



**EDAIII SYSTEM
CONDITION BASED MAINTENANCE OF
ROTATING MACHINES**

Sample Case:

**Hydraulic power generator tested before and after
repair (cleaning and drying)**



This document contains a case study to better understand the possibilities of EDA III System and its additional software EDA DiagHelp

Documents included are:

- EDA test report 19/11/2002
- EDA DiagHelp report (concerns 19/11/2002 test)
- EDA test report 03/03/2003
- EDA DiagHelp report (concerns 03/03/2003 test)
- Summary

IDENTIFICATION

SITE NAME	C.H. SAN TIBURCIO		
TECHNICAL SITE	CENTRAL		
MACHINE TYPE	Hydraulic Generator		
MFR. NUMBER	253827		
MANUFACTURER	GEE		
FUNCTION	GROUP 1		
DONE BY	Boris Batlle	INSTRUMENT	EDA3 99101

TECHNICAL DATA

VOLTAGE (KV)	5.00
POWER (MW)	1.700
INSTALLATION DATE	19-11-2002
TEST DATE	19-11-2002
LAST TEST DATE	19-11-2002
WORK HOURS NUMBER	0.0
HOURS FROM THE LAST TEST	0.0
RPM	428
IP PROTECTION GRADE	0
START TIMES	0
INSULATION THICKNESS (mm)	1.900
MANUFACT. AND REWIND YEARS	0 0

INSULATION CAT.

A: 105°C	<input type="checkbox"/>
E: 120°C	<input type="checkbox"/>
B: 130°C	<input type="checkbox"/>
F: 155°C	<input checked="" type="checkbox"/>
H: 180°C	<input type="checkbox"/>
C: 220°C	<input type="checkbox"/>
MORE	<input type="checkbox"/>

BINDER TYPE

ASPHALTIC	<input type="checkbox"/>
EPOXY	<input checked="" type="checkbox"/>
SHELLAC	<input type="checkbox"/>
POLYESTER	<input type="checkbox"/>
MORE	<input type="checkbox"/>

INSULATION TYPE

MICA	<input checked="" type="checkbox"/>
MORE	<input type="checkbox"/>

IMPREGNATION TYPE

GLOBAL	<input type="checkbox"/>
INDIVIDUAL	<input type="checkbox"/>
NONE	<input checked="" type="checkbox"/>

REMARKS

MEASURES

WINDING TEMP. (°C)	13	EXTERNAL TEMPERATURE (°C)	12
RELATIVE MOISTURE (%)	64		
DC CAPACITANCE (nF)	184	1KHz CAPACITANCE (nF)	85

FIRST TEST VOLTAGE (V)	498	SECOND TEST VOLTAGE (V)	2504
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CHARGE/REABS. CURRENT

labs1		lrabs1		labs2		lrabs2	
00:00	42.18 μ A	00:00	-31.98 μ A	00:00	257.5 μ A	00:00	-169.4 μ A
00:10	18.24 μ A	00:10	-10.56 μ A	00:10	137.4 μ A	00:10	-49.30 μ A
00:20	15.31 μ A	00:20	-6.718 μ A	00:20	102.2 μ A	00:20	-31.73 μ A
00:30	13.94 μ A	00:30	-5.100 μ A	00:30	96.10 μ A	00:30	-24.14 μ A
00:40	13.14 μ A	00:40	-4.137 μ A	00:40	92.64 μ A	00:40	-19.79 μ A
00:50	12.63 μ A	00:50	-3.529 μ A	00:50	90.98 μ A	00:50	-16.92 μ A
01:00	12.25 μ A	01:00	-3.085 μ A	01:00	88.89 μ A	01:00	-14.83 μ A
02:00	11.22 μ A	01:30	-2.279 μ A	02:00	84.91 μ A	01:30	-10.98 μ A
03:16	10.83 μ A	02:00	-1.825 μ A	03:16	82.76 μ A	02:00	-8.819 μ A
05:00	10.49 μ A			05:00	81.21 μ A		
10:00	10.29 μ A			10:00	82.95 μ A		
15:00	10.32 μ A			15:00	84.27 μ A		
20:00	10.26 μ A			20:00	86.49 μ A		
30:00	10.20 μ A			30:00	88.06 μ A		

TEST RESULTS

CAPACITANCE RATIO (%)	53.80	VOLTAGE RATIO	5.03	LEAKAGE CURRENT RATIO	1.72
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FIRST TEST VOLTAGE (V)

Insulation resistance 20°C (Gohm)	0.023
Insulation resistance 40°C (Gohm)	0.005
Polarization Index	1.16
Absorption Index	1.74
Time Constant (sec)	2.15
Absorption Ratio	6.91
Reabsorption Leakage Current Ratio	7.75
Leakage Current (nA)	9958.64
Std. Leakage Current 20°C (nA/V.F)	423.31
Std. Leakage Current 40°C (nA/V.F)	2121.59
Reabsorption Current	103.83
Standard Reabs. Current at Thickness	54.65

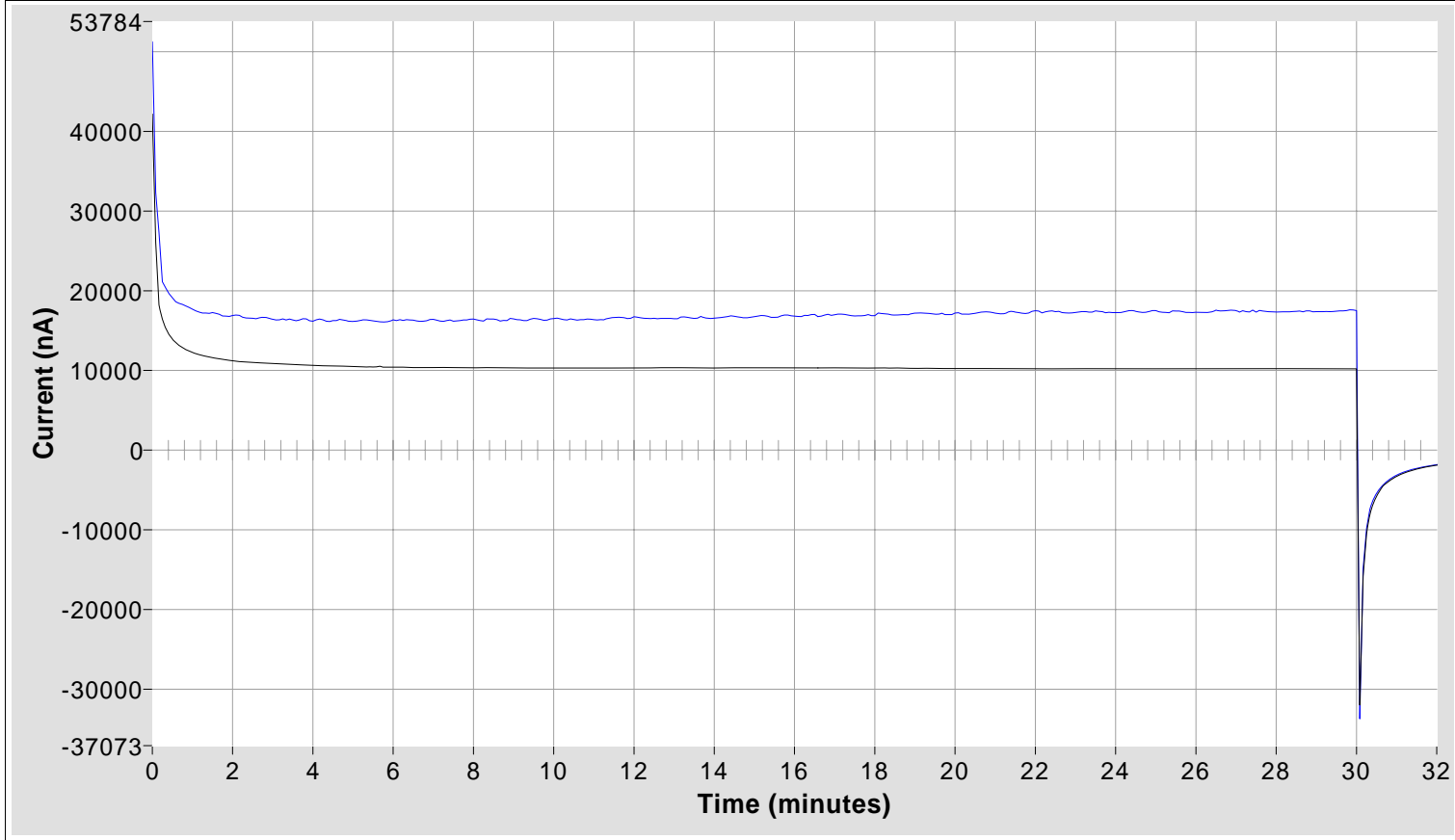
SECOND TEST VOLTAGE (V)

Insulation resistance 20°C (Gohm)	0.016
Insulation resistance 40°C (Gohm)	0.003
Polarization Index	1.04
Absorption Index	2.21
Time Constant (sec)	1.43
Absorption Ratio	1040.91
Reabsorption Leakage Current Ratio	13.91
Leakage Current (nA)	82944.29
Std. Leakage Current 20°C (nA/V.F)	727.11
Std. Leakage Current 40°C (nA/V.F)	3644.17
Reabsorption Current	99.30
Standard Reabs. Current at Thickness	52.26

TEST CURRENT GRAPH:

With reference graph

FIRST TEST VOLTAGE (V)	498	SECOND TEST VOLTAGE (V)	2504	Reference Graph
—————		-----		-----

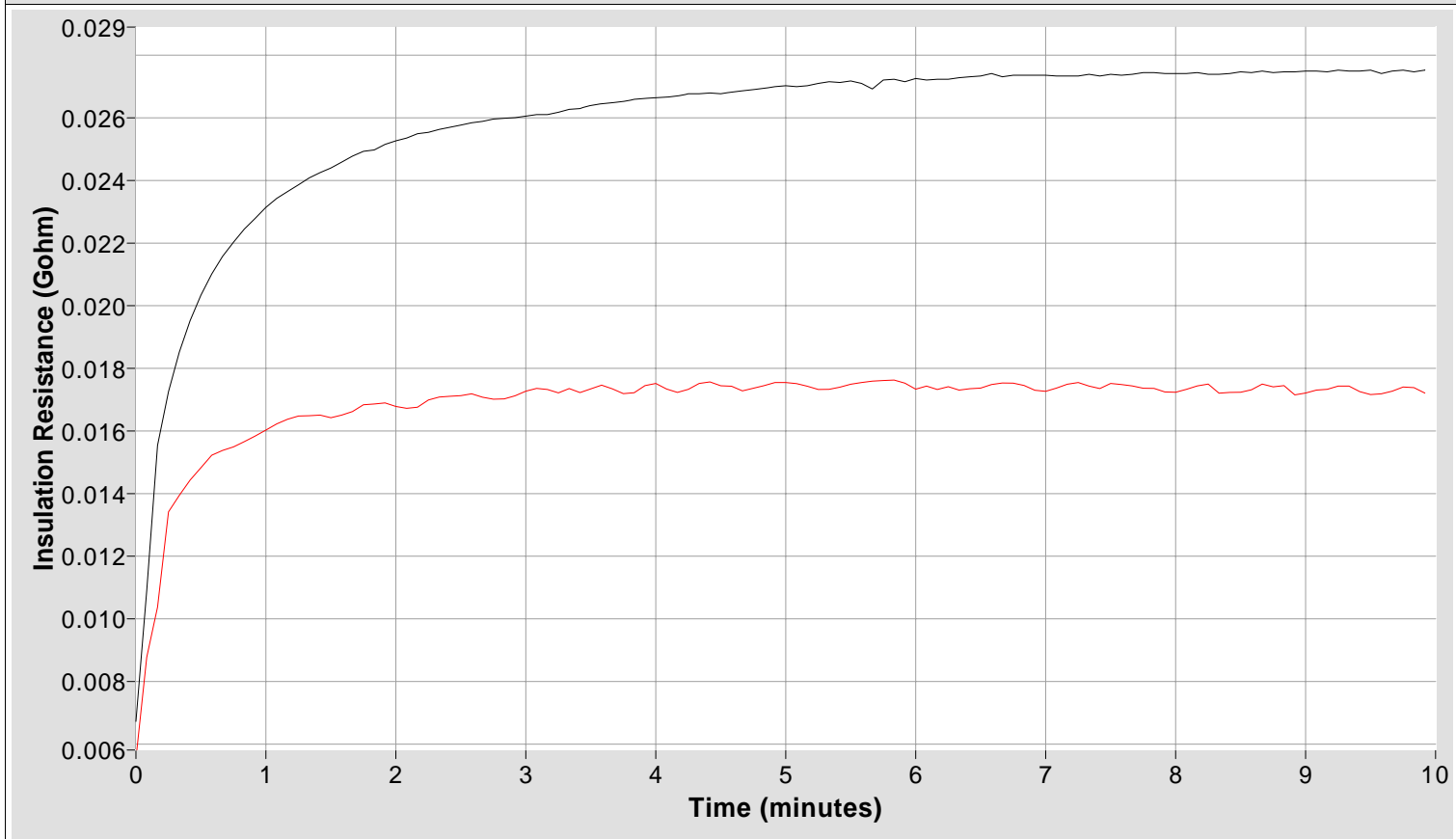


INSULATION RESISTANCE:

Corrected to 20 °C

No Smoothing

First Test Voltage	—————	Second Test Voltage	-----	Polarization I.
First Test Voltage (Smoothing)	-----	Second Test Voltage (Smoothing)	—————	1.16
				1.04



Identification

EDA Test Version: 3.2

Site Name: C.H. SAN TIBURCIO
Technical Site: CENTRAL
Machine Type: Hydraulic Generator
MFR. Number: 253827

Manufacturer: GEE
Function: GROUP 1
Done By: Boris Batlle
Instrument: EDA3

Technical Data

Voltage (KV): 5
 Power (MW): 1,7
 Installation Date: 19-11-02
 Test Date: 19-11-02
 Last Test Date: 19-11-02
 Total Running Hours: 300000
 Hours Since Last Test: 0
 R.P.M.: 428
 IP Protection Index: 0
 Start Times: 0
 Insulation Thickness (mm): 1,9
 Manufact. - Rewind Year: 1956 0

Insulation Category

A: 105°C
 E: 120°C
 B: 130°C
 F: 155°C
 H: 180°C
 C: 220°C
 Other

Insulation Type

MICA
 Other

Binder Type

Asphaltic
 Epoxi
 Shellac
 Polyester
 Other

Impregnation Type

Global
 Individual
 None

Remarks

Results

Winding Temperature (°C): 13

Relative Moisture (%): 64

DC Capacitance (nF): 184

External Temperature (°C): 12

1 KHz Capacitance (nF): 85

First Voltage Test (V): 500

Second Voltage Test (V): 2500

Charge / Reabsorption Current

labs 1		lrabs 1		labs 2		lrabs 2	
0 sec.	42,18 μ A	0 sec.	-31,98 μ A	0 sec.	257,5 μ A	0 sec.	-169,4 μ A
10 sec.	18,24 μ A	10 sec.	-10,56 μ A	10 sec.	137,4 μ A	10 sec.	-49,30 μ A
20 sec.	15,31 μ A	20 sec.	-6,718 μ A	20 sec.	102,2 μ A	20 sec.	-31,73 μ A
30 sec.	13,94 μ A	30 sec.	-5,100 μ A	30 sec.	96,10 μ A	30 sec.	-24,14 μ A
40 sec.	13,14 μ A	40 sec.	-4,137 μ A	40 sec.	92,64 μ A	40 sec.	-19,79 μ A
50 sec.	12,63 μ A	50 sec.	-3,529 μ A	50 sec.	90,98 μ A	50 sec.	-16,92 μ A
1 min.	12,25 μ A	1 min.	-3,085 μ A	1 min.	88,89 μ A	1 min.	-14,83 μ A
2 min.	11,22 μ A	1 m 30 s	-2,279 μ A	2 min.	84,91 μ A	1 m 30 s	-10,98 μ A
3 m 16 s	10,83 μ A	2 min.	-1,825 μ A	3 m 16 s	82,76 μ A	2 min.	-8,819 μ A
5 min.	10,49 μ A			5 min.	81,21 μ A		
10 min.	10,29 μ A			10 min.	82,95 μ A		
15 min.	10,32 μ A			15 min.	84,27 μ A		
20 min.	10,26 μ A			20 min.	86,49 μ A		
30 min.	10,20 μ A			30 min.	88,06 μ A		

Test Results

Capacitance Ratio

53,80

Voltage Ratio

5,01

Leakage Current Ratio

1,72

	First Test	Second Test
Insulation Resistance 20°C (Gohm):	0,023	0,016
Insulation Resistance 40°C (Gohm):	0,005	0,003
Polarization Index:	1,16	1,04
Absorption Index:	1,74	2,21
Time Constant (sec):	2,15	1,42
Absorption Ratio:	6,91	1040,91
Reabsorption Leakage Current Ratio:	7,75	13,91
Leakage Current (nA):	9958,64	82944,29
Std. Leakage Current 20°C (mA/V.F):	423,66	730,29
Std. Leakage Current 40°C (mA/V.F):	2123,34	3660,12
Reabsorption Current:	103,91	99,74
Standard. Reabs. Index at Thickness:	54,69	52,49

Diagnostic MV

Reversible Problems

Insulation State	Very weak because it's very moist or it has superficial contamination.	
Insulation Resistance	Anormal	
Surface Currents:	Trace	
Surface Moisture:	No Trace	
Surface Contamination	Trace	
Internal Moisture	No Trace	
Internal Contaminator	No Trace	

No Reversible Problems

Transverse Current:		
Abnormal Aging:		
Aglomerant State:		
Dielectric Structure:		

IDENTIFICATION

SITE NAME	<input style="width: 90%;" type="text" value="C.H. SAN TIBURCIO"/>		
TECHNICAL SITE	<input style="width: 90%;" type="text" value="CENTRAL"/>		
MACHINE TYPE	<input style="width: 90%;" type="text" value="Hydraulic Generator"/>		
MFR. NUMBER	<input style="width: 90%;" type="text" value="253827"/>		
MANUFACTURER	<input style="width: 90%;" type="text" value="GEE"/>		
FUNCTION	<input style="width: 90%;" type="text" value="GROUP 1"/>		
DONE BY	<input style="width: 60%;" type="text" value="Boris Batlle"/>	INSTRUMENT	<input style="width: 15%;" type="text" value="EDA3"/> <input style="width: 15%;" type="text" value="99101"/>

TECHNICAL DATA

<table style="width: 100%; border-collapse: collapse;"> <tr><td>VOLTAGE (KV)</td><td><input style="width: 80%;" type="text" value="5.00"/></td></tr> <tr><td>POWER (MW)</td><td><input style="width: 80%;" type="text" value="1.700"/></td></tr> <tr><td>INSTALLATION DATE</td><td><input style="width: 80%;" type="text" value="19-11-2002"/></td></tr> <tr><td>TEST DATE</td><td><input style="width: 80%;" type="text" value="03-03-2003"/></td></tr> <tr><td>LAST TEST DATE</td><td><input style="width: 80%;" type="text" value="01-03-2003"/></td></tr> <tr><td>WORK HOURS NUMBER</td><td><input style="width: 80%;" type="text" value="300000.0"/></td></tr> <tr><td>HOURS FROM THE LAST TEST</td><td><input style="width: 80%;" type="text" value="0.0"/></td></tr> <tr><td>RPM</td><td><input style="width: 80%;" type="text" value="428"/></td></tr> <tr><td>IP PROTECTION GRADE</td><td><input style="width: 80%;" type="text" value="0"/></td></tr> <tr><td>START TIMES</td><td><input style="width: 80%;" type="text" value="0"/></td></tr> <tr><td>INSULATION THICKNESS (mm)</td><td><input style="width: 80%;" type="text" value="1.900"/></td></tr> <tr><td>MANUFACT. AND REWIND YEARS</td><td><input style="width: 40%;" type="text" value="1956"/> <input style="width: 40%;" type="text" value="0"/></td></tr> </table>	VOLTAGE (KV)	<input style="width: 80%;" type="text" value="5.00"/>	POWER (MW)	<input style="width: 80%;" type="text" value="1.700"/>	INSTALLATION DATE	<input style="width: 80%;" type="text" value="19-11-2002"/>	TEST DATE	<input style="width: 80%;" type="text" value="03-03-2003"/>	LAST TEST DATE	<input style="width: 80%;" type="text" value="01-03-2003"/>	WORK HOURS NUMBER	<input style="width: 80%;" type="text" value="300000.0"/>	HOURS FROM THE LAST TEST	<input style="width: 80%;" type="text" value="0.0"/>	RPM	<input style="width: 80%;" type="text" value="428"/>	IP PROTECTION GRADE	<input style="width: 80%;" type="text" value="0"/>	START TIMES	<input style="width: 80%;" type="text" value="0"/>	INSULATION THICKNESS (mm)	<input style="width: 80%;" type="text" value="1.900"/>	MANUFACT. AND REWIND YEARS	<input style="width: 40%;" type="text" value="1956"/> <input style="width: 40%;" type="text" value="0"/>	<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; vertical-align: top;"> INSULATION CAT. A: 105°C <input style="width: 60%;" type="text"/> E: 120°C <input style="width: 60%;" type="text"/> B: 130°C <input style="width: 60%;" type="text"/> F: 155°C <input style="width: 60%; text-align: center;" type="text" value="X"/> H: 180°C <input style="width: 60%;" type="text"/> C: 220°C <input style="width: 60%;" type="text"/> MORE <input style="width: 60%;" type="text"/> </td> <td style="width: 50%; vertical-align: top;"> BINDER TYPE ASPHALTIC <input style="width: 60%;" type="text"/> EPOXY <input style="width: 60%; text-align: center;" type="text" value="X"/> SHELLAC <input style="width: 60%;" type="text"/> POLYESTER <input style="width: 60%;" type="text"/> MORE <input style="width: 60%;" type="text"/> </td> </tr> <tr> <td style="vertical-align: top;"> INSULATION TYPE MICA <input style="width: 60%; text-align: center;" type="text" value="X"/> MORE <input style="width: 60%;" type="text"/> </td> <td style="vertical-align: top;"> IMPREGNATION TYPE GLOBAL <input style="width: 60%;" type="text"/> INDIVIDUAL <input style="width: 60%;" type="text"/> NONE <input style="width: 60%; text-align: center;" type="text" value="X"/> </td> </tr> </table>	INSULATION CAT. A: 105°C <input style="width: 60%;" type="text"/> E: 120°C <input style="width: 60%;" type="text"/> B: 130°C <input style="width: 60%;" type="text"/> F: 155°C <input style="width: 60%; text-align: center;" type="text" value="X"/> H: 180°C <input style="width: 60%;" type="text"/> C: 220°C <input style="width: 60%;" type="text"/> MORE <input style="width: 60%;" type="text"/>	BINDER TYPE ASPHALTIC <input style="width: 60%;" type="text"/> EPOXY <input style="width: 60%; text-align: center;" type="text" value="X"/> SHELLAC <input style="width: 60%;" type="text"/> POLYESTER <input style="width: 60%;" type="text"/> MORE <input style="width: 60%;" type="text"/>	INSULATION TYPE MICA <input style="width: 60%; text-align: center;" type="text" value="X"/> MORE <input style="width: 60%;" type="text"/>	IMPREGNATION TYPE GLOBAL <input style="width: 60%;" type="text"/> INDIVIDUAL <input style="width: 60%;" type="text"/> NONE <input style="width: 60%; text-align: center;" type="text" value="X"/>
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REMARKS

MEASURES

WINDING TEMP. (°C)	25	EXTERNAL TEMPERATURE (°C)	15
RELATIVE MOISTURE (%)	74		
DC CAPACITANCE (nF)	61	1KHz CAPACITANCE (nF)	56

FIRST TEST VOLTAGE (V)	497	SECOND TEST VOLTAGE (V)	2495
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CHARGE/REABS. CURRENT

labs 1		lrabs 1		labs 2		lrabs 2	
00:00	3.530 µA	00:00	-3.377 µA	00:00	19.70 µA	00:00	-18.89 µA
00:10	1.422 µA	00:10	-1.329 µA	00:10	7.526 µA	00:10	-6.721 µA
00:20	1.006 µA	00:20	-874 nA	00:20	4.951 µA	00:20	-4.378 µA
00:30	814 nA	00:30	-672 nA	00:30	4.044 µA	00:30	-3.433 µA
00:40	752 nA	00:40	-553 nA	00:40	3.495 µA	00:40	-2.837 µA
00:50	621 nA	00:50	-474 nA	00:50	3.116 µA	00:50	-2.438 µA
01:00	566 nA	01:00	-417 nA	01:00	2.844 µA	01:00	-2.145 µA
02:00	403 nA	01:30	-310 nA	02:00	2.028 µA	01:30	-1.606 µA
03:16	320 nA	02:00	-250 nA	03:16	1.638 µA	02:00	-1.300 µA
05:00	274 nA			05:00	1.376 µA		
10:00	211 nA			10:00	1.089 µA		
15:00	182 nA			15:00	961 nA		
20:00	169 nA			20:00	898 nA		
30:00	153 nA			30:00	805 nA		

TEST RESULTS

CAPACITANCE RATIO (%)	8.20	VOLTAGE RATIO	5.01	LEAKAGE CURRENT RATIO	1.05
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FIRST TEST VOLTAGE (V)

Insulation resistance 20°C (Gohm)	1.316
Insulation resistance 40°C (Gohm)	0.263
Polarization Index	2.63
Absorption Index	1.56
Time Constant (sec)	103.51
Absorption Ratio	5.09
Reabsorption Leakage Current Ratio	0.60
Leakage Current (nA)	124.28
Std. Leakage Current 20°C (nA/V.F)	3.67
Std. Leakage Current 40°C (nA/V.F)	18.38
Reabsorption Current	11.61
Standard Reabs. Current at Thickness	6.11

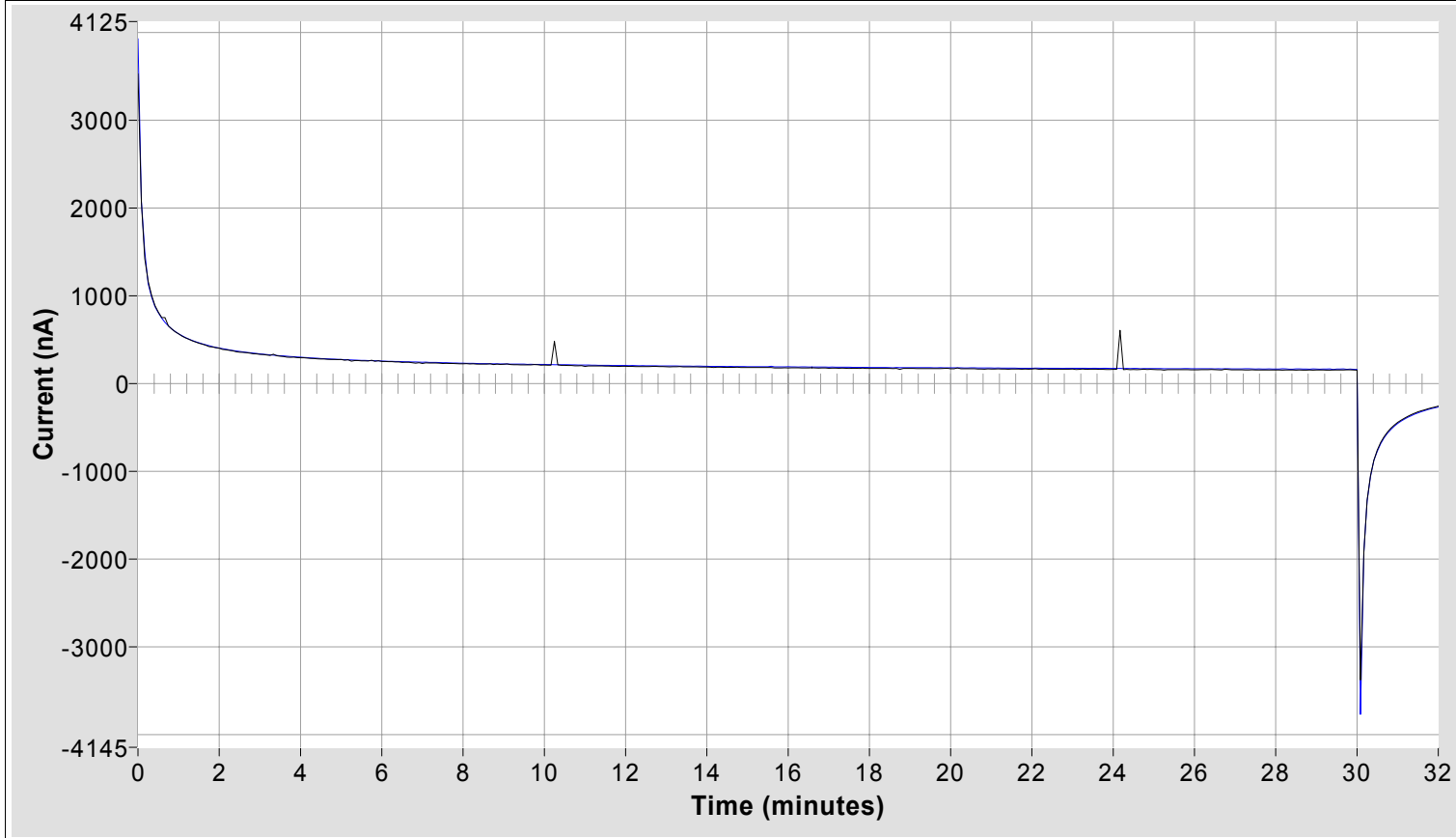
SECOND TEST VOLTAGE (V)

Insulation resistance 20°C (Gohm)	1.313
Insulation resistance 40°C (Gohm)	0.262
Polarization Index	2.59
Absorption Index	1.54
Time Constant (sec)	103.08
Absorption Ratio	4.83
Reabsorption Leakage Current Ratio	0.61
Leakage Current (nA)	630.25
Std. Leakage Current 20°C (nA/V.F)	3.85
Std. Leakage Current 40°C (nA/V.F)	19.30
Reabsorption Current	11.92
Standard Reabs. Current at Thickness	6.27

TEST CURRENT GRAPH:

With reference graph

FIRST TEST VOLTAGE (V)	497	SECOND TEST VOLTAGE (V)	2495	Reference Graph
—————		-----		-----

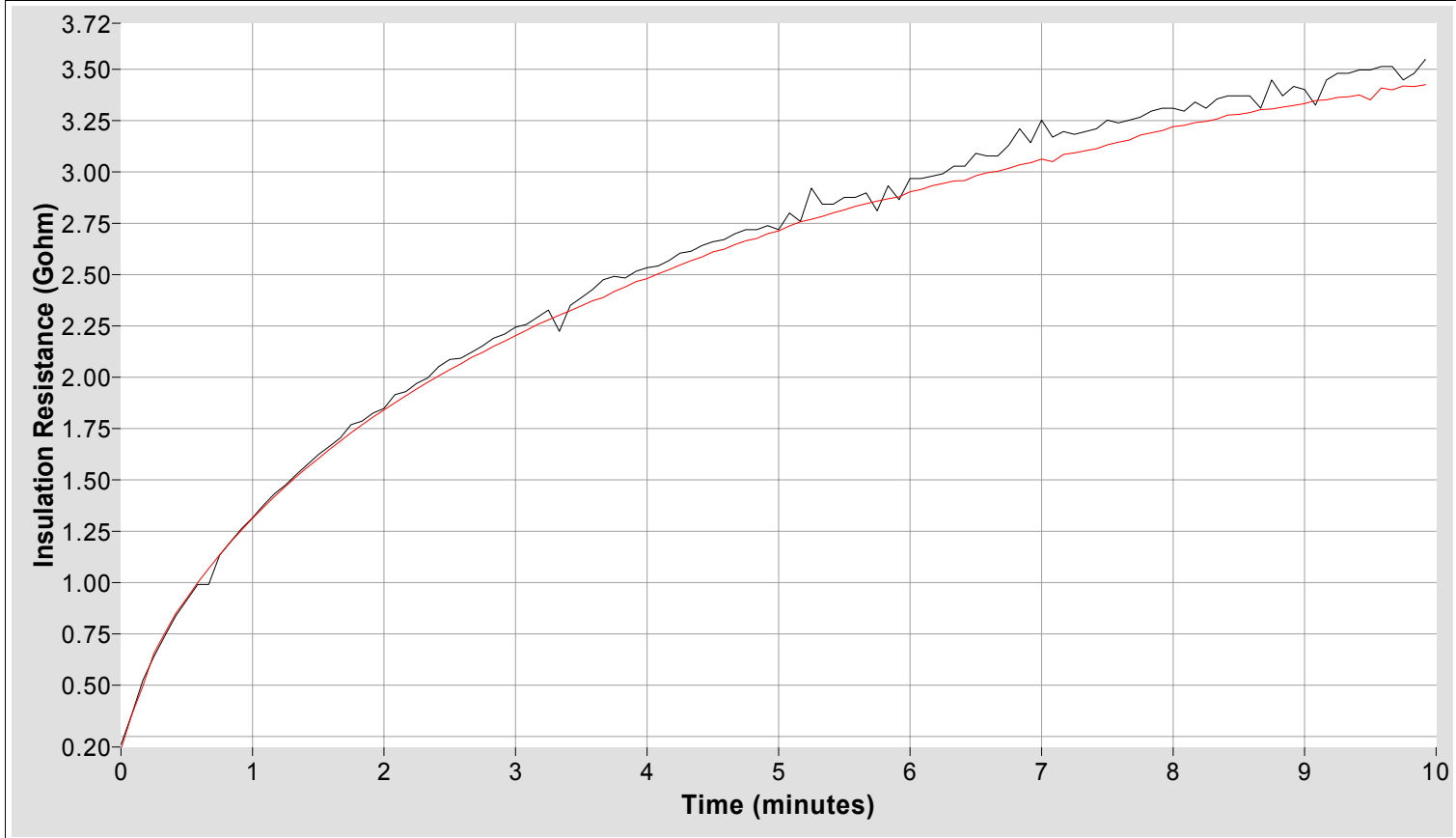


INSULATION RESISTANCE:

Corrected to 20 °C

No Smoothing

First Test Voltage	—————	Second Test Voltage	-----	Polarization I.
First Test Voltage (Smoothing)	-----	Second Test Voltage (Smoothing)	—————	2.63
				2.59



Identification

EDA Test Version: 3.99

Site Name: C.H. SAN TIBURCIO
Technical Site: CENTRAL
Machine Type: Hydraulic Generator
MFR. Number: 253827

Manufacturer: GEE
Function: GROUP 1
Done By: Boris Batlle
Instrument: EDA3

Technical Data

Voltage (KV): 5
 Power (MW): 1,7
 Installation Date: 19-11-02
 Test Date: 03-03-03
 Last Test Date: 01-03-03
 Total Running Hours: 300000
 Hours Since Last Test: 0
 R.P.M.: 428
 IP Protection Index: 0
 Start Times: 0
 Insulation Thickness (mm): 1,9
 Manufact. - Rewind Year: 1956 0

Insulation Category

A: 105°C
 E: 120°C
 B: 130°C
 F: 155°C
 H: 180°C
 C: 220°C
 Other

Binder Type

Asphaltic
 Epoxi
 Shellac
 Polyester
 Other

Insulation Type

MICA
 Other

Impregnation Type

Global
 Individual
 None

Remarks

Results

Winding Temperature (°C):	25
Relative Moisture (%):	74
DC Capacitance (nF):	61

External Temperature (°C):	15
1 KHz Capacitance (nF):	56

First Voltage Test (V): 500

Second Voltage Test (V): 2500

Charge / Reabsorption Current

labs 1		lrabs 1		labs 2		lrabs 2	
0 sec.	3,530 µA	0 sec.	-3,377 µA	0 sec.	19,70 µA	0 sec.	-18,89 µA
10 sec.	1,422 µA	10 sec.	-1,329 µA	10 sec.	7,526 µA	10 sec.	-6,721 µA
20 sec.	1,006 µA	20 sec.	-874 nA	20 sec.	4,951 µA	20 sec.	-4,378 µA
30 sec.	814 nA	30 sec.	-672 nA	30 sec.	4,044 µA	30 sec.	-3,433 µA
40 sec.	752 nA	40 sec.	-553 nA	40 sec.	3,495 µA	40 sec.	-2,837 µA
50 sec.	621 nA	50 sec.	-474 nA	50 sec.	3,116 µA	50 sec.	-2,438 µA
1 min.	566 nA	1 min.	-417 nA	1 min.	2,844 µA	1 min.	-2,145 µA
2 min.	403 nA	1 m 30 s	-310 nA	2 min.	2,028 µA	1 m 30 s	-1,606 µA
3 m 16 s	320 nA	2 min.	-250 nA	3 m 16 s	1,638 µA	2 min.	-1,300 µA
5 min.	274 nA			5 min.	1,376 µA		
10 min.	211 nA			10 min.	1,089 µA		
15 min.	182 nA			15 min.	961 nA		
20 min.	169 nA			20 min.	898 nA		
30 min.	153 nA			30 min.	805 nA		

Test Results

Capacitance Ratio

8,20

Voltage Ratio

5,01

Leakage Current Ratio

1,05





	First Test	Second Test
Insulation Resistance 20°C (Gohm):	1,316	1,313
Insulation Resistance 40°C (Gohm):	0,263	0,262
Polarization Index:	2,63	2,59
Absorption Index:	1,56	1,54
Time Constant (sec):	103,51	103,08
Absorption Ratio:	5,09	4,83
Reabsorption Leakage Current Ratio:	0,60	0,61
Leakage Current (nA):	124,28	630,25
Std. Leakage Current 20°C (mA/V.F):	3,67	3,85
Std. Leakage Current 40°C (mA/V.F):	18,38	19,30
Reabsorption Current:	11,61	11,92
Standard. Reabs. Index at Thickness:	6,11	6,27

Diagnostic MV

Reversible Problems

Insulation State	Dry and Clean	
Insulation Resistance	Normal	
Surface Currents:	No Trace	
Surface Moisture:	No Trace	
Surface Contamination	No Trace	
Internal Moisture	No Trace	
Internal Contaminator	No Trace	

No Reversible Problems

Transverse Current:	Traces of Cracked Insolation	
Abnormal Aging:	No Trace	
Agglomerant State:	Advanced Degradation Trace, end life is next.	
Dielectric Structure:	Advanced Degradation Trace, failure danger.	

SMC

EURO

SUMMARY

This hydraulic power generator has been stopped during 1 year. Even if its external aspect was correct, we detected high level of internal and superficial oil contamination. The following pictures show the external state of the machine:



The machine has been cleaned and dried and we proceed to a second EDA test before the varnish.

The second test shows the improvement of the major part of the parameters:

- Insulation resistance
- Polarisation index
- Time constant
- Leakage current
- Capacity ratio
- Recovery current

Anyway, Diaghel software indicates advanced degradation of the dielectric and the binder structure.

- Reabsorption current: very high level
- Time constant: remains too low

These criteria for non reversible problems have to be compared through the time, because in spite they don't seem good, maybe they have been always similar.