FALCON TESTING LABORATORY LTD.

PO Box 10, Loughborough, Leics., LE11 1HR, England.

NAMAS TESTING No. 0298

REPORT OF PERFORMANCE No. 6313

APPARATUS: A Single Phase Neutral Earthing Resistor.

DESIGNATION: Type "RP Outdoor Service", - Serial No. CR4099/5.
Rated Voltage 6.35kV: Rated Current 750A: Rated Resistance at 20°C 8.5 ohms: Rated Frequency 50Hz.

MANUFACTURER: **Standard Cressall Resistors Limited,** Evington Valley Road, Leicester, LE5 5LZ.

TESTED FOR: Standard Cressall Resistors Limited

DATE OF TESTS: 19th March 1996.

The apparatus, constructed in accordance with the description, drawings and photographs attached hereto, has been tested in accordance with the Client's instructions.

TESTS

To verify temperature rise limits under the following test conditions;

a. Raise resistor element temperature by applying 100A until resistor temperature stabilises

b. With resistor temperature stabilised apply 750A at 6.35kV for 10seconds.

The record of Proving Tests applies only to the apparatus tested. The responsibility for conformity of any apparatus having the same designation with that tested rests with the Manufacturer.

The documents forming part of this Report are:

Record of Proving Tests - Page Nos. 1 to 6.
Diagram Nos. 6313/1.
Oscillogram Nos. 296026.
Photograph Nos. 631301, 631302, 631303.
Drawing Nos. BA93270, 93845, 38A0003232, 91907/6.

" Opinions and interpretations expressed herein are outside the scope of NAMAS accreditation "

V.J. Thompson. Observer

J.M. New. Manager

13th June 1996. Date

RECORD OF PROVING TESTS

Laboratory Reference No. 6313

Apparatus Tested.

The apparatus tested consisted of a neutral earthing resistor assembly, comprising of six banks of type RP-9G (6 wide) (B.Z.P) resistors. The assembly was designated type "RP Outdoor Service" and was marked with Serial No. CR4099/5.

The following ratings were assigned by the manufacturer;

Rated voltage	:	6350V
Rated current	:	750A
Rated time	:	10s
Rated resistance at 20°C	:	8.5 [1] Ohms
Rated lightning impulse withstand voltage	:	75kV peak
Temperature coefficient	:	0.0155
Rated frequency	:	50Hz

Note 1. As supplied for test the Client declared that the resistance had been measured and found to be 8.1 Ohms at 20°C.

The resistor assembly was arranged and constructed in accordance with the drawings as listed in the Schedule of Drawings, see page number 3.

Date of receipt of apparatus for test	:	18th March 1996.
Customer's order number	:	108508.

Test Specification.

Temperature rise tests were carried out at 750A for 10 seconds in accordance with the Client's instructions as follows;

a. Mark resistor elements in top resistor bank with colour coded temperature indicating paints.

b. Carry out a preheating test by injecting 100A until the resistor temperature stabilises. Temperature stability to be determined by monitoring the air flow temperature from below the top cover. Stabilisation of temperature considered to be achieved when temperature change is not greater than 1K per 15 minutes.

c. With the resistor elements at the stabilised temperature achieved in a. inject 750A at 6.35kV for 10 seconds. Total I^2t and V^2t input to be 5625×10^3 and 403.23×10^3 respectively.

d. After cooling inspect resistor elements and determine maximum temperature reached during test by inspecting for changes in colour coded temperature sensitive paints.

Schedule of Tests.

Test and Oscillogram Number	Duty
960319-2002 [2]	Start of 100A pre-heating test.
960319-2003 [2]	End of 100A pre-heating test.
296026	Temperature rise test 6.35kV *(750A nominally)* for 10 seconds

Note 2. Oscillographic records are not included in this document.

Test witnesses.

Mr S. Duckworth Mr A.P. Symons	Standard Cressall Resistors Limited.
Mr A. Inglis	London Electricity Services.
Mr V.J. Thompson	Falcon Testing Laboratory Limited.

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Test Conditions

The neutral earthing resistor in its enclosure was set down on insulation and clamped to the floor of the test cell. The enclosure was solidly connected to earth.

Temperature sensitive paints, as detailed below, were applied to the resistor elements, in the top bank of resistors, by the Client in order to indicate the peak temperature reached as a result of the tests. The temperature sensitive paints type "OMEGALAQ" Temperature Indicating Liquid were manufactured by Omega Engineering Inc., Stamford, Conn., USA. The paints used covered a temperature range of 677°C to 804°C with a claimed accuracy of ± 1% of the nominal rated values listed below.
Samples of the paints used were submitted to MEC, Cambridge Road, Whetstone, Leicester, LE8 6LH, for calibration against measuring instruments traceable to national standards, and copies of their Certificates of Calibration Nos. 02247 and 02281 are retained by the Testing Authority. The calibration test results are listed below:

Paint Colour	Nominal Rating °C	Calibration Test Results	
		Equal to or greater than °C	Equal to or less than °C
Grey	677	642.4	663.2
Pale Pink	704	668.3	689.7
Pale Green	732	717.3	732.1
Red	760	744.5	760.0
Yellow	788	788	804.6

A thermocouple was positioned in the gap between the top cover and the main enclosure in order to monitor the temperature of the air flow during the final test, this thermocouple was connected to a single channel digital temperature recorder.

The Client accepted that due to test plant limitations the applied voltage and current during the final test would vary between plus 7% and minus 21% provided that the total energy input, as indicated by I^2t and/or V^2t measurements, during the 10 seconds test was within 10% of the totals required.

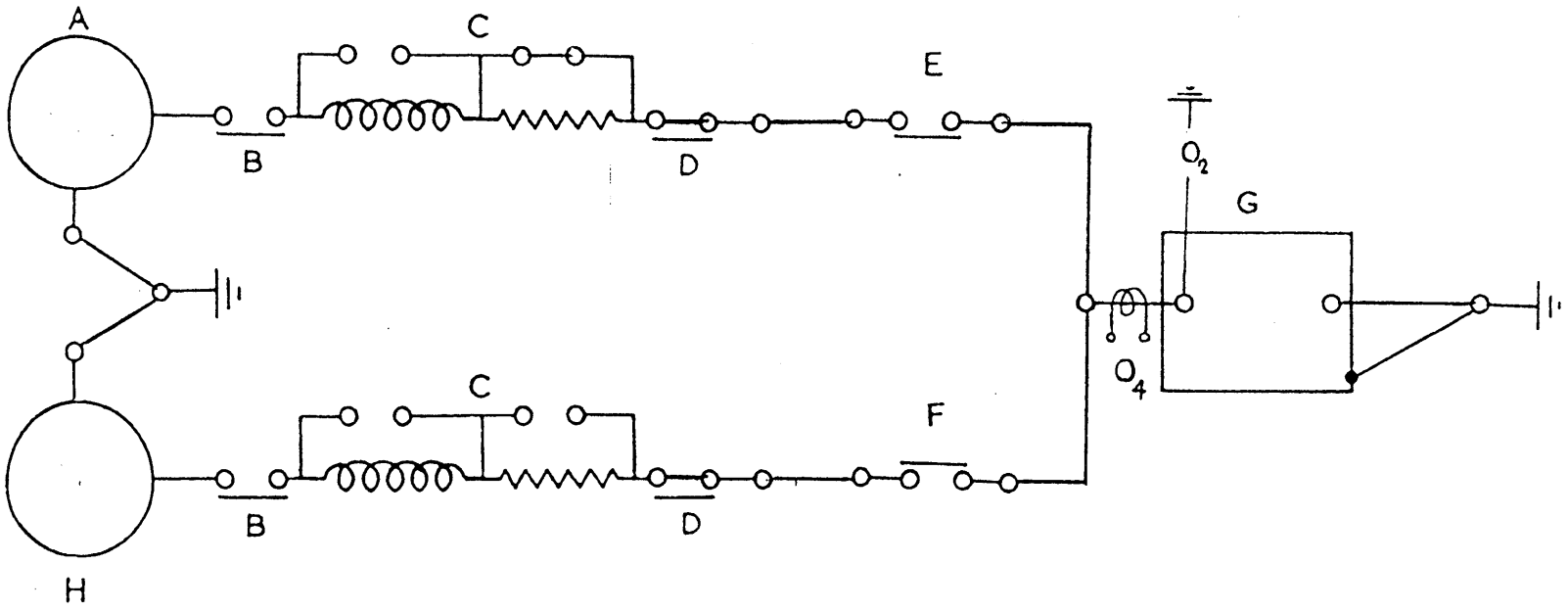
The resistor assembly was connected to a low voltage supply via an auxiliary oil circuit breaker for the preheating test and to a high voltage supply via an auxiliary vacuum circuit breaker for the temperature rise test. Changeover from the pre-heating supply to the temperature rise test supply was achieved within approximately 3 to 6 seconds by opening the auxiliary circuit breaker and then closing the main circuit breaker.

Test Circuit Details - Temperature rise test only

Diagram No.	Test No.	Station No.	Generator Connection and Voltage	Transformer Ratio	Test Supply (phase)
6313/1	296026	2	Series/Star 11kV	-	1

1. The test supply connected to the neutral earthing resistor's line terminal.
2. The neutral earthing resistor's earth terminal was solidly connected to earth.
3. Current measurement from a high voltage current transformer (O_4).
4. Voltage measurement from resistance potential divider (O_2) for applied voltage.

A SUPPLY ALTERNATOR FOR TEMPERATURE RISE TEST
B MASTER CIRCUIT BREAKERS
C SUPPLY SIDE IMPEDANCES
D MAKING SWITCHES
E AUXILIARY VACUUM CIRCUIT BREAKER
F AUXILIARY OIL CIRCUIT BREAKER
G APPARATUS UNDER TEST
H SUPPLY ALTERNATOR FOR PRE-HEATING TEST



TEST CIRCUIT DIAGRAM

DIAGRAM No. 6313/1

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Laboratory Reference No. 6313

Photographs.

The following photographs are included in this document:

Number	Description
631301	General arrangement for test.
631302	Resistor banks after test.
631303	Top resistor bank after test.

Schedule of Drawings.

	Drawing Number.	Issue Status. Ref.	Date.	Description.
*	BA93270	D	25.03.96	Neutral earthing resistor arrangement
*	93845	A	undated	RP-9G 6 Wide 6 high stack
	REA/P10180	D	12.05.87	Insulator
	70205	A	2.10.95	4 Inch stand-off *(insulator)*
	SA91456 (2 sheets)	B	25.01.95	Resistor terminal assembly
*	38A0003232	1st	31.7.95	Bushing assembly
	M/2575212/1	B	18.05.94	Insulator
*	91907/6	A	16.12.94	RP-9G Type bank assembly
	RE1/P9666	A	9.12.93	RP Unit insulator
	MM 756 (3 sheets)	D	4.95	Material specification - resistance strip
	RP 9G062N2	A	15.01.96	RP G Coil design sheet

* These drawings are included in this document, the remainder being retained by the Testing Authority for identification purposes.

Measurement Uncertainties.

The test values, where applicable, given in this document are subject to the following total arithmetic summation of uncertainty contributions.

	Via Oscillograph	Direct Measurement
Voltage up to 1kV.	± 5%	± 1·5%
Voltage 1kV. and over.	± 5%	± 5%
Current up to 5A.	± 5%	± 1·5%
Current 5A and over.	± 5%	± 2·5%
Joule Integral(I^2t)	± 15%	± 15%
Angular (Point on wave)	± 5°	± 5°
Power Factor	± 0·05	± 0·05
Pressure (Gas or fluid)	± 5%	± 5%
Displacement (travel)	± 10%	not applicable
Temperature up to 100°C	not applicable	± 2°C
Temperature 100°C and over	not applicable	± 3%
Relative Humidity	not applicable	± 5%
Resistance Ω	not applicable	± 5%
Insulation Resistance	not applicable	see note a) below
Time (the greater of)		
i) less than 5 seconds	± 5%	± 0·2% or 10ms
ii) 5 secs. up to 2 minutes	not applicable	± 0·5% or 10ms
iii) 2 mins. up to 1 hour	not applicable	± 1%
iv) over 1 hour	not applicable	± 2%

Notes.

a) Measured on instrument having marked values whose uncertainties are within ± 10%.

RECORD OF PROVING TESTS

Laboratory Reference No. 6313

Pre-heating test

Condition Before Test

Neutral earthing resistor assembly as supplied by the Client.
Single phase heating supply connected to resistor bank.
Ambient air temperature 8°C.

Photograph number : 631301

Test No. and Oscillogram No.	Time Interval from Initiation of Test	TEST QUANTITIES		PERFORMANCE	Observations During Test
		Applied Voltage	Current	Internal Air	
	Min	kV rms	A rms	°C	
960319-2002	0	[1]	100	8	No visible disturbance
960319-2003	50	[1]	100	400	No visible disturbance

Condition After Test

Internal air temperature above resistor banks stabilised at 400°C after 50 minutes.
Not inspected further at this stage.

1. Applied voltage constantly adjusted to maintain constant 100A current flow.

Temperature Rise Test : 10 seconds duration

Condition Before Test

Neutral earthing resistor assembly as immediately after test number 960319-2003.
Single phase high voltage supply connected to resistor bank.

Test No. and Oscillogram No.	Time Interval from Initiation of Test	TEST QUANTITIES				Observations During Test
		Applied Voltage	Current	Total I^2t	Total V^2t	
	s	kV rms	A rms	$A^2 t x 10^3$	$V^2 t x 10^3$	
296026	0	6.45	754			No visible disturbance
	2	6.81	785	1,184	87.91	
	4	6.72	760	1,194	91.53	
	6	6.44	709	1,079	86.59	
	8	5.89	653	928	76.01	
	10	5.50	593	776	64.87	
			Totals	5,161 [1]	406.91 [2]	

Condition After Test

Temperature of external covers ranged from being cold at the lower ends to very hot at the top ends.
Grey temperature sensitive paint on mid top resistor element changed slightly but not completely indicating a maximum temperature of 663°C.
Resistor elements very hot.
Assembly otherwise as before test.

Photograph number : 631302, 631303.

1. Equivalent to 91.75% of energy input requirement.
2. Equivalent to 100.91% of energy input requirement.

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RECORD OF PROVING TESTS

Laboratory Reference No. 6313

CALIBRATION OF OSCILLOGRAMS

Time Marking		0.1s	s	s	s	s
Trace ↓	Phase ↓	Test Number	Test Numbers	Test Numbers	Test Numbers	Test Numbers
		296026				
VOLTAGE V/mm						
2		500.0				
CURRENT A/mm						
1		50.0				

Trace number 1 is indicated on each oscillogram. Traces are numbered from top to bottom except for travel records. For practical reasons travel recorder traces bear no number.

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