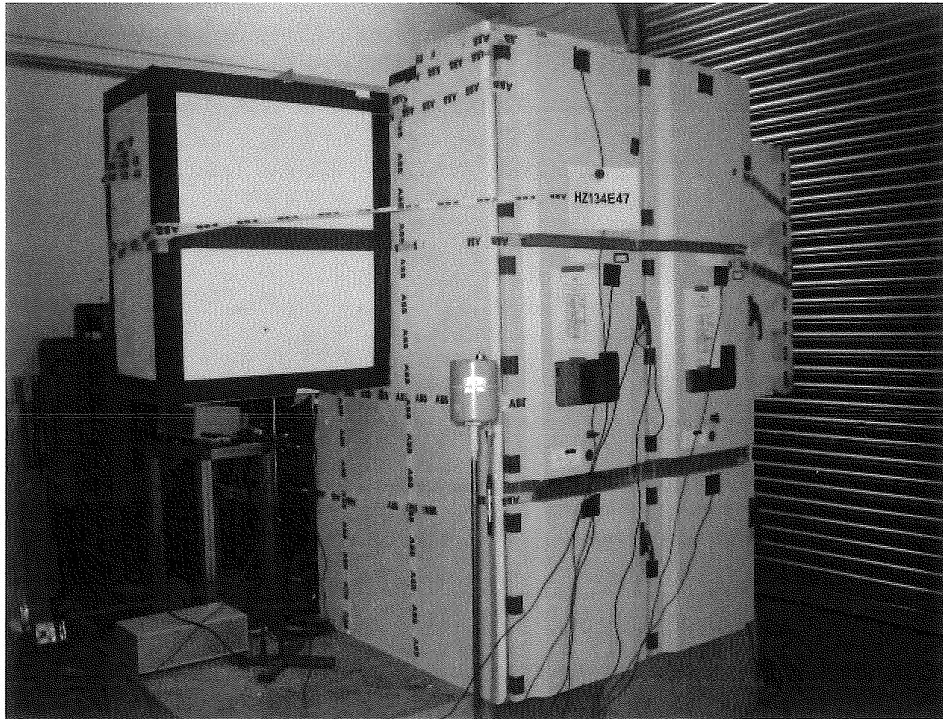


Fig. 1: Front view / left side

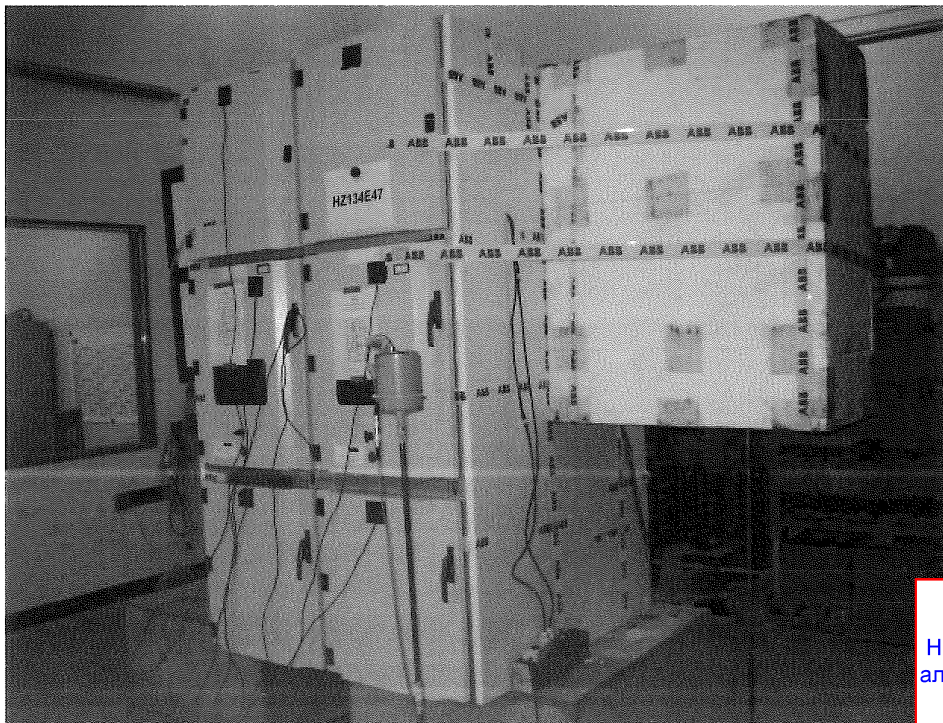


Fig. 2: Front view / right side

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Photos of Test Object

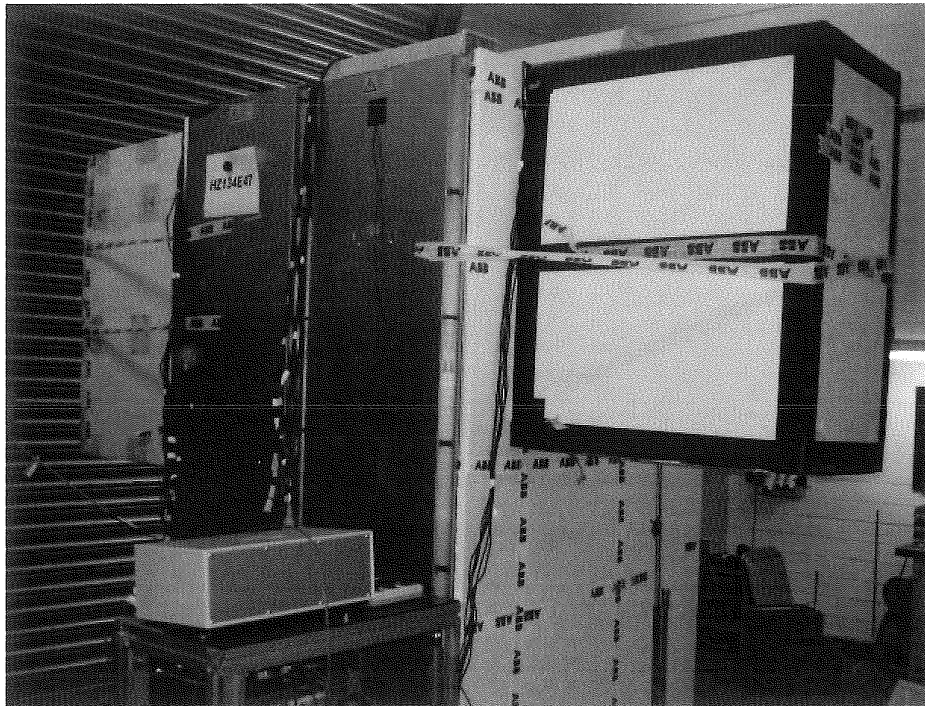


Fig. 3: Rear view / right side



Fig. 4: Top view

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Photos of Test Object



Fig. 5: Circuit-breaker VD4/P 17.12.25

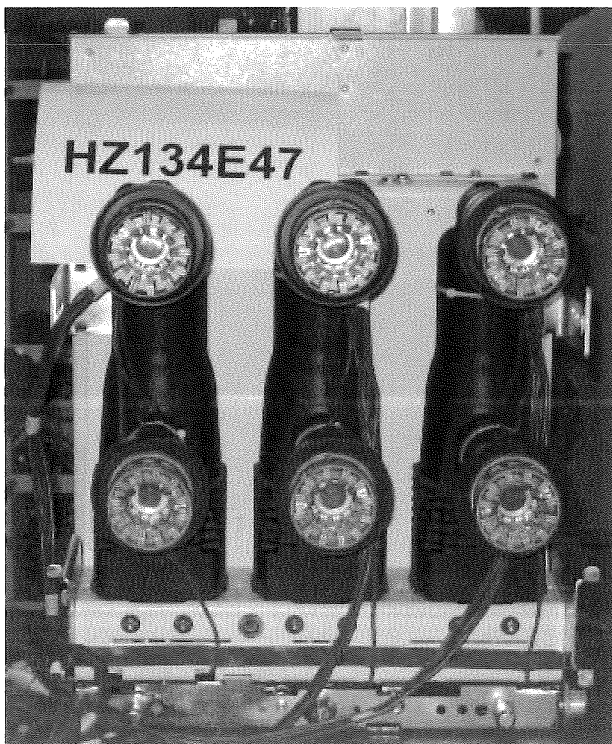


Fig. 6: Circuit-breaker VD4/P 17.12.25

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Photos of Test Object

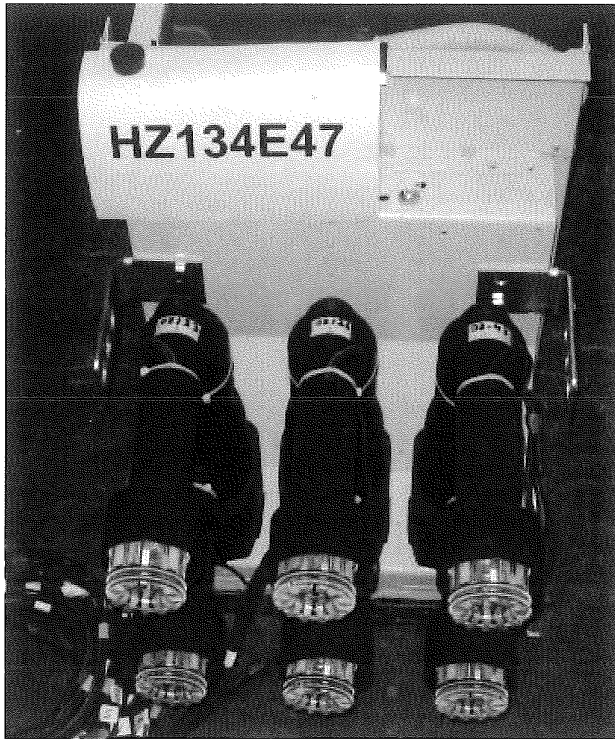


Fig. 7: Circuit-breaker VM1 17.06.25



Fig. 8: Circuit-breaker VM1 17.06.25

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PEHLA

GESELLSCHAFT FÜR ELEKTRISCHE HOCHLEISTUNGSPRÜFUNGEN
Member of the SHORT-CIRCUIT TESTING LIAISON (STL)

Test Report

Report No.: 09070Ra

Copy No.: 0

Contents: 16 Sheets

Test object: Vacuum circuit-breaker for fixed installation in air-insulated switchgear system

Designation: VD4/P 17.12.32 including terminal zone

Rated voltage: 12 kV Rated normal current: 1250 A Rated frequency: 50/60 Hz

Manufacturer: ABB P.T. S.p.A., Dalmine, Italy (circuit-breaker)
ABB AG, Calor Emag Medium Voltage Products, Ratingen, Germany (pole part)
both under license of ABB Technology Ltd., Zürich, Switzerland

Client: ABB Technology Ltd., Zürich, Switzerland

Testing station: PEHLA-Testing Laboratory Ratingen, Germany

Date of test: 20th May 2009

Applied test specifications:

IEC 62271-100, Edition 2.0, 2008-04 clause 6.2,

IEC 62271-1, Edition 1.0, 2007-10 clause 6.2,

and client instructions.

Tests performed:

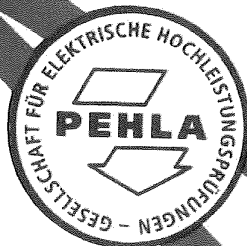
Dielectric type test.

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 circuit breaker.

Additional power-frequency withstand voltage test at 42 kV to earth, between phases and
across open circuit breaker.

Test results:

The vacuum circuit-breaker for fixed installation in air-insulated switchgear system passed the above
mentioned tests successfully. The respective requirements are met.



GESELL
HOCH

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Mannheim, 22nd March 2010

The test results relate only to the items tested.
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document. Copying the cover sheet accompanied by sheet 2 and the sheets mentioned here is
an exception.

03PEU0804



Notes

Accreditation

The PEHLA-Testing Laboratory Ratingen has been approved by the DATech (German accreditation body for technology) according to EN ISO/IEC 17025 for tests in the field of high-voltage switchgear and controlgear and power engineering equipment (Registration-No. DAT-PL-032/93-63).

STL-Member

PEHLA is founder member of the SHORT-CIRCUIT TESTING LIAISON (STL) which has been established in 1969. STL is a forum for the international cooperation of the testing organisations with the further full members ASTA (UK), CESI (IT), CPRI (IND), ESEF (FR), KEMA (NL), SATS (NO, SE, FI), STLNA (US, CA) and JSTC (JP). In the framework of EC, STL (EU) has been recognised in 1992 by EOTC as agreement group.

PEHLA-Documents

A Type Test 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 test object 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 test object 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 test object, and its condition after the tests.

A Test Confirmation

is issued immediately after the tests. It confirms that the tests have been conducted and is valid only until publishing the detailed results in an entire document.

Uncertainty of the measurement systems

The PEHLA - Testing Laboratories apply the PEHLA Guide No. 12 for determining the uncertainties of measurement, based on ENV 13005 (Guide to the expression of uncertainty in measurement). As long as no explicit statements are made, the uncertainties required by the relevant standards have been complied with.

Addresses

Office: PEHLA-Geschäftsstelle
Hallenweg 40
68219 Mannheim
Germany
Internet: www.pehla.com

Testing Station: PEHLA-Testing Laboratory Ratingen
Oberhausener Strasse 33
40472 Ratingen
Germany

Manufacturer circuit-breaker: ABB P.T.S.p.A.
Via Friuli, 4
I-24044 Dalmine
Italy

Manufacturer pole part: ABB AG
Calor Emag Medium Voltage Products
Oberhausener Strasse 33
40472 Ratingen
Germany

Client: ABB Technology Ltd.
Affolternstrasse 44
8050 Zürich
Switzerland

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List of Test Participants

Representatives of Technical Committee:

Mr. Herbert Feld PEHLA-Testing Laboratory, Berlin-Marzahn, Germany
Mr. Rafael Kleine Stegemann PEHLA-Testing Laboratory Ratingen, Germany

Test Engineer / Test Operator:

Mr. Rafael Kleine Stegemann PEHLA-Testing Laboratory Ratingen, Germany

Representatives of Client:

--

Further Participants:

Mr. Gerd Langwieler ABB Laboratories Ratingen, Germany
Mr. Hassan Al Mawla ABB Laboratories Ratingen, Germany

На основании чл.36а
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**Technical Data of Test Object
Circuit-Breaker**

Test object: Vacuum circuit-breaker
Designation: VD4/P 17.12.32
Manufacturer: ABB P.T. S.p.A., Via Friuli, 4, I-24044 Dalmine, Italy
Serial No.: 1VC1AM00011918
Year of manufacture: 2009
Vacuum interrupter: VG4-S
Drawing No.: 1VB7004852R3104

Ratings assigned by the manufacturer:

Rated voltage	12	kV
Rated normal current	1250	A
Rated frequency	50/60	Hz
Rated lightning impulse withstand voltage	75	kV
Rated switching impulse withstand voltage	-	kV
Rated power-frequency withstand voltage	28	kV
Rated peak withstand current	80/82	kA
Rated short-time withstand current	31.5	kA
Rated duration of short-circuit	3	s
Rated short-circuit breaking current	31.5	kA
DC component of the rated short-circuit breaking current	<=30	%
Rated short-circuit making current	80/82	kA
Rated transient recovery voltage	20.6	kV
Rate of rise of transient recovery voltage	0.34	kV/μs
First-pole-to-clear factor	1.5	
Rated operating sequence	O - 0.3 s - CO - 15 s - CO	
Arc extinguishing medium	vacuum	
Rated filling pressure for operation	-	MPa Abs. at 20 °C
Minimum functional pressure for operation	-	MPa Abs. at 20 °C
Insulating medium	air	
Rated filling pressure for insulation	-	MPa Abs. at 20 °C
Minimum functional pressure for insulation	-	MPa Abs. at 20 °C
Driving mechanism (type)	Spring Drive	
Number of poles	3	
Number of units per pole	1	
Rated opening time	33...60	ms
Rated closing time	60...80	ms
Rated supply voltage of opening device	110	V d.c.
Rated supply voltage of closing device	110	V d.c.
Rated supply voltage of auxiliary circuits	110	V d.c.
Rated frequency of supply voltage	-	Hz
Rated line-charging breaking current	-	
Rated cable-charging breaking current	25	

Further data: --

Essential characteristics: --

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List of Identified Drawings

The manufacturer has submitted to the testing laboratory drawings and other data containing sufficient information to unambiguously identify by type the essential details and parts of the test object presented for test.

The drawings have been stamped and signed by the manufacturer in order to guarantee that the drawings or data schedules truly represent the test object to be tested.

Further these drawings have been stamped and signed by PEHLA representatives and are kept

at the client.

with the test documents at the test laboratory.

The testing laboratory has checked that drawings and data schedules adequately represent the essential details and parts of the test object to be tested, but is not responsible for the accuracy of the detailed information.

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

Drawing No.	Rev.	P/D ^{*)}	Title	Additional remarks
1VB7004852R3104	00	D	VM1-Antrieb p=150 31.5kA 12kV VM1-Drive p=150 31.5kA 12kV	-
1VB7004820P0106	00	D	Anschlusszone L1 / L3 unten 12kV 1250A	-
1VB7004820P0101	00	D	Anschlusszone L2 unten 12kV 1250A	-
1VB7004820P0102	00	D	Anschlusszone L1/L2/L3 oben 12kV 1250A	-
1VCR016097G0020	V2544	D	BASE C.B: POLES P1 INTERRUTTORE BASE POLI P1	-
1VCR016097G0020	-	P	BASE C.B: POLES P1 INTERRUTTORE BASE POLI P1	-
1VCR016092G0020	V2544	D	BASE BREAKER POLES P1 ASSEMBLY SOTTOGRUPPO INTERRUTTORE BASE POLI P1	-
1VCR016092G0020	-	P	BASE BREAKER POLES P1 ASSEMBLY SOTTOGRUPPO INTERRUTTORE BASE POLI P1	-
1VCR016089G0001	V2072	D	FRAME+OPERATING MECHANISM P.150 STRUTTURA * COMANDO P.150	-
1VCR016089G0001	-	P	FRAME+OPERATING MECHANISM P.150 STRUTTURA * COMANDO P.150	-

*) P: Parts list, D: Drawing

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List of Identified Drawings (2)

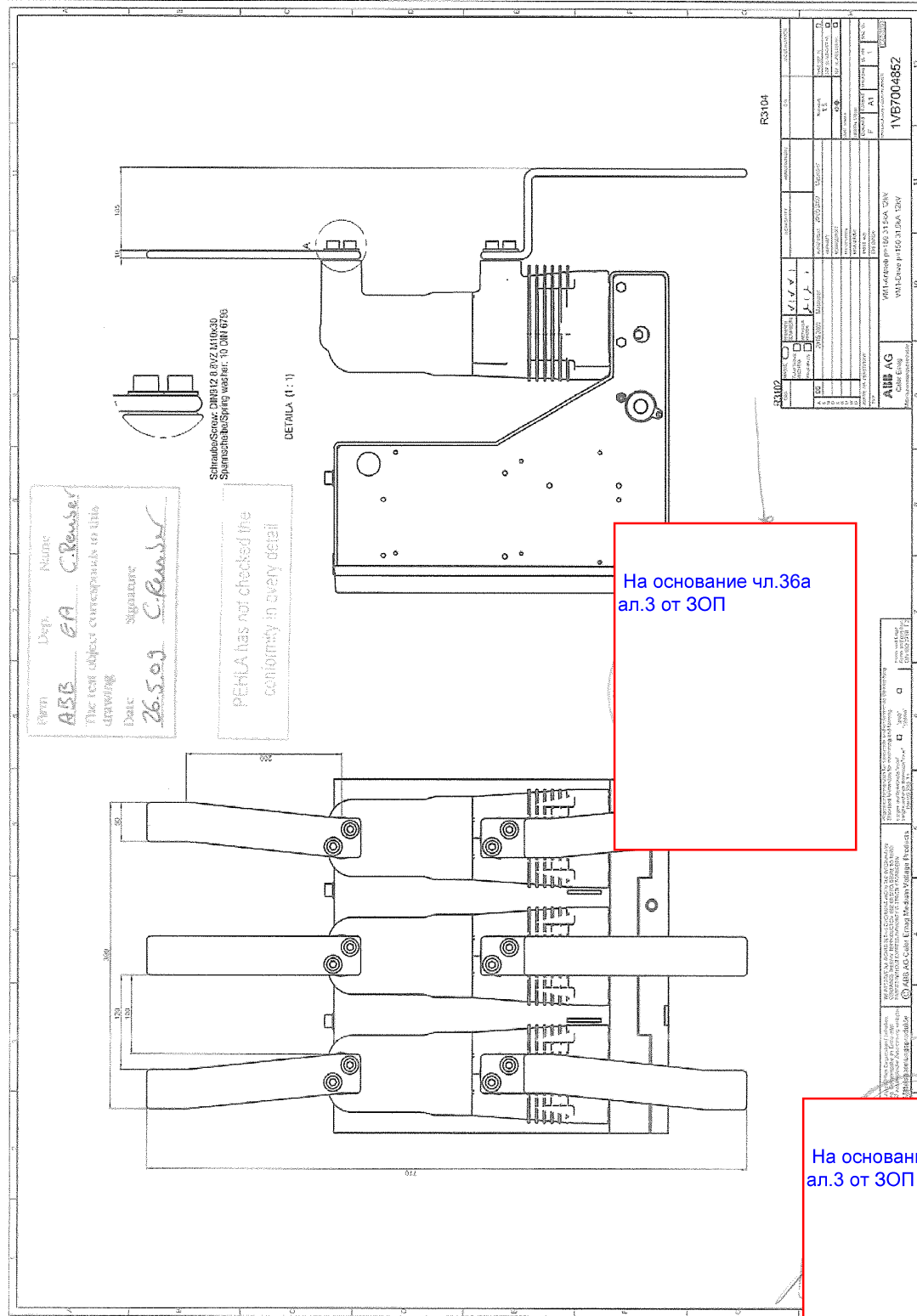
Drawing No.	Rev.	P/D *)	Title	Additional remarks
1VCR003321G0001	V1969	D	COMNADO CON ALBERO OPERATING MECHANISM WITH SHAFT	-
1VB7006200R0103	00	D	Verkaufsgruppe Assembly for sale	-
1VB7006200R0103	-	P	PT1 sales group with VG4S	-
1VB7006200R0102	00	D	Polteil vollständig Pole Complete	-
1VB7006200R0102	-	P	PT1 Pole complete with VG4S	-
GCE7003142R0132	13	D	Antriebsstange vollst. Operation stud compl.	-
GCE7001851P0106	08	D	Sromband VM1 1250A Flexible conductor VM1 1250A	-
1VB7003199P0130	02	D	Abschirmlatte	-
1VB7006200R0101	00	D	Eingießgruppe Mold group	-
1VB7006200R0101	-	P	PT1 mould group with VG4S	-
1VB7003128R0119	02	D	VMTG PT1 mit VG4S	-
1VB7003128R0119	-	P	PT1 VTMG with VG4S	-
GCE7005535R0101	08	D	Assembly Group MTG	-

*) P: Parts list, D: Drawing

Remarks: -

На основание чл.36а
ал.3 от ЗОП

Drawing No. 1VB7004852R3104



Form: ABB
Dept: EA
Name: C. Bensch
The test object corresponds to this drawing.
Date: 26.5.09
Signature: C. Bensch

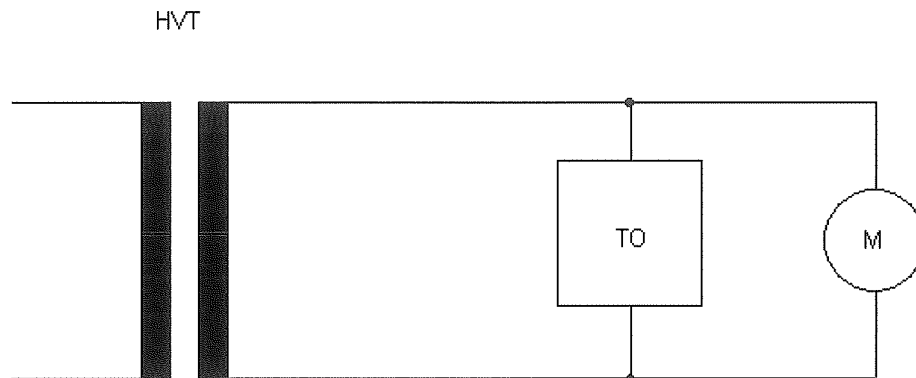
PEHLA has not checked the conformity in every detail

На основании чл.36а ал.3 от ЗОП

На основании чл.36а ал.3 от ЗОП

000522

Technical Data of Test Circuit Power-Frequency Voltage



Technical Data:

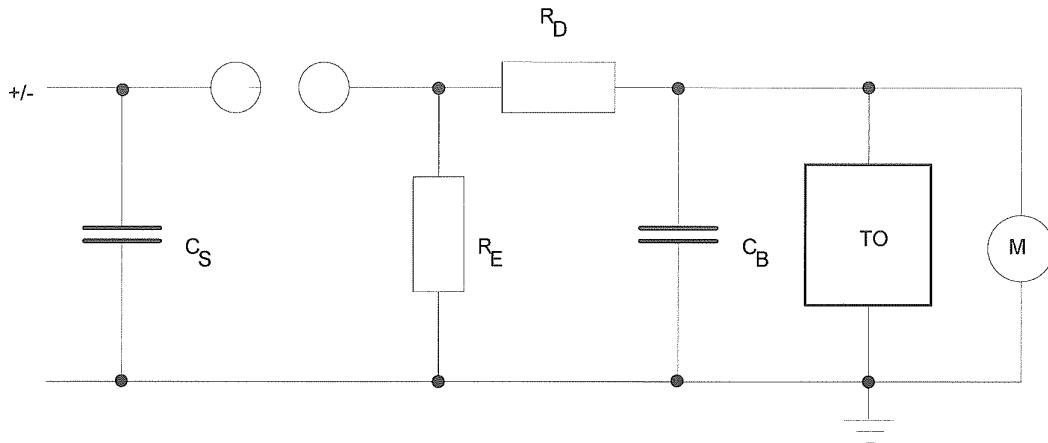
HVT -	High Voltage Test Transformer	
	Rated Voltage	260 kV
	Rated Capacity	50 kVA
	Short Circuit Impedance	14.6 %
TO -	Test Object	
M -	Voltage Measurement	

Measurement:

Capacitive Divider C = 66.6 pF (Ident-No. ELK-001342) in connection with a Peak Voltmeter Type DMI 551/Haefely (Ident-No. ELK-000989).

На основании чл.36а
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**Technical Data of Test Circuit
Lightning Impulse Voltage 1.2/50µs**



Technical Data:

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
- M - Voltage Measurement

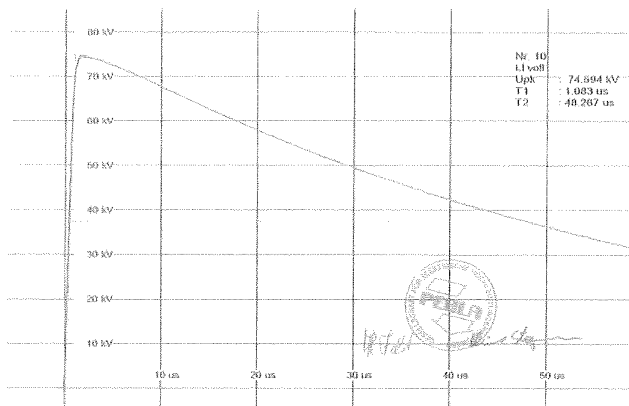
Measurement:

Resistance Divider Type RT400 (Ident-No. ELK-000937)
in connection with a Peak Voltmeter Type SV 642 / Haefely
(Ident-No. ELK-000064) and Digital Impulse Analysing System
Type DiAS 733 (Ident-No. ELK-001264).

На основании чл.36а
ап.3 от ЗОП

Lightning Voltage Impulse with the Test Object connected
(Standard Value: 1.2μs ± 30 %/50μs ± 20 %/peak ± 3 %)

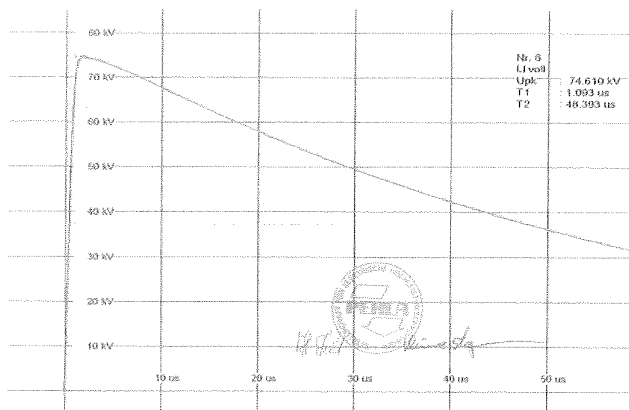
Test Arrangement 1:



T₁ = 1.08 μs

T₂ = 48.3 μs

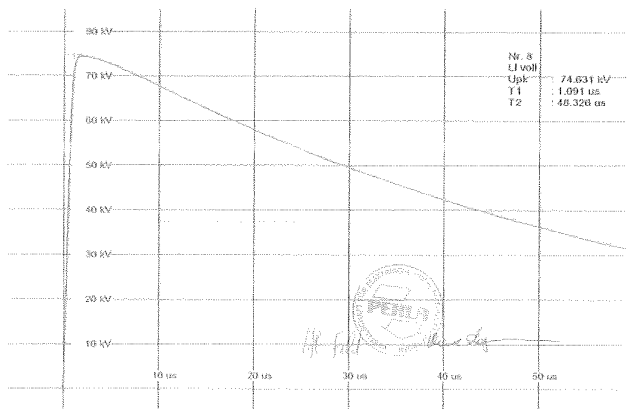
Test Arrangement 2:



T₁ = 1.09 μs

T₂ = 48.4 μs

Test Arrangement 3:



T₁ = 1.09 μs

T₂ = 48.3 μs

На основании чл.36а
 ал.3 от ЗОП

390527

Atmospheric Conditions during Tests

Date of test: 20th May 2009

Atmospheric correction factors					
(Indices: ~ power-frequency voltage; + positive impulse voltage; - negative impulse voltage)					
Input data		Correction factors		Calculated	Applied
Air temperature t:	22 °C	Air density correction factors	$k_{1\sim}$:	1.005	—
Air pressure b:	1024.5 hPa		$k_{1+/-}$:	1.005	—
Air humidity h:	9.174 g/m ³	Air humidity correction factors	$k_{2\sim}$:	0.978	—
50% disruptive discharge voltages	$U_{B\sim}$: -- kV		$k_{2+/-}$:	0.981	—
	U_{B+} : -- kV	Atmospheric correction factors	$k_{1\sim}$:	0.982	0.982
	U_{B-} : -- kV		$k_{1+/-}$:	0.986	0.986
Minimum discharge path L:		-- m			

На основании чл.36а
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Test Results
Power-Frequency and Lightning Impulse Withstand Voltage Test

Test performed: Test of insulation phase-to-phase, phase-to-earth and across open circuit-breaker

Date of test: 20th May 2009

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

Connections to test object: The test voltage was applied to the upper terminals

Front time T_1 : 1.08 μ s Time to half-value T_2 : 48.3 μ s Test frequency f: 50 Hz

All voltage values are corrected with the atmospheric correction factors.

Test Arrangement 1:			Test Voltages kV Related to standard reference atmosphere 20°C, 1013 hPa, 11g/m ³ .	Result Test duration or number of impulses / disruptive discharges
Condition	Voltage applied to	Earthed		
Circuit-breaker in OFF-position	A	BCabcF	28	1 min / 0
			42	1 min / 0
			+75	15 / 0
			-75	15 / 0
	B	ACabcF	28	1 min / 0
			42	1 min / 0
			+75	15 / 0
			-75	15 / 0
	C	ABabcF	28	1 min / 0
			42	1 min / 0
			+75	15 / 0
			-75	15 / 0

Legend: A,a = Phase L1 B,b = Phase L2 C,c = Phase L3 F = Frame
 Remark: -

На основании чл.36а
 ал.3 от ЗОП

Test Results

Power-Frequency and Lightning Impulse Withstand Voltage Test

Test performed: Test of insulation phase-to-phase and phase-to-earth

Date of test: 20th May 2009

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

Connections to test object: The test voltage was applied to the upper terminals

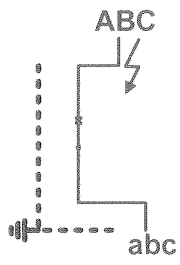
Front time T_1 : 1.09 μ s

Time to half-value T_2 : 48.4 μ s

Test frequency f: 50 Hz

All voltage values are corrected with the atmospheric correction factors.

Test Arrangement 2:			Test Voltages kV	Result
Condition	Voltage applied to	Earthed		
Circuit-breaker in ON-position	Aa	BCbcF	28	1 min / 0
			42	1 min / 0
			+75	15 / 0
			-75	15 / 0
	Bb	ACacF	28	1 min / 0
			42	1 min / 0
			+75	15 / 0
			-75	15 / 0
	Cc	ABabF	28	1 min / 0
			42	1 min / 0
			+75	15 / 0
			-75	15 / 0



Legend: A,a = Phase L1 B,b = Phase L2 C,c = Phase L3 F = Frame
 Remark: -

На основании чл.36а
ал.3 от ЗОП

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Test Results

Power-Frequency and Lightning Impulse Withstand Voltage Test

Test performed: Test of insulation phase-to-phase, phase-to-earth and across open circuit-breaker

Date of test: 20th May 2009

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

Connections to test object: The test voltage was applied to the lower terminals

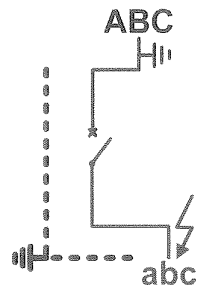
Front time T_1 : 1.09 μ s

Time to half-value T_2 : 48.3 μ s

Test frequency f : 50 Hz

All voltage values are corrected with the atmospheric correction factors.

Test Arrangement 3:			Test Voltages kV Related to standard reference atmosphere 20°C, 1013 hPa, 11g/m ³ .	Result Test duration or number of impulses / disruptive discharges
Condition	Voltage applied to	Earthed		
Circuit-breaker in OFF-position	a	ABCbcF	28	1 min / 0
			42	1 min / 0
			+75	15 / 0
			-75	15 / 0
	b	ABCacF	28	1 min / 0
			42	1 min / 0
			+75	15 / 0
			-75	15 / 0
	c	ABCabF	28	1 min / 0
			42	1 min / 0
			+75	15 / 0
			-75	15 / 0



Legend: A,a = Phase L1 B,b = Phase L2 C,c = Phase L3 F = Frame
 Remark: -

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Photos

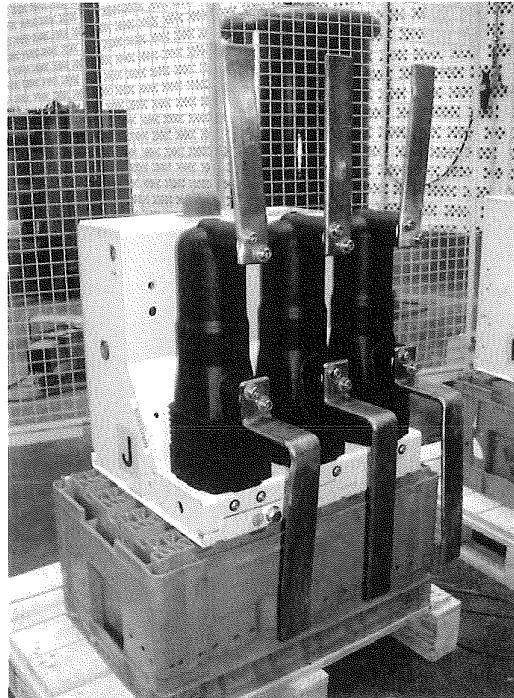


Fig. 1: VD4/P 17.12.32, rear and right view



Fig. 2: VD4/P 17.12.32, rear and left view

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0907032

PEHLA

GESELLSCHAFT FÜR ELEKTRISCHE HOCHLEISTUNGSPRÜFUNGEN
Member of the SHORT-CIRCUIT TESTING LIAISON (STL)

Test Report

Report No.: 10219 Ra

Copy No.: 1

Contents: 24 Sheets

Test object: Vacuum circuit-breaker

Designation: VD4 12.12.32

Rated voltage: 12 kV

Rated normal current: 1250 A

Rated frequency: 50/60 Hz

Manufacturer: ABB P.T.S.p.A., Dalmine, Italy (circuit-breaker)

ABB AG – Calor Emag Medium Voltage Products, Ratingen, Germany (pole part)
under licence of ABB Ltd., Zurich, Switzerland

Client: ABB Technology Ltd., Zurich, Switzerland

Testing station: PEHLA-Testing Laboratory Ratingen

Date of test: 18th November - 10th December 2010

Applied test specifications:

IEC 62271-100, Ed.2.0, 2008-04, clause 6.101.1 and 6.101.2

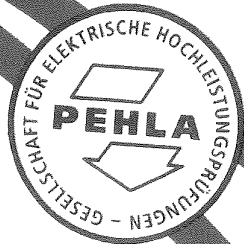
Tests performed:

Type test 'Mechanical endurance test'.

In accordance with the requirements of class M2, an extended mechanical endurance test, including 10000 mechanical operating cycles without voltage on or current in the main circuit, has been carried out.

Test results:

The test object passed the test performed in accordance with the applied test specifications.



Mannheim, 13th January 2011

The test results relate only to the items tested.

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Notes

Accreditation

The PEHLA-Testing Laboratory Ratingen has been approved by the TGA GmbH according to EN ISO/IEC 17025 for tests in the field of high-voltage switchgear and controlgear and power engineering equipment (Registration-No. DAT-PL-032/93-63).

STL-Member

PEHLA is founder member of the SHORT-CIRCUIT TESTING LIAISON (STL) which has been established in 1969. STL is a forum for the international cooperation of the testing organisations with the further full members ASTA (UK), CESI (IT), CPRI (IND), ESEF (FR), KEMA (NL), SATS (NO; SE, FI), STLNA (US, CA) and JSTC (JP). In the framework of EC, STL (EU) has been recognised in 1992 by EOTC as agreement group.

PEHLA-Documents

A Type Test 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 test object 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 test object 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 test object, and its condition after the tests.

A Test Confirmation

is issued immediately after the tests. It confirms that the tests have been conducted and is valid only until publishing the detailed results in an entire document.

Uncertainty of the measurement systems

The PEHLA - Testing Laboratories apply the PEHLA Guide No. 12 for determining the uncertainties of measurement, based on ENV 13005 (Guide to the expression of uncertainty in measurement). As long as no explicit statements are made, the uncertainties required by the relevant standards have been complied with.

Addresses

Office: PEHLA-Geschäftsstelle
Hallenweg 40
68219 Mannheim
Germany
Internet: www.pehla.com

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

Manufacturer CB: ABB P.T.S.p.A.
Via Friuli, 4
I-24044 Dalmine
Italy

Manufacturer pole part: ABB AG
Calor Emag Medium Voltage Products
Oberhausener Strasse 33
40472 Ratingen
Germany

Client: ABB Technology Ltd.
Affolternstrasse 44
8050 Zürich
Switzerland

На основании чл.36а
ал.3 от ЗОП

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На основании чл.36а
ал.3 от ЗОП

List of Test Participants

Representatives of Technical Committee:

Mr. Joachim Mendorf	PEHLA-Testing Laboratory Ratingen, Germany
Mr. Herbert Feld	PEHLA-Testing Laboratory Berlin-Marzahn, Germany
Mr. Torsten Grell	PEHLA-Testing Laboratory Frankfurt am Main; Germany

(09th to 10th Dec 2010)

Test Engineer / Test Operator:

Mr. Joachim Mendorf	PEHLA-Testing Laboratory Ratingen, Germany
Mr. Kristijan Dujmovic	PEHLA-Testing Laboratory Ratingen, Germany
Mr. Gerd Langwieler	PEHLA-Testing Laboratory Ratingen, Germany

(09th Dec 2010 – Dielectric Test)

Representatives of Client:

-

Further Participants:

-

На основании чл.36а
ал.3 от ЗОП

**Technical Data of Test Object
Circuit-Breaker**

Test object: Vacuum circuit-breaker
Designation: VD4 12.12.32
Manufacturer: ABB S.p.A., Power Products Division, Dalmine, Italy
Serial No.: 1VC1BA00030260
Year of manufacture: 2010
Serial No. of drive: -
Drawing No.: 1VCR016097G0024

Ratings assigned by the manufacturer:

Rated voltage	12 kV	
Rated normal current	1250 A	
Rated frequency	50/60 Hz	
Rated lightning impulse withstand voltage	75 kV	
Rated switching impulse withstand voltage	- kV	
Rated power-frequency withstand voltage	28 kV	
Rated peak withstand current	80/82 kA	
Rated short-time withstand current	31.5 kA	
Rated duration of short-circuit	3 s	
Rated short-circuit breaking current	31.5 kA	
DC component of the rated short-circuit breaking current	≤30 %	
Rated short-circuit making current	80/82 kA	
Rated transient recovery voltage	30 kV	
Rate of rise of transient recovery voltage	0.42 kV/μs	
First-pole-to-clear factor	1.5	
Rated operating sequence	O - 0.3 s - CO - 15 s - CO	
Arc extinguishing medium	vacuum	
Rated filling pressure for operation	- MPa	abs. at 20 °C
Minimum functional pressure for operation	- MPa	abs. at 20 °C
Insulating medium	air	
Rated filling pressure for insulation	- MPa	abs. at 20 °C
Minimum functional pressure for insulation	- MPa	abs. at 20 °C
Driving mechanism (type)	Spring Drive EL2	
Number of poles	3	
Number of units per pole	1	
Rated opening time	33...60 ms	
Rated closing time	50...80 ms	
Rated supply voltage of opening device	110 V	d.c.
Rated supply voltage of closing device	110 V	d.c.
Rated supply voltage of auxiliary circuits	110 V	d.c.
Rated frequency of supply voltage	- Hz	
Rated line-charging breaking current	- A	
Rated cable-charging breaking current	25 A	

Further data:

VD4EL 12.12.32, p275, mechanical actuator type EL2, Serial-No. --
 Vacuum interrupter type VG4S in Pole part PT1
 Serial-No.: L1: 00847757, L2: 00847742, L3: 00847744

Essential characteristics: -

На основании чл.36а
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List of Identified Drawings

The manufacturer has submitted to the testing laboratory drawings and other data containing sufficient information to unambiguously identify by type the essential details and parts of the test object presented for test.

The drawings have been stamped and signed by the manufacturer in order to guarantee that the drawings or data schedules truly represent the test object to be tested.

Further these drawings have been stamped and signed by PEHLA representatives and are kept at the client.

with the test documents at the test laboratory.

The testing laboratory has checked that drawings and data schedules adequately represent the essential details and parts of the test object to be tested, but is not responsible for the accuracy of the detailed information.

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

Drawing No.	Rev.	P/D *)	Title	Additional remarks
1VCR016097G0024 Sheet 1/1	--	P	Tabella Materiali	-
1VCR016097G0024 Sheet 1/-	V2641	D	BASE C.B.POLES P1	included in test report
1VCR016092G0024 Sheet 1/1	--	P	Tabella Materiali	-
1VCD000051 Sheet 1/-	E0949 080731	D	Vacuum circuit breaker type VD4 12-17,5kV 630-1250A	-
1VCR003321G0007 Sheet 1/1	--	P	Tabella Materiali	-
1VCR003321G0007 Sheet 1/-	V2943	D	Operating mechanism with shaft	included in test report
510507 Sheet 1/1	--	P	Tabella Materiali	-
510507 Sheet 1/1	V2943	D	Operating mechanism assembly EL2	-
510428 Sheet 1/1	V2555	D	Tension spring	-
510564GR.802 Sheet 1/1	V3116	D	Closing springs assembly	-
1VCR000006G	--	P	Tabella Materiali	-
GCE7006200R0102 Sheet 1/1	--	P	Polteil vollständig Pole complete	-
GCE7006200R0102 Sheet 2/-	02	D	Polteil vollständig Pole complete	included in test report
GCE7003142R0132 Sheet 2/-	16	D	Antriebsstange vollst. Operating stud compl.	На основании чл.36а ал.3 от ЗОП
GCE7005535R0101 Sheet 1/1	08	D	Assembly Group MTG VG4S	

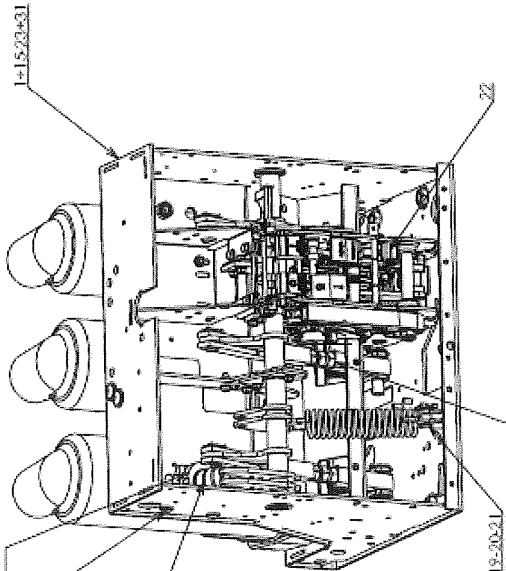
*) P: Parts list, D: Drawing

Remarks: -

050313

**Drawing No. 1VCR016097G0024
BASE C.B.POLES P1**

TIPO TYPE	INTERASSE POLI POLES DISTANCE	TIPO POLO POLES TYPE
G0001	P.150	P1V65
G0002	P.150	P1V645
G0003	P.210	P1V65
G0004	P.210	P1V645
G0005	P.275	P1V65
G0006	P.275	P1V645
G0007	P.150	P1V65
G0008	P.150	P1V64
G0009	P.275	P1V64
G0010	P.210	P1V64
G0011	P.150	P1V64
G0012	P.150	P1V64
G0013	P.275	P1V64
G0014	P.210	P1V64
G0015	P.150	P1V64
G0016	P.150	P1V64
G0017	P.210	P1V65
G0018	P.210	P1V64
G0019	P.150	P1V64
G0020	P.150	P1V645
G0021	P.210	P1V64
G0022	P.210	P1V64
G0023	P.275	P1V64
G0024	P.275	P1V645



DOPO LA REGOLAZIONE SERRARE A 100NM E OSCILLARE CON VERNICE GIALLA. AFTER A DISTINCTION TIGHTEN AT 100 N·M AND SEAL WITH YELLOW VARNISH.

COPPIA DI SERRA (G310): 22NM. TORQUE WRENCH : 22NM.

REGOLAZIONE BIELLE DOPO ASSEMBLAMENTO POLE. COPPIA DI SERRAGGIO 110NM. RODS SETTING AFTER CONSOLIDATION PROCESS. TORQUE WRENCH SETTING 110NM.

RIPIASARE DI MONI A CASSO LUBRIFICARE CON GRASSO GC 000249R100 DURING THE ASSEMBLY LUBRICATING WITH GREASE GC 000249R100

TORQUE WRENCH SETTING ACC TO 080823 COPPIA DI SERRAGGIO 220-280NM

(00) DIMENSION CHECK SEPARATED BILL OF MATERIAL LABEL A MATERIALA PARTE

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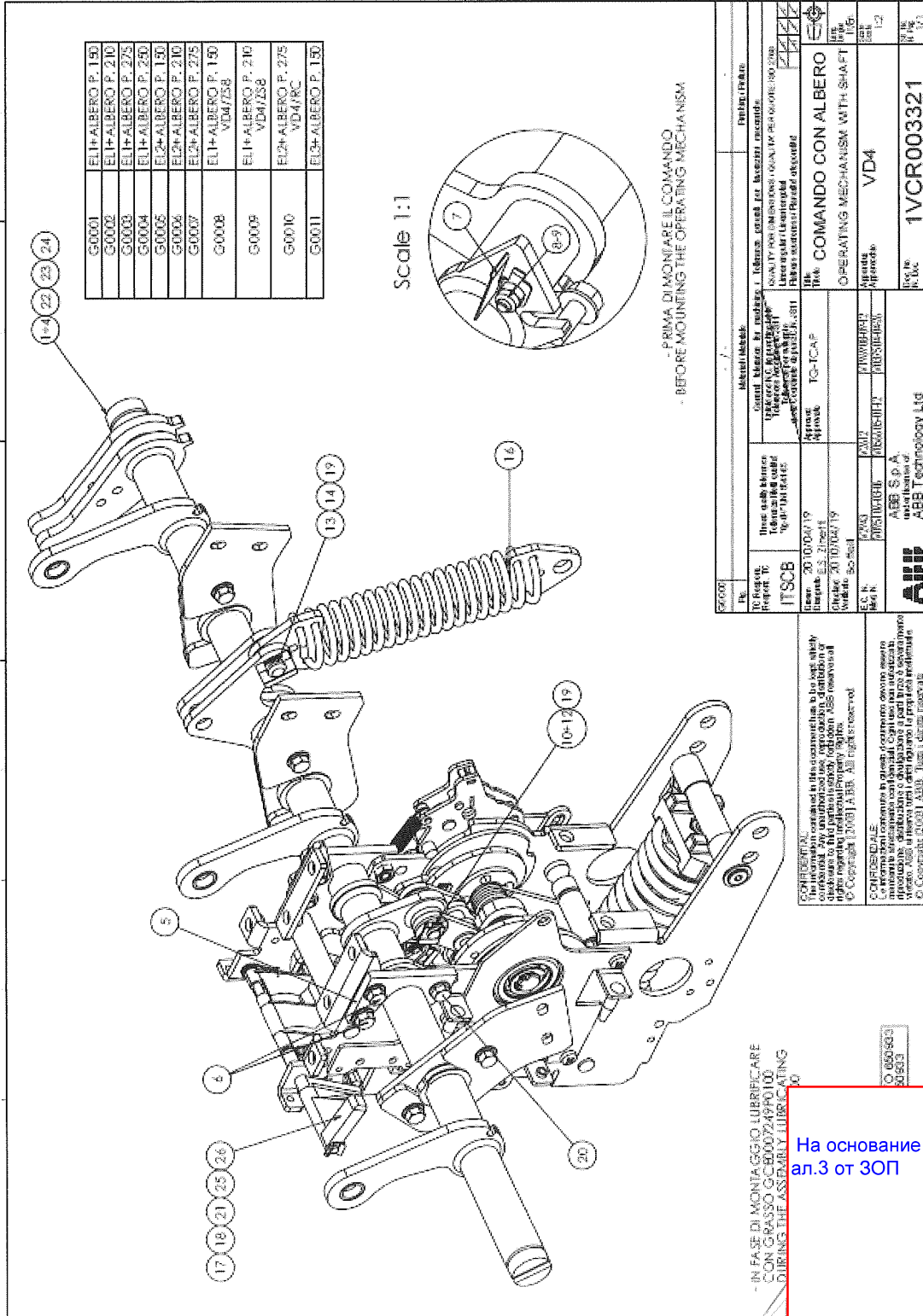
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ITSCB Date: 2009/04/14 Design: Valerio Check: 2009/04/14 Write: Valerio T.		Material (Materiale) General: Interasse per montaggio. I. Idistanza: generale per il montaggio generale. Specific: Interasse per montaggio. I. Idistanza: generale per il montaggio generale. Linea: Interasse per montaggio. I. Idistanza: generale per il montaggio generale.	
Item: 2009/04/14 Design: Valerio Check: 2009/04/14 Write: Valerio T.		Approvato: [Signature] Data: 2009/04/14	
E.C. N. [Blank] Mod. N. [Blank]		Base C.B. POLES P1 INTERRUPTORE BASE POLI P1	
ABB S.p.A. ABB Technology Ltd		Approvato: [Signature] Data: 2009/04/14	
(00) DIMENSION CHECK SEPARATED BILL OF MATERIAL LABEL A MATERIALA PARTE		V.D.4 1VCR016097	

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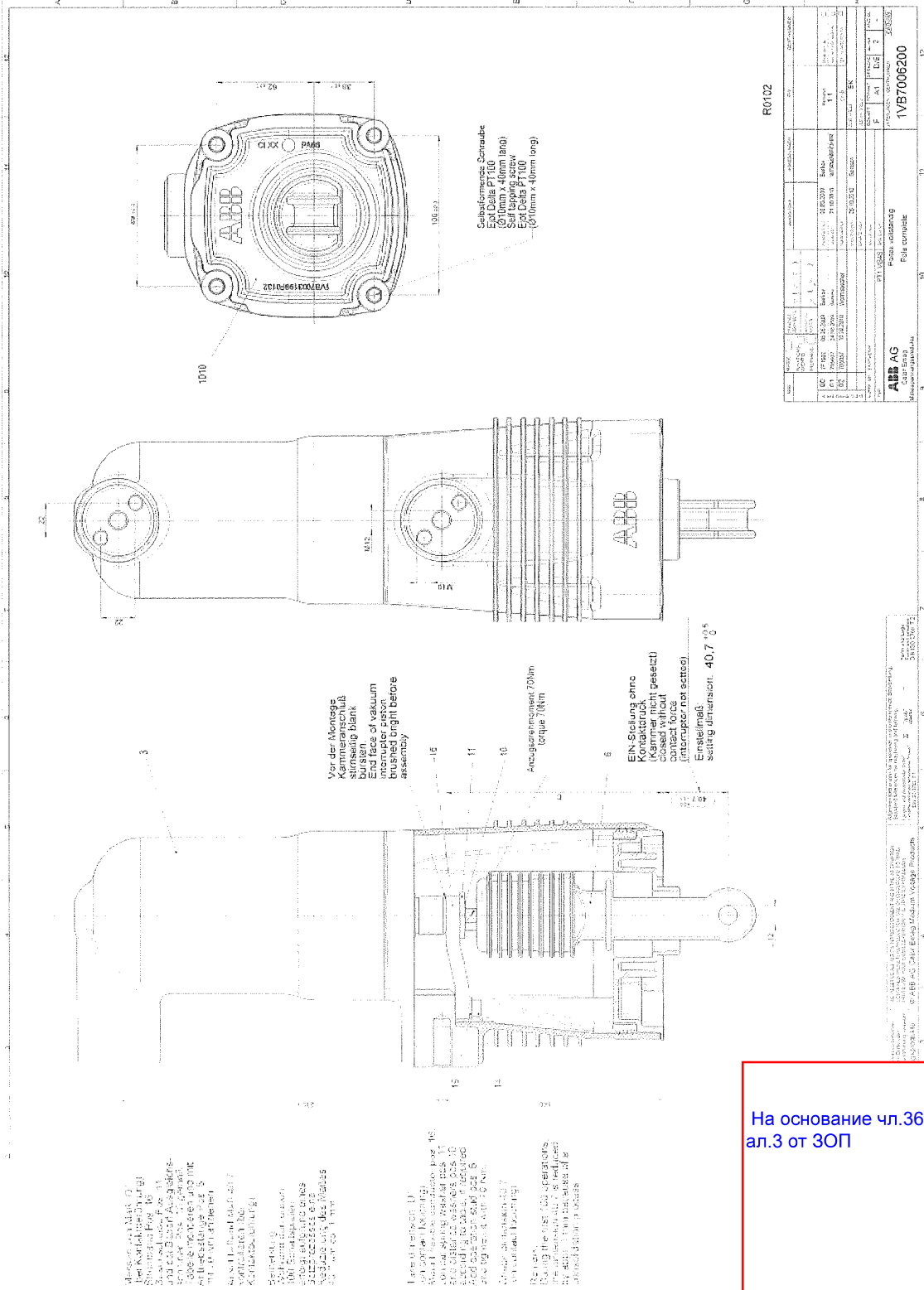
500339

Drawing No. 1VCR003321G0007
Operating mechanism with shaft



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Drawing No. GCE7006200R0102
Pole complete



Details on Performance of the Test

10000 mechanical close-open switching operations were performed with the vacuum circuit-breaker to demonstrate its mechanical reliability in accordance with IEC 62271-100, Ed.2.0, 2008-04, clause 6.101.1 and 6.101.2

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 - not applicable
- 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 each at rated, minimum and maximum supply voltage.

The subsequent endurance test comprising 10000 mechanical operating cycles was structured as follows and the below described sequence was carried out five times:

500 operating cycles with operating sequence C - 45 s - O - 45 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 - 45 s - O - 45 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 - 45 s - O - 45 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 O - 300 ms - CO - 90 s - C - 90 s at the rated supply voltage of closing and opening devices and motorized operating mechanism and at the rated pressure for operation

After each series of 2000 operating sequences the operating characteristics: a), b), d), above have been recorded.

Following the mechanical endurance test, the measurements carried out before the test for comparison. Check, whether the travel characteristics fell within the envelope curve of the mechanical endurance test.

На основании чл.36а
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Results of Measurements before the Mechanical Endurance Test

Number of operations: 0

Measured values:

Measured during the 5 x CO operations

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

a,b) Closing and opening time:

	operating time tc (closing)			operating time to (opening)		
	0.85xUa	1.0xUa	1.1xUa	0.7xUa	1.0xUa	1.1xUa
t / ms	61.6	58.0	55.9	55.3	42.9	40.6
	62.2	57.7	55.8	55.2	42.9	40.5
	61.9	57.7	56.1	55.2	42.7	40.5
	62.1	57.7	56.1	55.0	42.7	40.6
	61.9	58.0	55.9	55.0	42.6	40.6

Rated voltage: Ua = 110 V d.c.

d) Time spread between the circuit-breaker poles:

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

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

No	charging time of the operating mechanism / s			Current Consumption / A			Power Consumption / W		
	0.85 x Ua	1.00 x Ua	1.10 x Ua	0.85 x Ua	1.00 x Ua	1.10 x Ua	0.85 x Ua	1.00 x Ua	1.10 x Ua
1	7.21	5.81	5.41	1.04	1.07	1.07	97.06	117.24	129.80
2	7.17	6.08	5.27	1.04	1.07	1.10	97.56	117.78	132.89
3	7.22	6.06	5.36	1.05	1.06	1.11	98.34	116.91	134.12
4	7.23	6.08	5.31	1.05	1.06	1.09	97.98	116.93	132.24
5	7.24	6.02	5.35	1.05	1.05	1.10	98.06	115.75	132.99

Rated voltage: Ua = 110 V d.c.

000343

На основании чл.36а
ал.3 от ЗОП

g) Consumption of the tripping devices:

	current consumption shunt-release (close)			current consumption shunt-release (open)		
	0.85xUa	1.0xUa	1.1xUa	0.7xUa	1.0xUa	1.1xUa
I / A	1.96	2.32	2.55	1.21	1.90	2.11
	1.96	2.32	2.55	1.20	1.88	2.12
	1.96	2.32	2.55	1.21	1.90	2.14
	1.96	2.32	2.55	1.20	1.84	2.15
	1.96	2.31	2.55	1.19	1.83	2.15

Rated voltage: Ua = 110 V d.c.

h) Duration of opening and closing command impulse:

	command duration closing			command duration opening		
	0.85xUa	1.0xUa	1.1xUa	0.7xUa	1.0xUa	1.1xUa
t / ms	99.8	99.7	99.9	100.2	100.3	100.2
	99.9	99.9	99.7	100.2	100.3	100.2
	99.9	99.7	99.7	100.2	100.2	100.2
	99.9	99.7	99.9	100.2	100.2	100.3
	99.9	99.7	99.7	100.2	100.2	100.2

Rated voltage: Ua = 110 V d.c.

i) Tightness

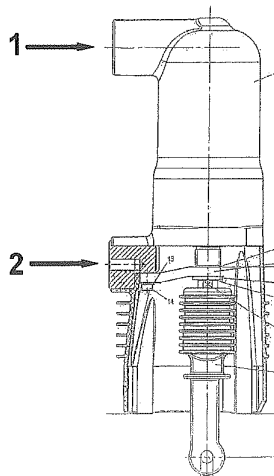
not applicable

j) Gas pressure

not applicable

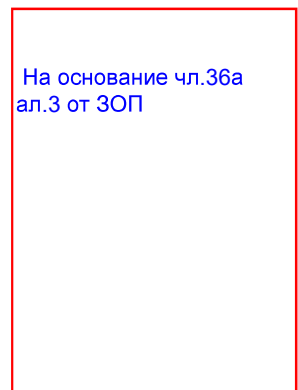
k) Resistance of the main conductors:

Measuring points



050344

На основании чл.36а
ал.3 от ЗОП



Ambient air temperature:		23 °C		
Resistance measurement at direct current of:		50 A (d.c.)		
Measurement between points (see sheet 12)	Resistance of the main circuit μΩ			
	L1	L2	L3	
1 - 2	16.6	16.3	15.9	
1 - 2	16.6	16.3	15.8	
1 - 2	16.8	16.3	16.0	

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

Speed in [m/s]; U_a = 110 V d.c.
at U = 1.0 x U_a

	V _c	V _o
L2	0.99	1.34

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

m) Other important characteristics:

▪ **Contact travel:**

	L1	L2	L3
Total Travel [mm]	15.0	14.8	14.8
Contact-travel [mm]	11.7	11.5	11.3
Contact-spring travel [mm]	3.3	3.3	3.5

▪ **Check of vacuum of interrupters:**

60 kV d.c. ok

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

O-0.3s-CO-15s-CO at rated voltage ok

▪ **Ambient atmospheric conditions:**

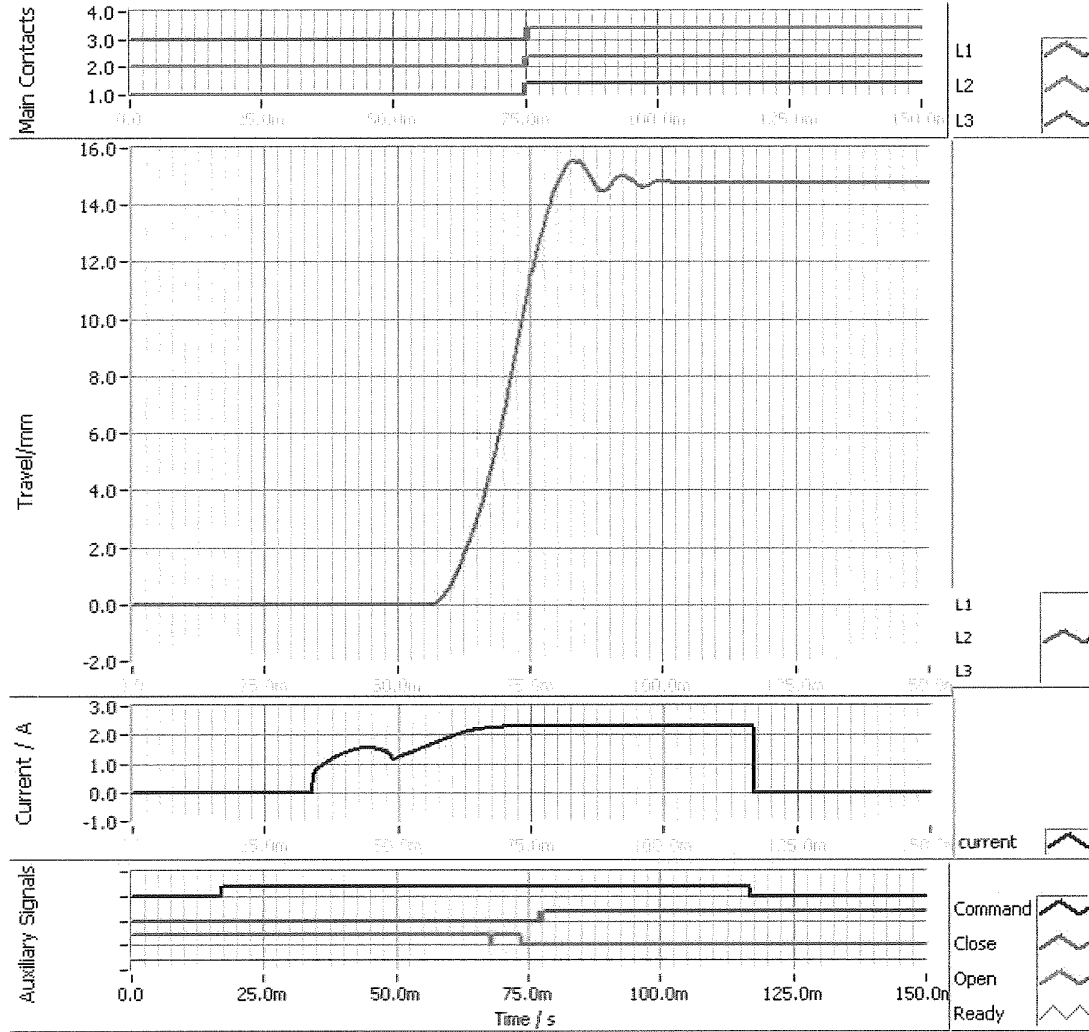
Date: November 18th, 2010

During the above mentioned measurements the mean temperature was 23°C

На основании чл.36а
ал.3 от ЗОП

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

Close-Operation



No	Pole Symmetry	Operating Time	Command Duration	I_Release (Cursor)	I_Release (max)	I_Release (avg)	U_Release (avg)	P_Release (avg)
C6	0.6 ms	58.0 ms	99.7 ms	2.32 A	2.32 A	2.06 A	110.0 V	226.1 W

No	Phase	Velocity	Total Travel	Disconnection Gap	Contact Spring
C6	L2	0.99 m/s	14.74 mm	11.42 mm	3.32 mm

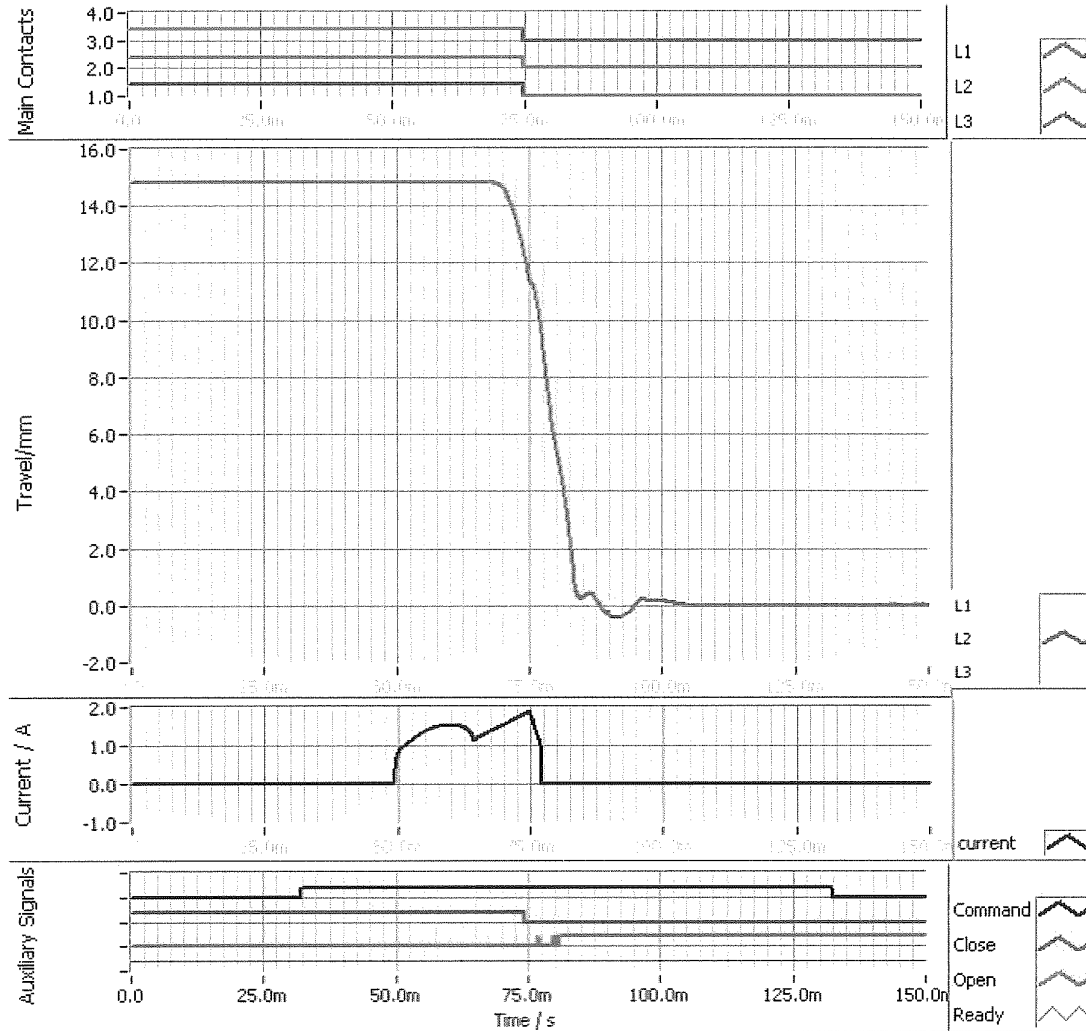
- Measuring point: Insulated coupling rod in phase L2
- Operating speed measured: $V_C = 0.99 \text{ m/s}$ at $U = 1.0 \times U_a$

На основании чл.36а
ал.3 от ЗОП

000343

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

Open-Operation



No	Pole Symmetry	Operating Time	Command Duration	I_Release (Cursor)	I_Release (max)	I_Release (avg)	U_Release (avg)	P_Release (avg)
O6	0.0 ms	42.9 ms	100.3 ms	1.90 A	1.90 A	1.43 A	110.0 V	156.8 W

No	Phase	Velocity	Total Travel	Disconnection Gap	Contact Spring
O6	L2	-1.34 m/s	14.80 mm	11.42 mm	3.38 mm

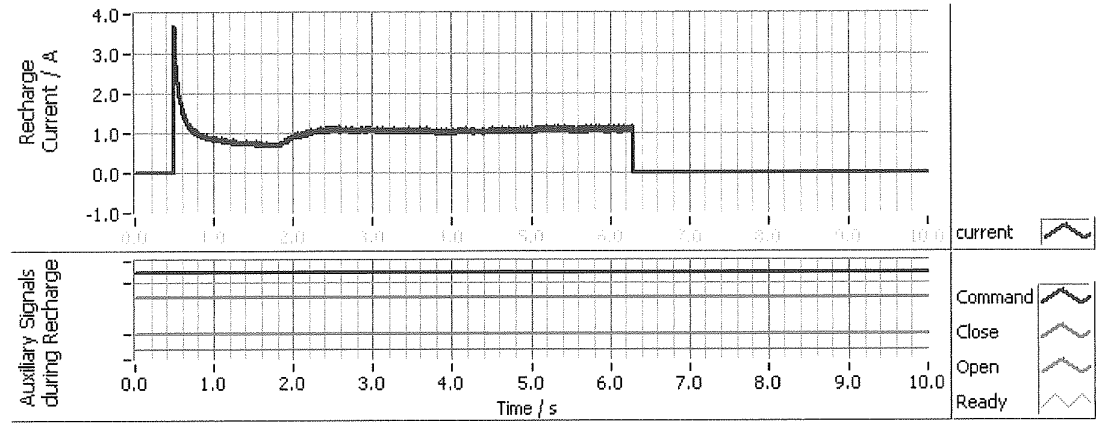
- Measuring point: Insulated coupling rod in phase L2
- Operating speed measured: $V_0 = 1.34 \text{ m/s}$ at $U = 1.0 \times U_a$

На основании чл.36а
ал.3 от ЗОП

000347

Diagram 1.3: Measurement of the recharging characteristics before the mechanical endurance test

Recharging after Close-Operation



No	Duration of Recharging	Recharge Current (Crs)	Recharge Current (max)	Recharge Current (avg)	Average Voltage	Power Cons. (avg)
C6	5.81 s	3.71 A	3.71 A	1.07 A	110.0 V	117.24 W

На основании чл.36а
ал.3 от ЗОП

100043

Results of Measurements during the Mechanical Endurance Test

a/b) Opening and closing time:

Operating time [ms] U _a = 110 V d.c.	U [V]	t _c (closing)			t _o (opening)		
		0.85 x U _a	1.0 x U _a	1.1 x U _a	0.7 x U _a	1.0 x U _a	1.1 x U _a
Number of operations: 2000	t [ms]	60.9	57.3	55.1	56.7	43.0	41.2
Number of operations: 4000	t [ms]	61.0	57.2	55.6	56.0	43.0	41.3
Number of operations: 6000	t [ms]	60.1	56.5	54.6	54.9	42.7	40.5
Number of operations: 8000	t [ms]	59.9	56.5	54.4	55.2	42.8	40.7

d) Time spread between the circuit-breaker poles:

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

e) Charging time of the motorized operating mechanism:

Motor voltage	charging time for O-C [s]		
	U = 0.85 x U _a = 93.5 V d.c.	U = 1.0 x U _a = 110 V d.c.	U = 1.1 x U _a = 121 V d.c.
Number of operations: 2000	7.29	6.00	5.26
Number of operations: 4000	7.89	6.20	5.50
Number of operations: 6000	7.28	5.88	5.37
Number of operations: 8000	7.29	6.04	5.33

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

Speed in [m/s]; at U _a = 110 V d.c. L2	V _c	V _o
Number of operations: 2000	0.97	1.33
Number of operations: 4000	0.95	1.32
Number of operations: 6000	0.93	1.32
Number of operations: 8000	0.96	1.30

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

На основание чл.36а
ал.3 от ЗОП

10219

Results of Measurements after the Mechanical Endurance Test

Number of operations: 10000

Measured values:

Measured during the 5 x CO operations

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

a,b) Closing and opening time:

	operating time tc (closing)			operating time to (opening)		
	0.85xUa	1.0xUa	1.1xUa	0.7xUa	1.0xUa	1.1xUa
t / ms	60.7	56.6	54.8	54.9	42.8	40.7
	60.3	56.4	54.6	53.7	42.8	40.6
	60.4	56.5	54.7	54.8	42.7	40.4
	60.5	56.6	54.8	54.9	42.8	40.6
	60.4	56.5	55.0	54.8	42.8	40.5

Rated voltage: Ua = 110 V d.c.

d) Time spread between the circuit-breaker poles:

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

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

No	charging time of the operating mechanism / s			Current Consumption / A			Power Consumption / W		
	0.85 x Ua	1.00 x Ua	1.10 x Ua	0.85 x Ua	1.00 x Ua	1.10 x Ua	0.85 x Ua	1.00 x Ua	1.10 x Ua
1	7.62	6.04	5.65	1.05	1.08	1.10	97.48	118.68	133.47
2	7.40	6.20	5.53	1.06	1.07	1.14	98.70	117.69	137.59
3	7.46	6.29	5.67	1.06	1.08	1.15	98.65	118.65	139.62
4	7.47	6.02	5.75	1.06	1.11	1.16	98.87	121.74	139.77
5	7.52	6.32	5.79	1.06	1.09	1.17	99.09	119.32	141.09

Rated voltage: Ua = 110 V d.c.

На основании чл.36а
ал.3 от ЗОП

g) Consumption of the tripping devices:

	current consumption shunt-release (close)			current consumption shunt-release (open)		
	0.85xUa	1.0xUa	1.1xUa	0.7xUa	1.0xUa	1.1xUa
I / A	1.95	2.31	2.55	1.14	1.80	2.07
	1.96	2.31	2.55	1.14	1.80	2.08
	1.95	2.31	2.54	1.15	1.79	2.07
	1.95	2.31	2.55	1.14	1.80	2.07
	1.95	2.31	2.54	1.14	1.80	2.07

Rated voltage: Ua = 110 V d.c.

h) Duration of opening and closing command impulse:

	command duration closing			command duration opening		
	0.85xUa	1.0xUa	1.1xUa	0.7xUa	1.0xUa	1.1xUa
t / ms	99.8	99.7	99.8	100.1	100.3	100.3
	99.8	99.8	99.7	100.1	100.3	100.3
	99.8	99.7	99.8	100.1	100.2	100.3
	99.7	99.8	99.8	100.1	100.2	100.3
	99.8	99.8	99.8	100.1	100.3	100.2

Rated voltage: Ua = 110 V d.c.

i) Tightness

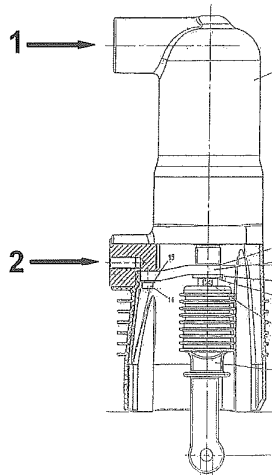
not applicable

j) Gas pressure

not applicable

k) Resistance of the main conductors:

Measuring points



0.152

На основании чл.36а
ал.3 от ЗОП

Ambient air temperature:		23 °C		
Resistance measurement at direct current of:		50 A (d.c.)		
Measurement between points (see sheet 19)	Resistance of the main circuit μΩ			
	L1	L2	L3	
1 - 2	16.5	16.0	16.5	
1 - 2	16.4	16.0	16.2	
1 - 2	16.7	16.2	16.0	

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

Speed in [m/s]; U_a = 110 V d.c.
at U = 1.0 x U_a

	V_c	V_o
L2	1.03	1.28

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

m) Other important characteristics:

▪ **Contact travel:**

	L1	L2	L3
Total Travel [mm]	14.9	14.8	14.6
Contact-travel [mm]	12.5	11.6	12.0
Contact-spring travel [mm]	2.4	3.2	2.6

▪ **Check of vacuum of interrupters:**

60 kV d.c. ok

▪ **Voltage test as a condition check according to IEC62271-100 Ed.2.0, cl. 6.2.11:**

Power-frequency withstand voltage test at 22.4 kV – 1 min passed.

▪ **Additional Voltage test:**

Power-frequency withstand voltage test at 42 kV – 1 min passed.

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

O-0.3s-CO-15s-CO at rated voltage ok

▪ **Ambient atmospheric conditions:**

Date: December 09th – 10th, 2010

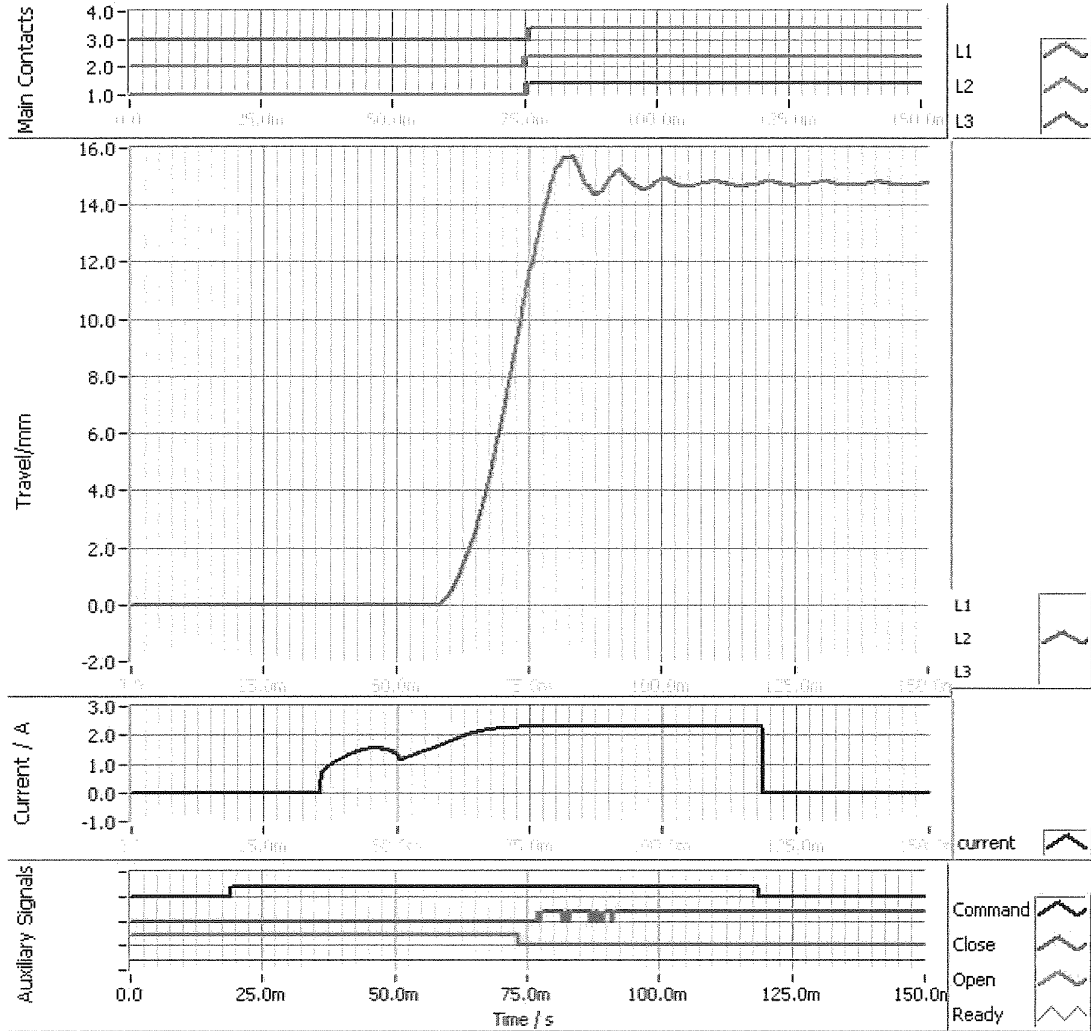
During the above mentioned measurements the mean temperature was 23°C

На основании чл.36а
ап.3 от ЗОП

090352

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

Close-Operation



No	Pole Symmetry	Operating Time	Command Duration	I_Release (Cursor)	I_Release (max)	I_Release (avg)	U_Release (avg)	P_Release (avg)
C6	0.7 ms	56.6 ms	99.7 ms	2.31 A	2.31 A	2.04 A	110.0 V	224.7 W

No	Phase	Velocity	Total Travel	Disconnection Gap	Contact Spring
C6	L2	1.03 m/s	14.76 mm	11.58 mm	3.18 mm

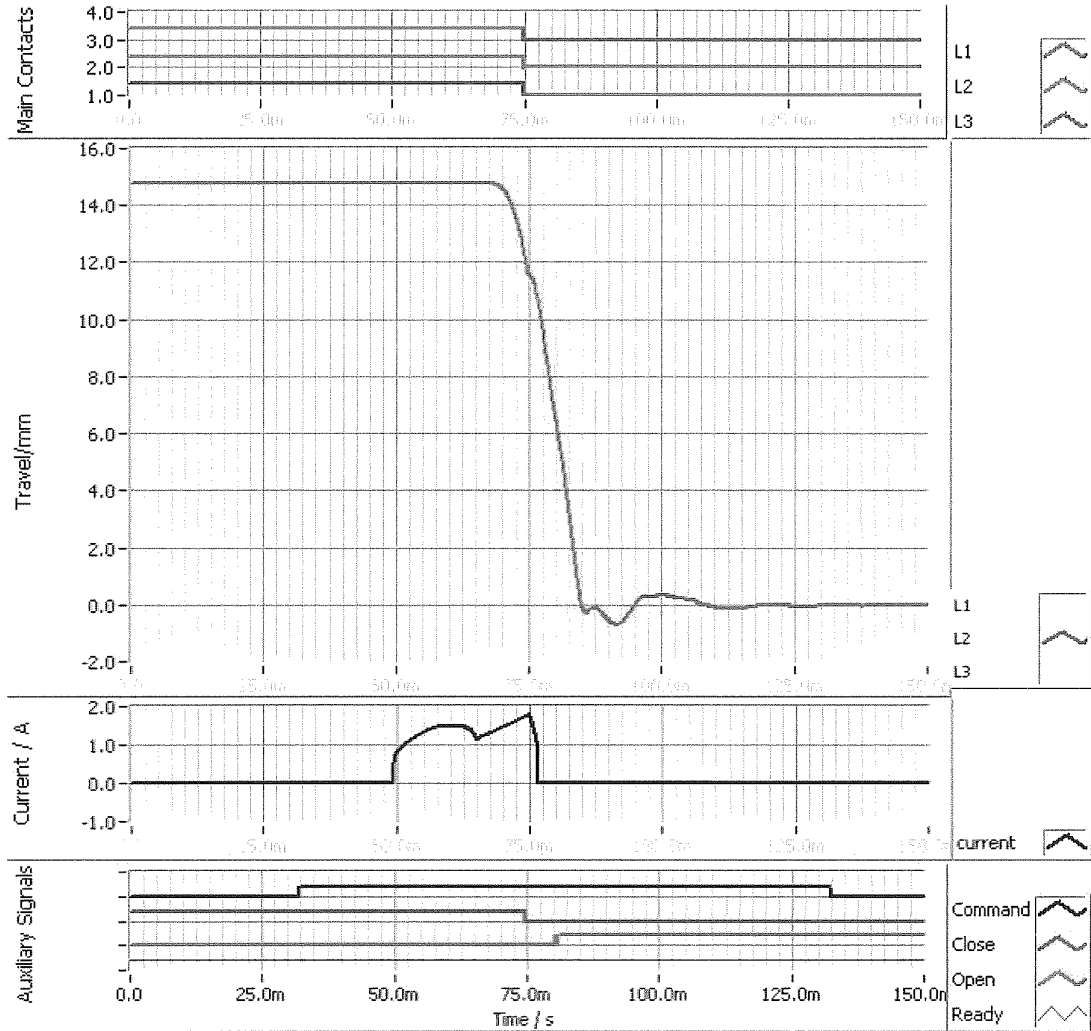
- Measuring point: Insulated coupling rod in phase L2
- Operating speed measured: $V_C = 1.03 \text{ m/s}$ at $U = 1.0 \times U_a$

На основании чл.36а
ал.3 от ЗОП

000353

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

Open-Operation



No	Pole Symmetry	Operating Time	Command Duration	I_Release (Cursor)	I_Release (max)	I_Release (avg)	U_Release (avg)	P_Release (avg)
O6	0.3 ms	42.8 ms	100.3 ms	1.80 A	1.80 A	1.38 A	110.0 V	152.0 W

No	Phase	Velocity	Total Travel	Disconnection Gap	Contact Spring
O6	L2	-1.28 m/s	14.76 mm	11.58 mm	3.18 mm

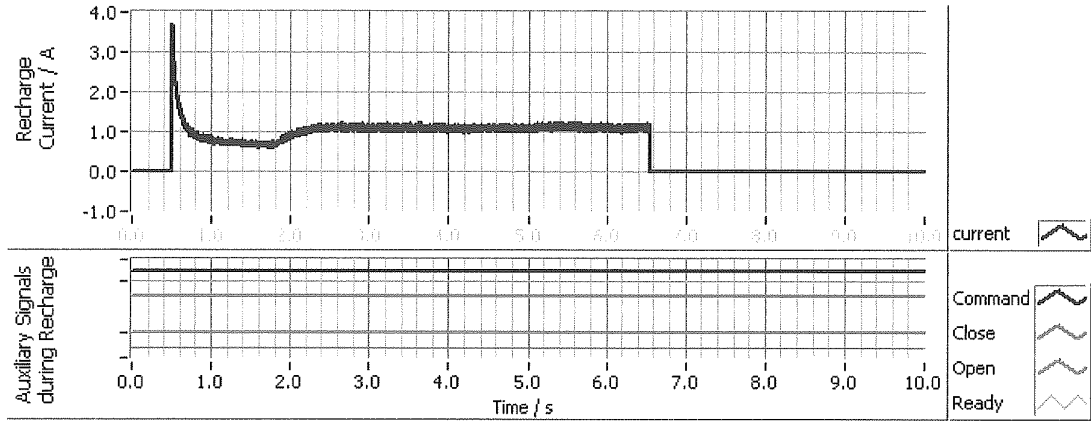
- Measuring point: Insulated coupling rod in phase L2
- Operating speed measured: $V_0 = 1.28 \text{ m/s}$ at $U = 1.0 \times U_a$

На основании чл.36а
ал.3 от ЗОП

090334

Diagram 2.3: Measurement of the recharging characteristics after the mechanical endurance test

Recharging after Close-Operation



No	Duration of Recharging	Recharge Current (Crs)	Recharge Current (max)	Recharge Current (avg)	Average Voltage	Power Cons. (avg)
C6	6.04 s	3.70 A	3.70 A	1.08 A	109.9 V	118.68 W

На основании чл.36а
ал.3 от ЗОП

000355

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 essential deviations.

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

Photo of Test Object

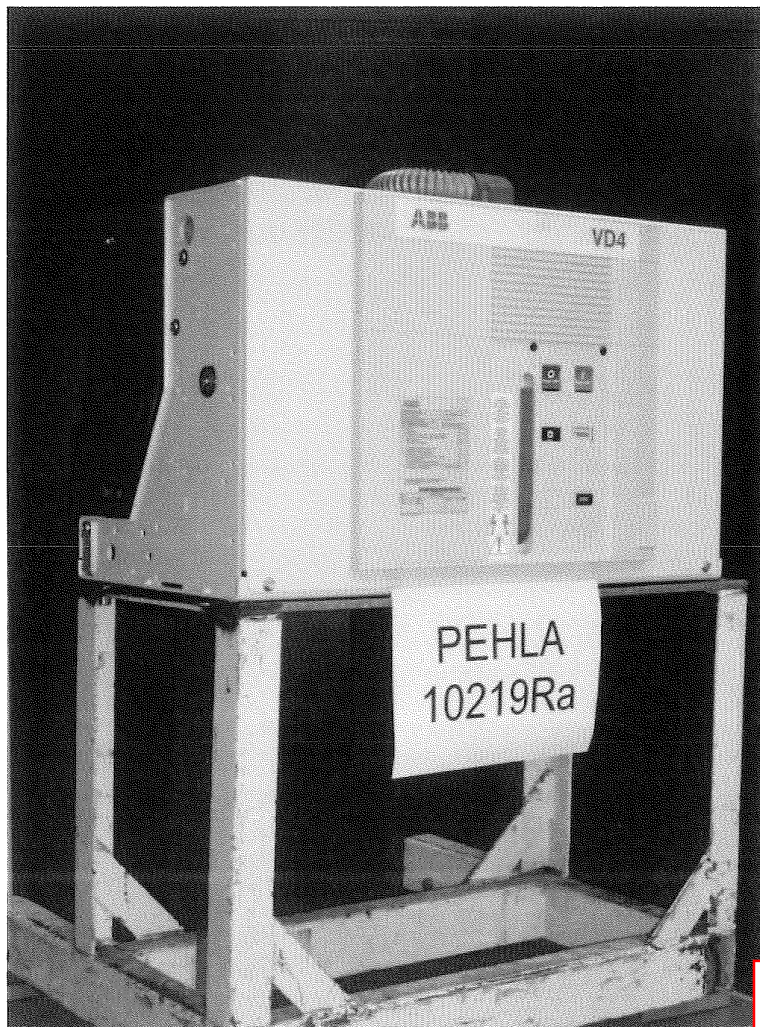


Photo 1: Test object

На основании чл.36а
ал.3 от ЗОП

000553