



A KEMA company.

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**HIGH
POWER
LABORATORY**

11 - 156

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e-version

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TEST REPORT

No. 11 - 156

Test object : Neutral earthing resistor
Type : RP
Serial No. : CR034553/1-1
Design : SDS-6811

Ratings
Rated system voltage : 33 kV
Resistance at 54°C : 47,6 Ω

Manufacturer : Cressall Resistors Ltd,
Evington Valley Road, Leicester, LE5 5LZ,
United Kingdom

Test performed : Short-time current test
Customer's request based on IEEE 32-1972, section 4.6 and
Cressall Test Acceptance Criteria, Issue B

Customer : Cressall Resistors Ltd,
Evington Valley Road, Leicester, LE5 5LZ,
United Kingdom

Date of test : 16. 08. 2011

◆ **Interpretation of results:**

The test object passed successfully the temperature-rise test, no visible damage appeared.

THIS TEST REPORT IS CONFIDENTIAL AND SHALL NOT BE PASSED OVER OR TRANSFERRED TO ANY THIRD PARTY WITHOUT WRITTEN APPROVAL OF THE CUSTOMER.
WITHOUT THE WRITTEN APPROVAL OF THE TESTING LABORATORY ZKRATOVNA SHALL NOT BE REPRODUCED EXCEPT IN FULL.

Praha 9, Běchovice

Tested by: 12.09.2011

Jan Štangler



Robert Jech
Head of the Laboratory



Copy No.: E

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Description of the test object

An outdoor neutral earthing resistor for a purpose of controlling the ground of an alternating current system. The active parts of the resistor are manufactured from a stainless steel alloy.

The test object was identified according to the drawing No. 119034 Issue B – sheet 1.

Ratings assigned by the manufacturer

Type	: RP
Serial No.	: CR034553/1-1
Tag number	: NER-11-AEH1A
Design	: SDS-6811
Manufacturer	: Cressall Resistors Ltd, United Kingdom
Year of manufacture	: 2011
Rated system voltage	: 33 kV
Rated continuous current	: 0 A
Rated line-neutral voltage	: 19,05 kV
Rated frequency	: 50 Hz
Rated short-time current	: 400 A
Rated time for short-time current	: 10 s
Resistance at 25°C	: 47,1 Ω
Resistance at 54°C	: 47,6 Ω
Maximum element temperature-rise	: 760°C
Temperature coefficient of resistance	: $0,36 \times 10^{-3} \text{ K}^{-1}$
Rated insulation level	: 170 kV (BIL)
Overall dimensions (width x depth x height)	: 1940 x 2182 x 2046 mm
Degree of protection	: IP55
Weight	: 930 kg
Installation	: Outdoor

Test specification

The test was carried out according to the customer's instructions. The test procedures, parameters and test assessment criteria are based on Test Acceptance Criteria – IP54 NERs Issue B dated March 16, 2011 by Cressall Resistors Ltd and IEEE 32-1972, section 4.6.

Test parameters

Test voltage	: 19 kV
Test current	: 400 A
Duration of test current	: 10 s

Summary

The test was carried out as required by the test specification. The test object **passed successfully** the short-time current test.

More details of the test performed are given in the enclosed tables and oscillogram.

Test conditions

Working frequency $f = 48,5 \text{ Hz} \div 49,5 \text{ Hz}$

The short-time current test was performed in a single-phase test circuit with a value of the no-load supply voltage of ca 20,5 kV.

The test object was mounted on a wooden base frame and connected to the test circuit by means of two Cu cables with a cross-section of 240 mm² each. The connection to the test circuit (earthed side of the test object) was earthed.

The temperature of the active part was measured by means of 3 thermocouples θ_A , θ_B and θ_C welded to the resistor's active parts. The thermocouples were placed as close as possible to each other. The thermocouples positions are documented by the photograph in Fig 2. The wires for thermocouples had to be additionally insulated from the metal cover by means of insulated tube (see Fig. 2).

The measurement of the resistance was carried out before and after the test.

The test circuit, including measurement points, is illustrated in the diagram REV122.

The connection of the test object to the test circuit is documented by the photograph in Fig. 1.

The test was witnessed by

John Everitt, Cressall Resistors Ltd, United Kingdom
Alan Thorburn, Cressall Resistors Ltd, United Kingdom

Notice:

The test results relate only to the tests given in this Test Report. No documents of administrative, business or other character can be substituted by this Test Report.

List of symbols

a) Used in the test conditions and the table of test results

I_1	- test current at the beginning of the test (first period)
I_2	- test current at the end of the test ($t \cong 0,99 t_i$)
I_e	- equivalent value of test current, r.m.s. value
U_1	- test voltage at the beginning of the test (first period)
U_2	- test voltage at the end of the test ($t \cong 0,99 t_i$)
U_e	- equivalent value of test voltage, r.m.s. value
W	- total injected energy
$\theta_A, \theta_B, \theta_C$	- temperatures on active parts of neutral earthing resistor
$\theta_{Ai}, \theta_{Bi}, \theta_{Ci}$	- initial temperatures on active parts of neutral earthing resistor (before the test)
$\theta_{mA}, \theta_{mB}, \theta_{mC}$	- maximum temperatures of $\theta_A, \theta_B, \theta_C$
$\Delta\theta_A, \Delta\theta_B, \Delta\theta_C$	- temperature-rises on active parts of neutral earthing resistor ($\Delta\theta = \theta_m - \theta_i$)
t_i	- duration of test current
I_{DC}	- DC current
ΔU_{DC}	- DC voltage drop
R	- resistance
ΔR	- change of resistance
R_{25}	- resistance recalculated to 25 °C

b) Used in the oscillogram

I	- short-circuit current course
U	- voltage drop course
t	- time
T_a, T_b, T_c	- temperatures on active parts of neutral earthing resistor

The Test Report contains: **13** sheets i.e.:

- 1 introductory sheet
- 1 title sheet
- 3 text sheets
- 3 table sheets
- 1 test circuit diagram
- 4 photograph sheets

1 oscillogram

1 enclosure

Drawing No.: 119034 Issue B – sheet 1

1. Table of test results: Short-time current test

Test circuit diagram: REV122

File denomination: resi16hx

Test No.	I ₁ (A)	I ₂ (A)	I _e (A)	U ₁ (kV)	U ₂ (kV)	U _e (kV)	W ¹⁾ (MJ)	θ _{Ai} θ _{Bi} θ _{Ci} (°C)	θ _{mA} θ _{mB} θ _{mC} (°C)	Δθ _A Δθ _B Δθ _C (K)	t _i (s)	Note
019	420	340	374	19,2	19,7	19,6	73,0	36,0 35,4 37,2	608 579 672	572 544 635	10,0	No effects, no faults.
Condition of the test object after tests: No visible damage appeared.												

Note ¹⁾: Total injected energy was analytically evaluated by the curves of course of test voltage and course of test current in the evaluation programme.

For ambient air temperature see table of Meteorological conditions.

2. Table of test results: Resistance measurement

Before test (ambient temperature: 24,9°C)			After test (ambient temperature: 16,6°C)			ΔR (%)
I _{DC} (mA)	ΔU _{DC} (V)	R (Ω)	I _{DC} (mA)	ΔU _{DC} (V)	R (Ω)	
189	8,91	47,2	183	8,58	46,9	---
---	---		183	8,57		
Calculated correction to 25°C						
R ₂₅ = 47,2 Ω			R ₂₅ = 47,0 Ω			- 0,4

3. Verification after test

Resistance at 26,1 °C (ambient temperature 22,0°C)	46,9 Ω
Resistance between active parts and enclosure at 16,6 °C , 1000 V DC	>11 GΩ
Tested resistor withstood power frequency voltage test 45 kV / 1 min between active parts and enclosure (LV terminal disconnected).	

Meteorological conditions

Test No.	Date (dd.mm.yy)	Time (hh:mm)	Temperature (°C)	Relative humidity (%)	Wind speed (m/s)	Atmospheric pressure (hPa)
019	16.8.2011	15:37	22,8	58	0,0	986

Test circuit parameters

File denomination		resi16hx
Test No.		019
Test circuit diagram		REV122
Generator		SIJ
Rated (phase to phase) voltage (kV)		14
Phases connected		R, T
Inductance per phase (mH)		0,150
Inductance of reactors per phase (mH)		0,138
Resistance of resistors per phase (Ω)		0
Supply transformer – Type		$S_S + S_T$
Connection		63
Transf. ratio		5,25
Inductance per phase (mH)		0,051
Total inductance per phase of supply circuit (mH)		0,339
Capacity in parallel (μF)		---
Resistance in series (Ω)		---
Neutral point of supply circuit		insulated
Short-circuit point		earthed
Load transformer – Type		---
Connection		---
Transf. ratio		---
Resistance of load resistors (Ω)		---
Inductance of load reactors (mH)		---
Capacity of load capacitors (μF)		---
Neutral point of load circuit		---
Power factor / impedance of supply circuit (- / %)		---
Power factor / impedance of load circuit (- / %)		---
Power factor of test circuit (-)		0,05

Measuring devices used

Test circuit diagram: REV122

File denomination: resi16hx.019

Measurand	Measuring sensor / device			Digital measuring system, type DMS
	Type	Serial No.	Transfer constant	Input channel, serial No.
I	Cage shunt	005/95	5 kA / 2 V	100-10100-2
Ta	Thermocouple to analog converter	1033-KL-30009-11	1 °C / 1 mV	100-10100-17
Tb	Thermocouple to analog converter	1033-KL-30008-11	1 °C / 1 mV	100-10100-15
Tc	Thermocouple to analog converter	1033-KL-3065-09	1 °C / 1 mV	100-10100-25
U	Combined voltage divider	DK 003/90	0,5 kV / 1 V	100-10100-19

Resistance measurement

Digital multimeter METEX, type M-4660A, serial No. 928225

Digital multimeter METEX, type M-4660A, serial No. EB290286

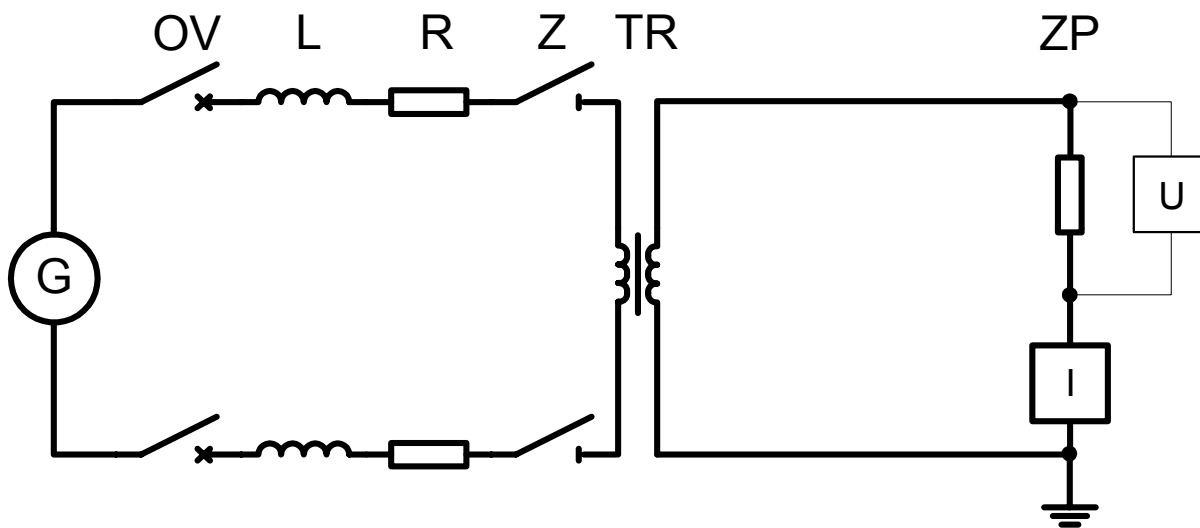
Verification after test

Megaohmmeter METRA PU 186, serial No. 9713779

Digital multimeter METEX, type M-4660A, serial No. EB290286

Meteorological conditions measurement

Meteorological station, type Vantage Pro 2, serial No. 3788A-6312



G - Short-circuit generator
OV - Master breaker
L, R - Reactors and resistors
Z - Make switch

TR - Short-circuit transformer
ZP - Tested object
I, U - Current and voltage measurement

Test circuit diagram REV122



Fig. 1

Test object before the test – connection to the test circuit and connection point

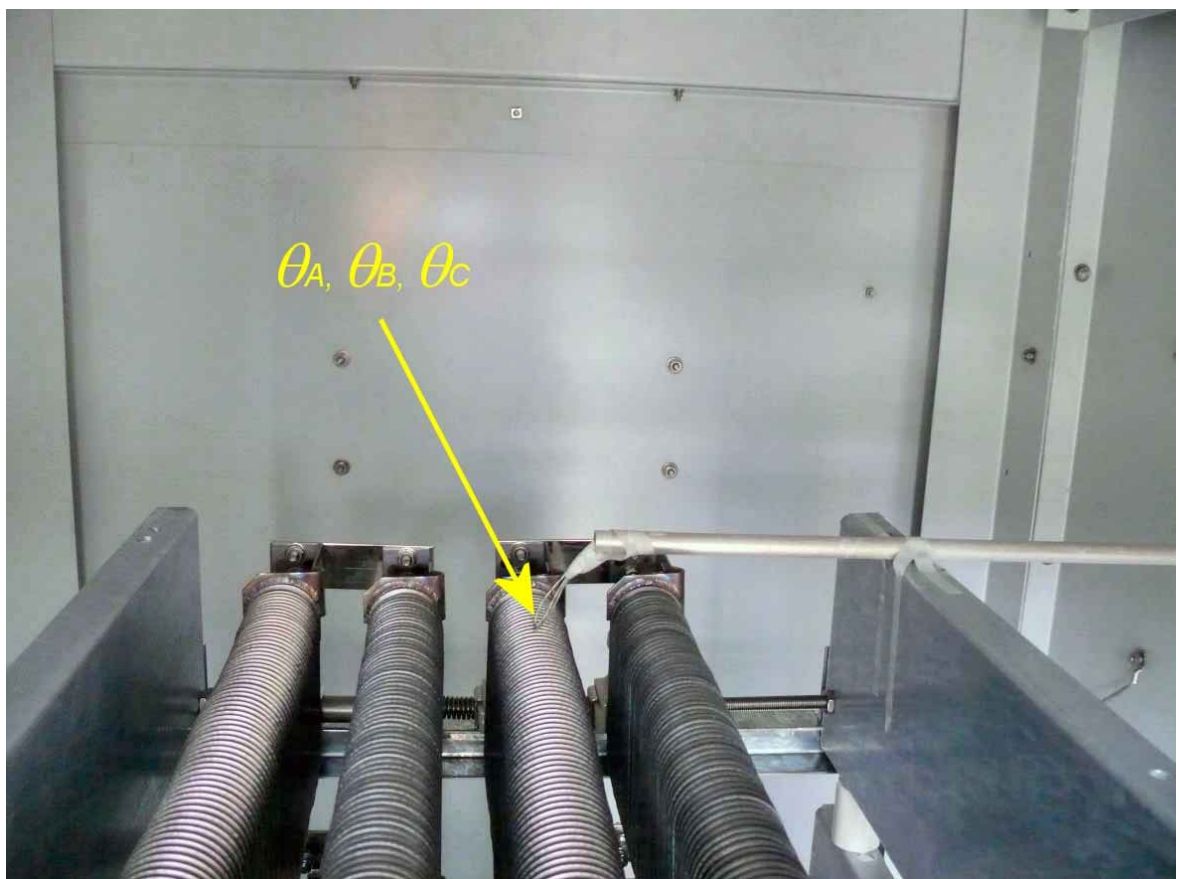
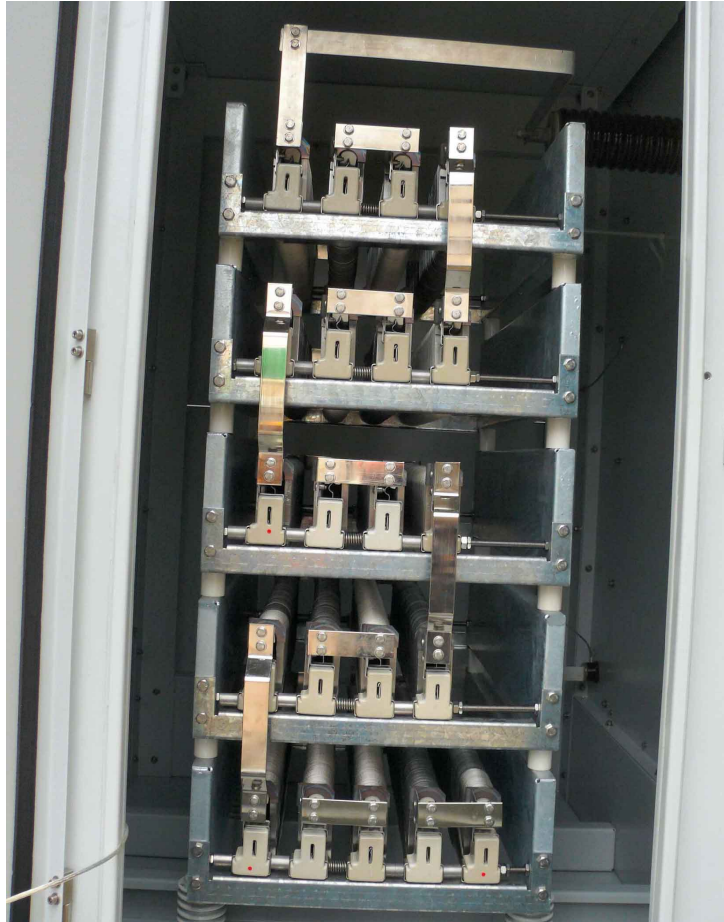


Fig. 2

Neutral earthing resistor before the test and the thermocouples positions (removed cover)



Fig. 3
Test object after the test (removed cover)

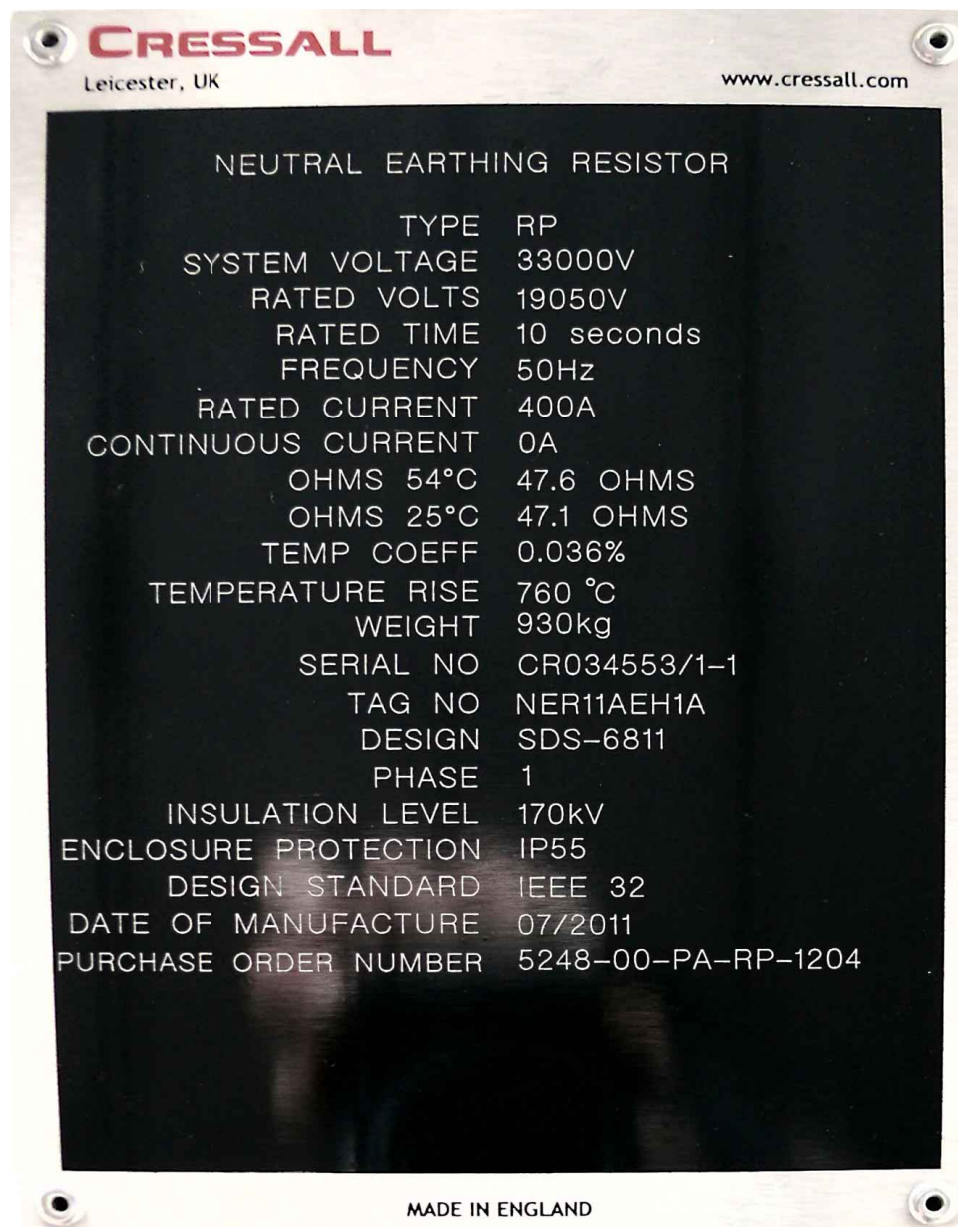
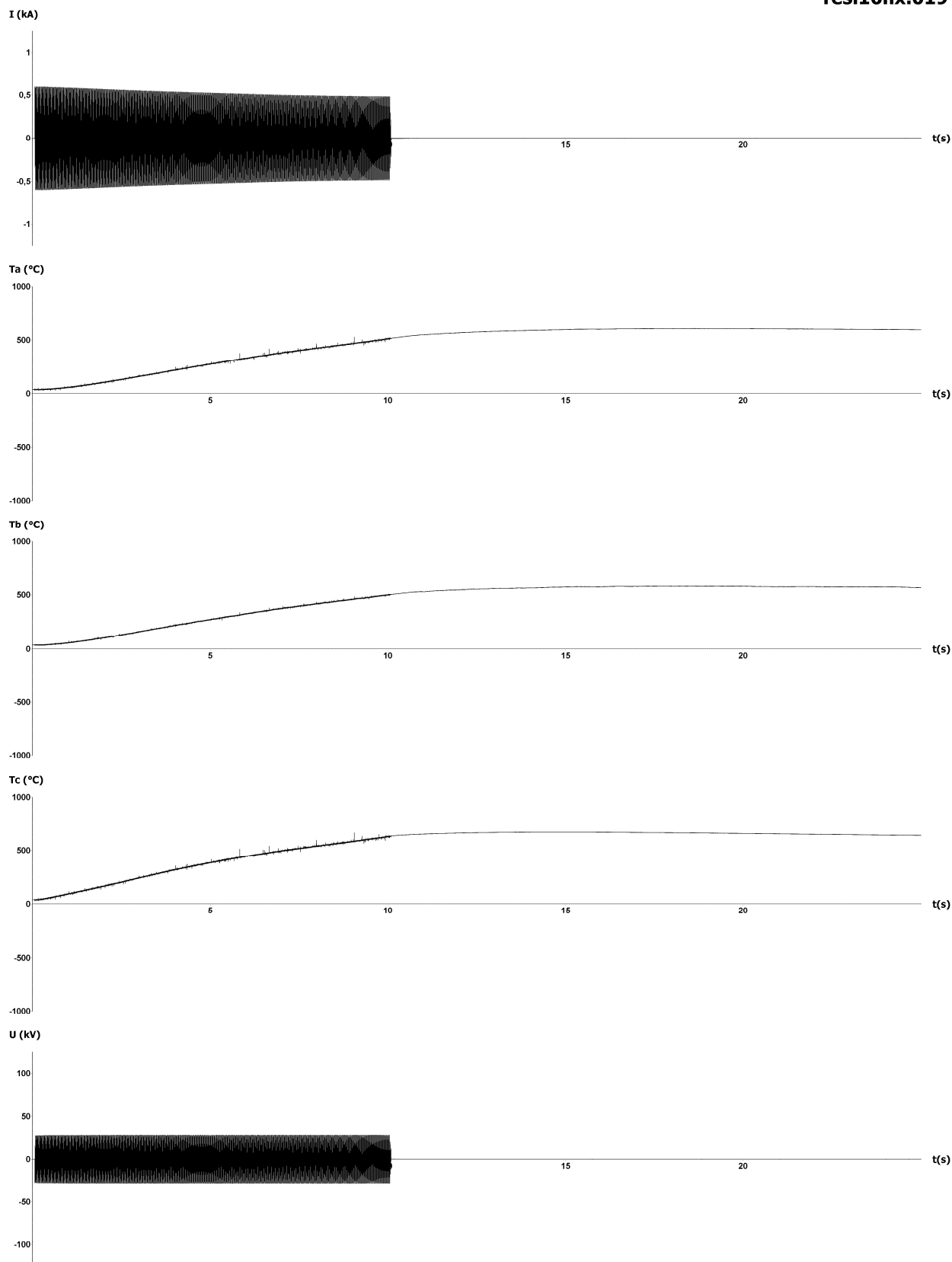


Fig. 4
Nameplate

Short-time current test 19,6 kV / 374 A / 10,0 s

resi16hx.019



ENCLOSURE MATERIAL
FRAME: 2mm STAINLESS STEEL GRADE 316
COVERS: 2mm STAINLESS STEEL GRADE 316
FINISH: RAL 7035

DEGREE OF PROTECTION

RESISTOR ENCLOSURE INGRESS (IEC60529) IP55
HV CABLEBOX INGRESS (IEC60529) IP55
ELECTRICAL (IEC60071) 170kV BIL (GRADED TO EARTH)

TECHNICAL DATA

SYSTEM VOLTAGE 33kV
LINE NEUTRAL VOLTAGE 19.05kV
RATED CURRENT 400A
RATED TIME 10s
CONTINUOUS CURRENT 0A
RESISTANCE AT 54°C 47.6 Ohms (±5%)
MAX ELEMENT TEMP RISE 760°C
ESTD. ENCLOSURE SURFACE TEMP. AFTER 10SECS. 200°C
ELEMENT TYPE EDGEWOUND 'RP' TYPE
ELEMENT MATERIAL STAINLESS STEEL ALLOY
TEMP COEFF OF RESISTANCE 0.036% PER °C
RESISTANCE CHANGE FOR 760°C RISE 27% APPROX
APPROX UNIT WEIGHT 930kg

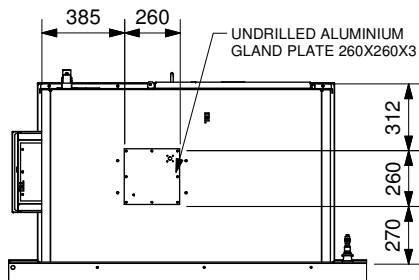
RESISTOR ENCLOSURE
HINGED DOOR WHICH
CAN BE PADLOCKED
IN CLOSED POSITION

NEUTRAL CONNECTION
1 HOLE M12 CLEARANCE
NEUTRAL CABLE
1C - 630 mm sq

'B'

BOLTED REMOVABLE
COVERS

C

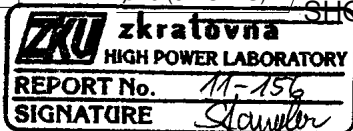


NOTES

- PLEASE NOTE THE UNIT REQUIRES A MINIMUM OF 600mm HORIZONTAL CLEARANCE FOR ACCESS PURPOSES (EXCEPT AT THE REAR FACE 100mm ONLY REQUIRED)
- ENCLOSURE SUITABLE FOR OUTSIDE INSTALLATION
- ALL FASTENERS ARE STAINLESS STEEL
- ALL INSULATION IS CERAMIC

TAG NUMBERS :
NER11AEH1A
NER11AEH1B
NER11AEH1C

ISOLATION SWITCH TO BE EQUIPPED WITH MECHANICAL KEY INTERLOCK BASED ON THE FOLLOWING:
- KEY CAN BE REMOVED FROM NER ONLY WHEN ISOLATION SWITCH IS CLOSED
- KEY SHALL BE TRAPPED WHILE ISOLATION SWITCH IS OPENED



SECTION 'B'-'B'
SHOWING FOUNDATIONS

Ø18 (4 HOLES)

Ø10 (6 HOLES)

1940

STAINLESS STEEL
RATING PLATE

1012

1370

1840

NEUTRAL CABLE ENTRY
VIA REMOVEABLE
UNDRILLED ALUMINIUM
GLAND PLATE
260x260x3 THK

EARTH BUSHING
PORCELAIN M12
1.2kV / 30kV BIL
EARTH CABLE
2 - 1C x 240 mm sq

2 x M10 FRAME EARTH
(DIAGONALLY
OPPOSITE)
WITH ASSOCIATE NUTS,
WASHERS ETC
SUITABLE FOR EARTH
CABLE 1C x 70mm sq

INCLINED CANOPY TO
PREVENT WATER BUILD UP

RESISTOR ENCLOSURE
HINGED DOOR WHICH
CAN BE PADLOCKED
IN CLOSED POSITION

HEATER AND ISOLATOR
AUXILIARIES IN LV
TERMINAL BOX
3mm THICK GLAND
PLATE FITTED

2182

1350

1662

2046

302

BASE PLATE FITTED

ANTI CON HEATER
FITTED IN CABLE BOX
AND RESISTOR
COMPARTMENT

812

400

1330

LIFTING EYE

RESISTOR
ENCLOSURE
BOLTED REMOVABLE
COVERS

HV CABLEBOX
BOLTED
REMOVABLE
COVER

SINGLE POLE OFF LOAD ISOLATOR 36kV 400A
PADLOCKABLE IN OPEN / CLOSED POSITION
2N/C AND 2 N/O AUXILIARY CONTACTS
MECHANICAL / CODED KEY INTERLOCK
(FORTRESS BM1)

B

5406

ADDED CUSTOMER'S NOTE

25/05/2011

KA

AK

ISSUE

ECN

DESCRIPTION

DATE

DRAWN

APPROVED

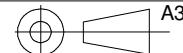
MATERIAL: -

WEIGHT: N/A

FINISH: -

1st CONTRACT: CR034553

TOLERANCE:- +/- 0.5 mm (UOS)
DIMENSIONS IN mm (UOS)



DRAWING TITLE

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NER ARRANGEMENT 33kV

DRAWING.No.

119034

SHEET

1 of 1

ISS

B

DRAWING STATUS: Released