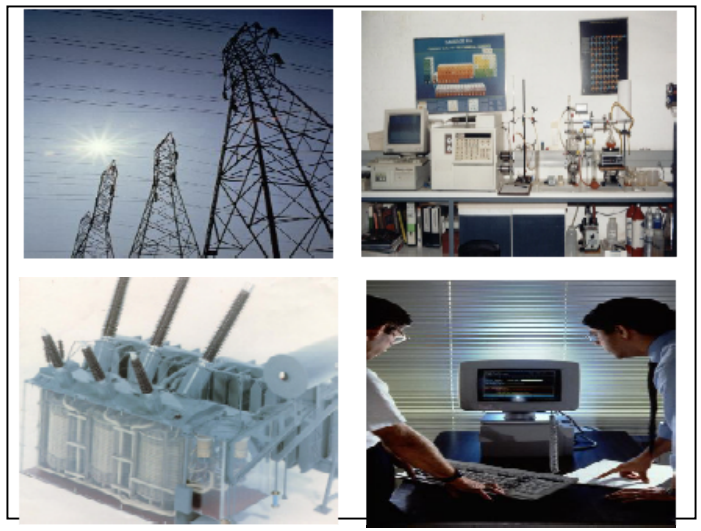
Transformer Chemistry Services[TCS]

THE LEADER IN CONDITION ASSESSMENT

Specialists in Testing, Diagnostic for the Electrical Power Industry



PREDICTIVE MAINTENANCE THROUGH TRANSFORMER OIL ANALYSIS

INCREASING YOUR PROFITS AND PRODUCTIVITY

TCS

Overview

TCS. is an independent laboratory and consulting firm that specializes in diagnostic testing of insulating materials used in high-voltage electrical equipment.

Established in 1992 as the first commercial laboratory to offer gas-in-oil and Furanic analysis in South Africa.

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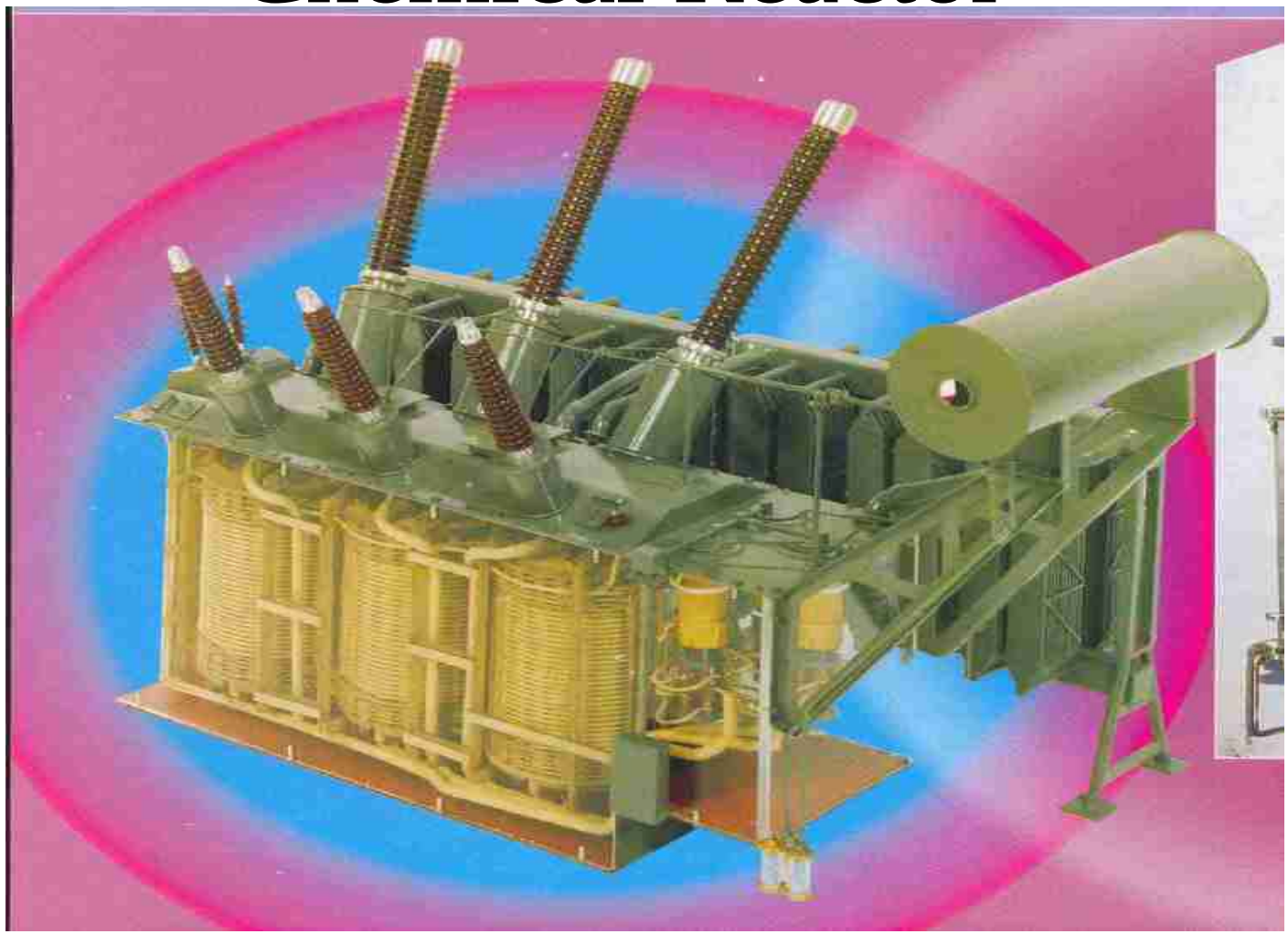
Chemical Reactor



That just happens to Transform Electricity

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TRANSFORMERS DO FAIL

In the event of failure , the force applied to the structure may approximate 360 PSI due to the steep wave front and high velocity , representing a loading sufficient to distort the container or shear the holding bolts and possibly cause a transformer oil fire.

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TRANSFORMER FAILURE MODE

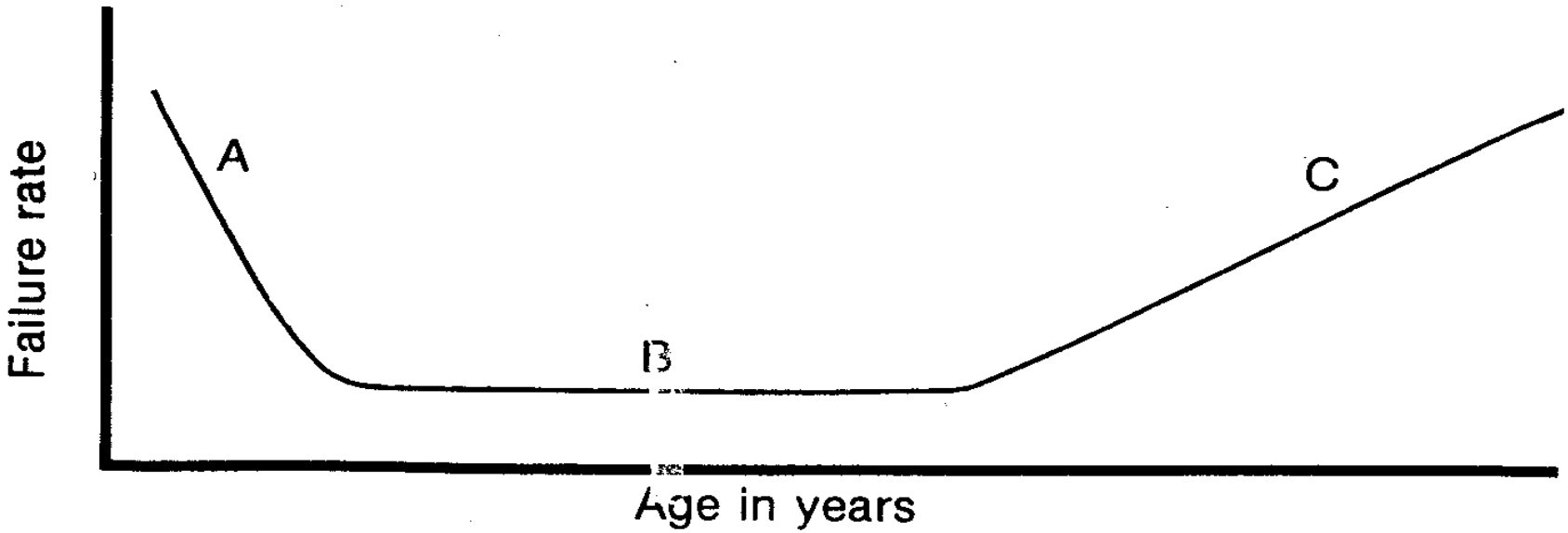

Figure 1.76 - Transformer failure rate "Bathtub Curve": (A) is failures due to infant mortality; (B) is constant failure rate (random); and (C) is failures due to aging. (R. Sahu, "Using Transformer Failure Data to Set Spare Equipment Inventories"-1980).

Importance of Transformer Maintenance

Modern Transformers

The increased stress require more frequent and improved Condition Monitoring

1,500 KVA
1945

The fault free operation of power transformers is of major economic/safety importance to power utilities and industrial consumers of electricity.

1,500 KVA
1970

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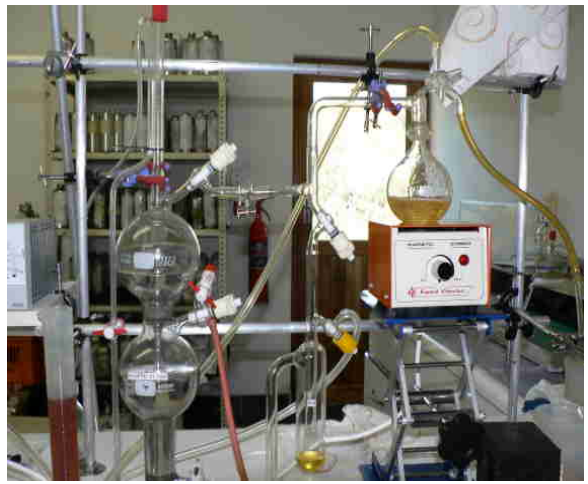
The application of Dissolved Gas Analysis(DGA)

The insulating oil is capable of dissolving gases in the event of developing faults in the transformer

These gases are extracted from the oil →



Analysed by the sophisticated technique of Gas Chromatography.

Diagnosis methods are utilised to diagnose the type and severity of the fault occurring in the transformer.

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Dissolved Gas (DGA)

Universal accepted method of choice to locate incipient thermal and electrical faults

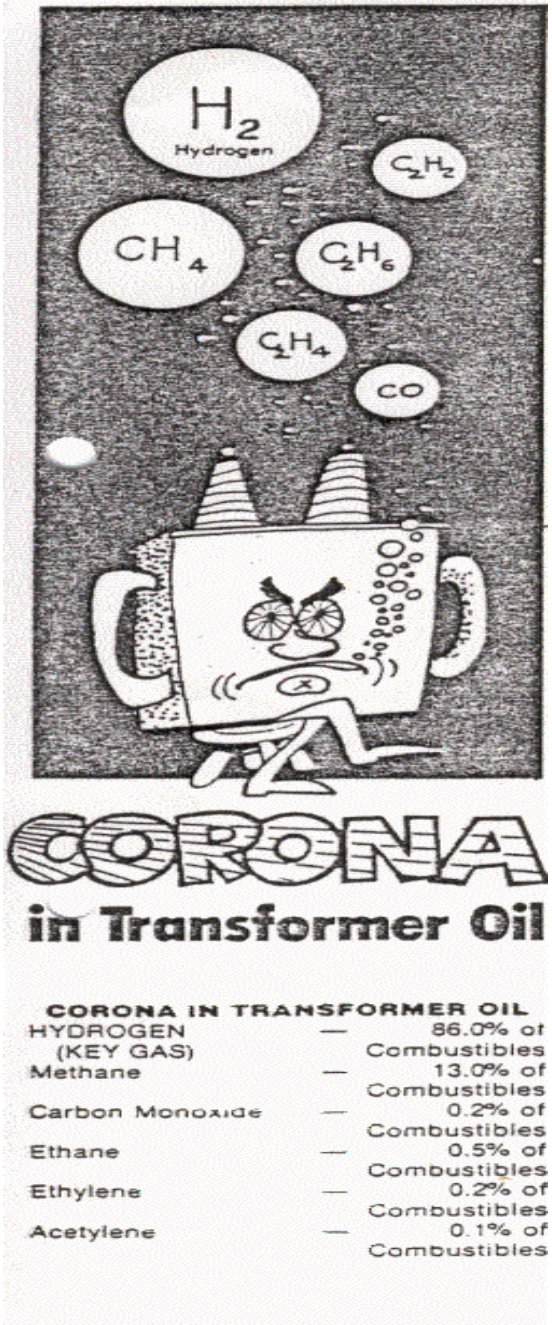
DGA methodology and applicability have evolved significantly since its inception 30 years ago.

There are various interpretation Codes for diagnosis

The interpretation should be left to a specialist and his advice and recommendations should be followed.

The incorrect diagnosis can lead to costly Transformer failure

Sapref Petroleum Refinery

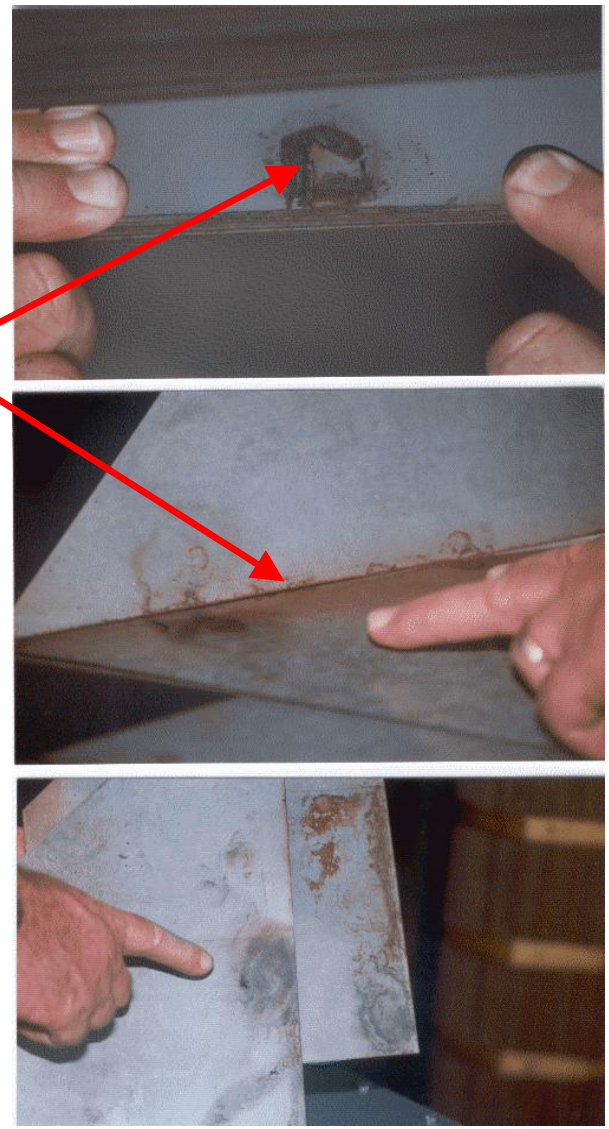


Voltage: 6.6 kV **Rating: 1250 KVA**

Diagnosis: Partial Discharge(Corona)

Condition Code 4

Findings The core of the transformer was found to be delaminating due to corrosion caused by high humidity(73 ppm water in oil)



Savings: R Hundred Thousand range possible R Million range if the Transformer failed with Fire

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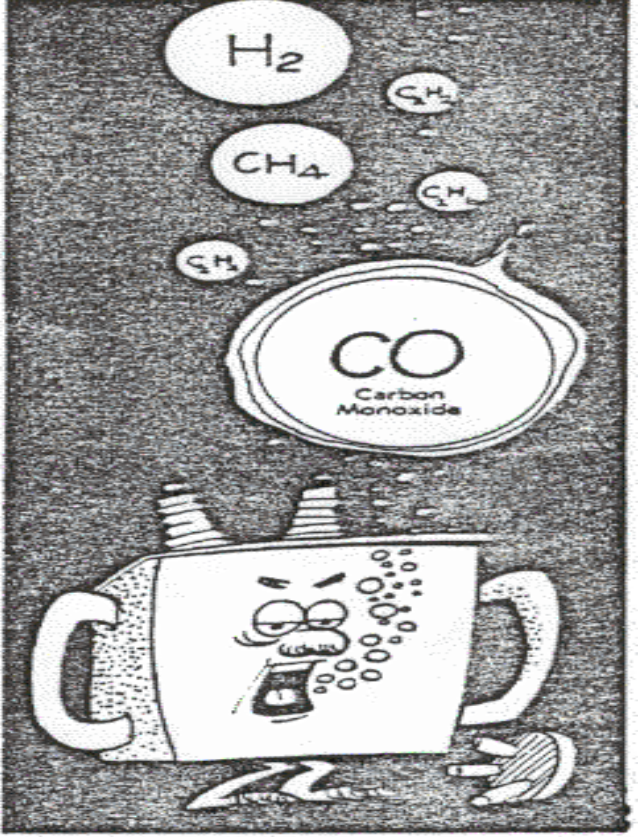
Tongatt-Huletts Refinery

6.6 kV 1000 KVA

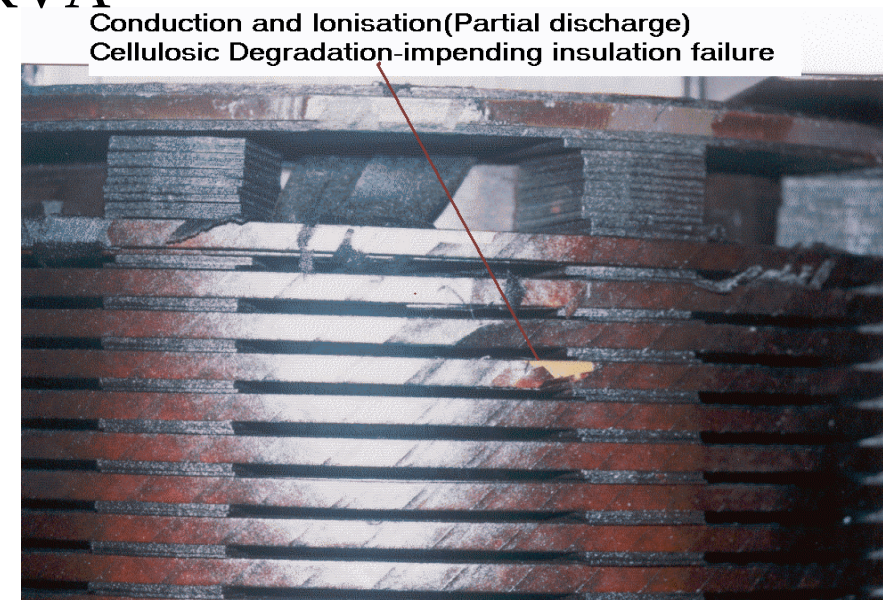


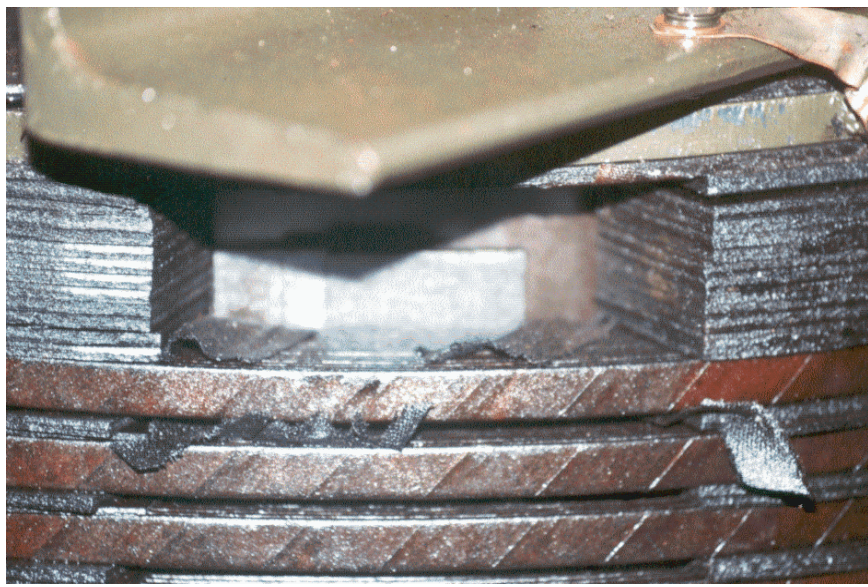
OVERHEATED

Cellulose

OVERHEATED CELLULOSE

CARBON MONOXIDE (KEY GAS)	—	92.0% o Combustibles
Hydrogen	—	6.7% o Combustibles
Methane	—	1.2% o Combustibles
Ethane	—	0.01% o Combustibles
Ethylene	—	0.01% o Combustibles
Acetylene	—	0.01% o Combustibles





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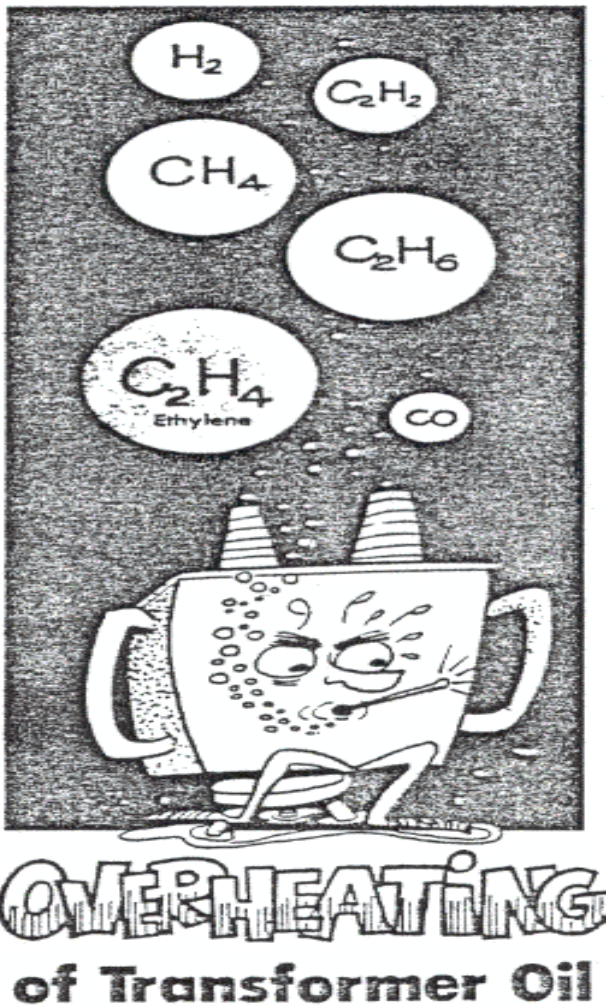
UMGENI WATER

Voltage: 11/6.6 kV Rating 5000 KVA

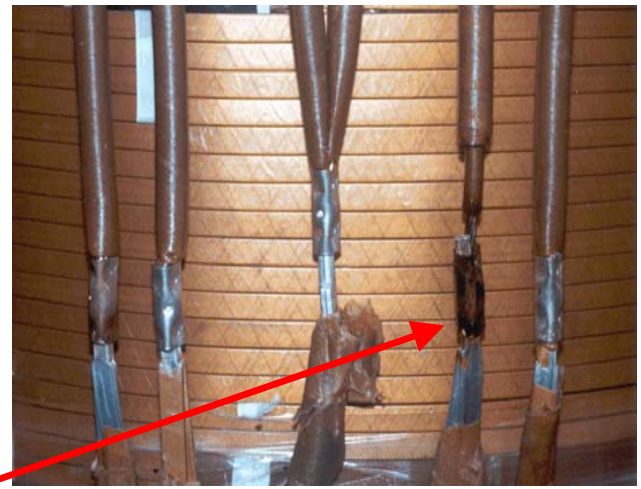
OVERHEATING OF TRANSFORMER OIL		
ETHYLENE (KEY GAS)	—	63.0% of Combustibles
Ethane	—	17.0% of Combustibles
Methane	—	16.0% of Combustibles
Acetylene	—	Trace
Misc. Gases	—	Trace

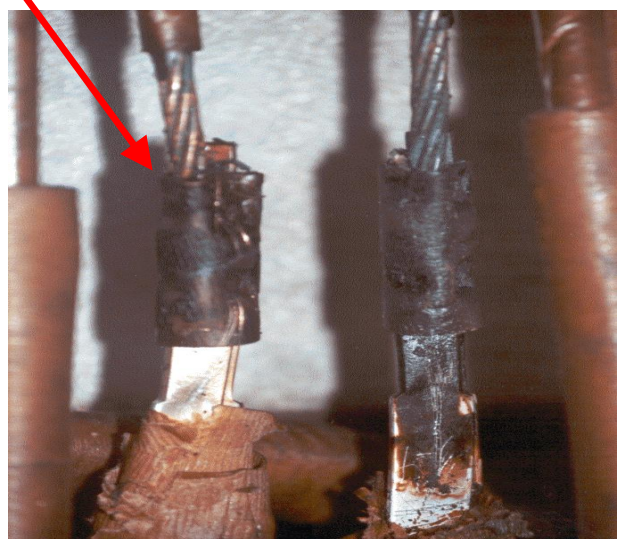


Analysis/Diagnosis:
Condition Code 4

The DGA indicated a Thermal Fault 300-700 Deg C

Findings: Various Copper to Aluminium (bi-metal) connection's were found burned





Savings:

The transformer was repaired at the Manufacturer cost, i.e First year warranty

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NORDBERG SMELTER

FURNACE 10 TON

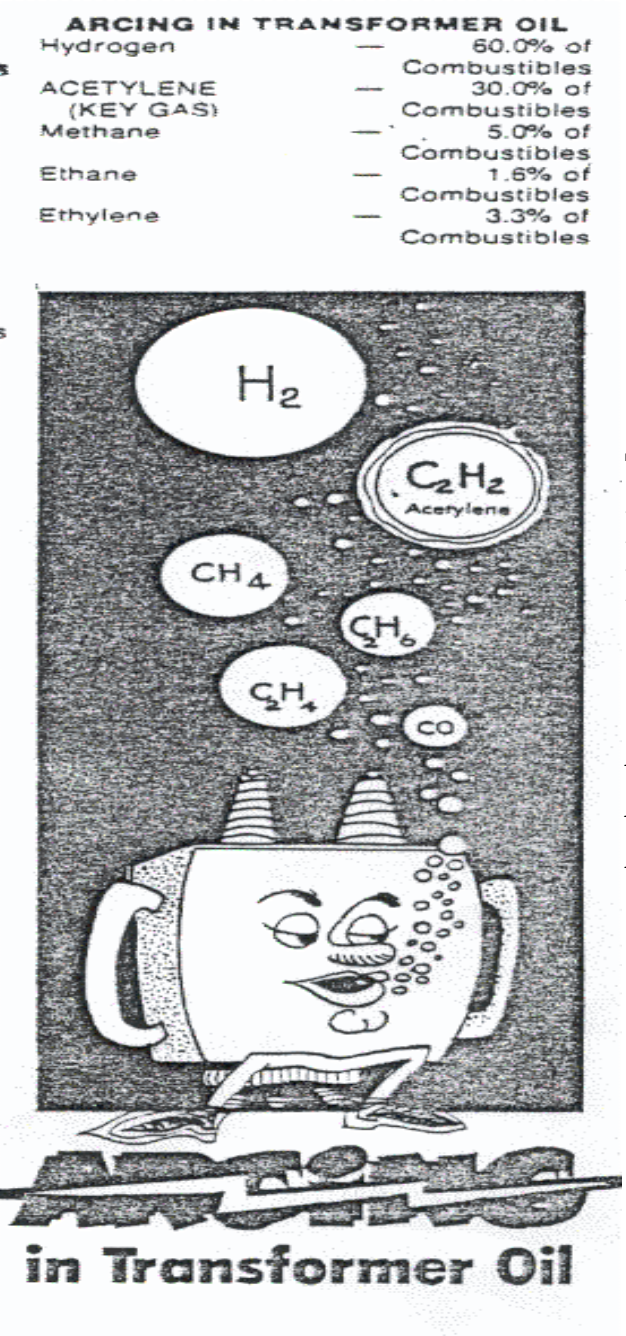
Voltage: 11 kV/5250v
Rating: 3000 KVA

The DGA analysis indicated a Discharge of High Energy(Arcing)

Condition Code 4

Note: The Electrical tests- Meghom Meter(Insulation Resistance) passed

Caution: In the event of a unit trip conduct a DGA before Re-energising



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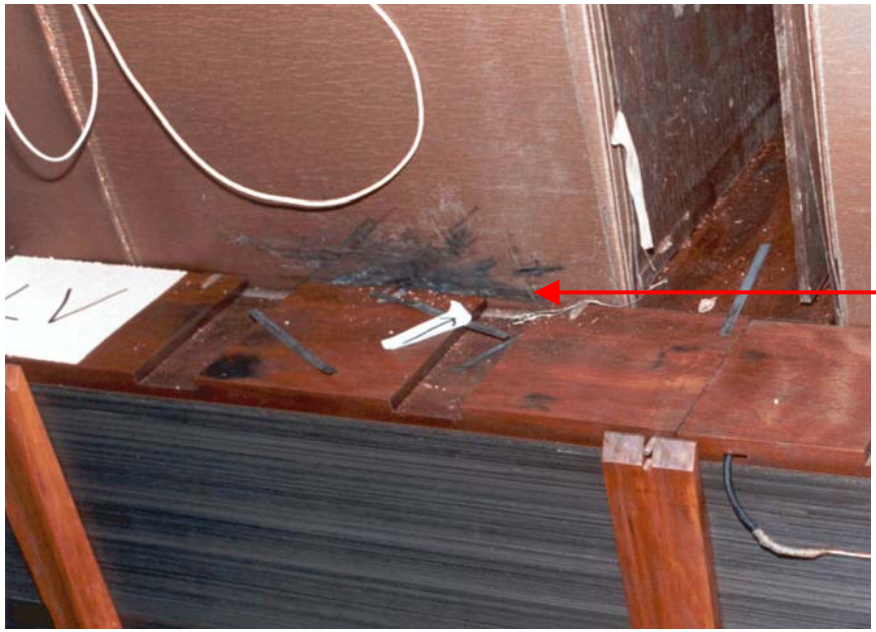
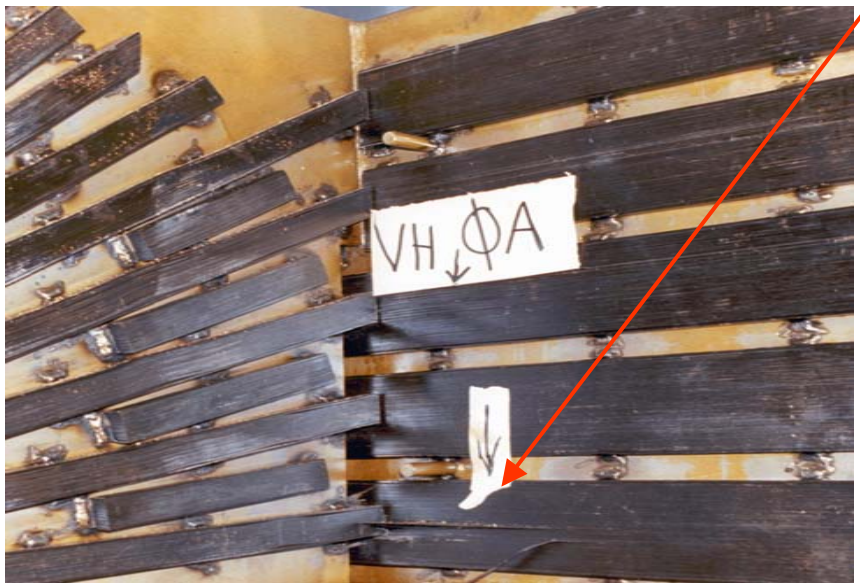


ESKOM: Chivelston Substation

Voltage: 400/275 kV Rating: 400MVA

Diagnosis: The Dissolved Gas Analysis indicated a Thermal Fault Of High Temperature>700 DegC

Note: Calculated time to Buchholz activation: 2 years



Findings: The core of this shell form transformer was found to delaminating

Savings: R Million Range

The Distribution losses had the transformer failed would have been catastrophic(50% of KZN affected)

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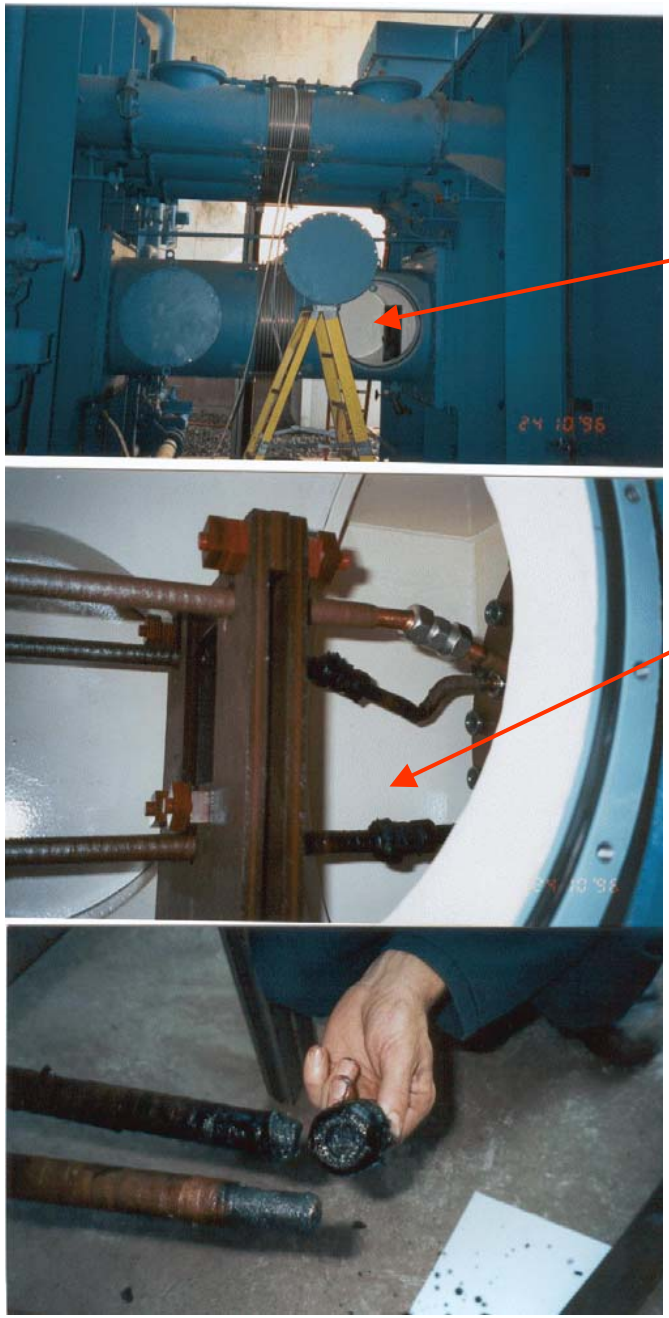

HILLSIDE ALUMINIUM
Interconnector

Voltage: 132 kV Rating:90.8/93.5MVA

Analysis/Diagnosis: The Interconnected system Tripped on Buchholz 6 months after energising. The manufacturer suspected a Corona Fault on the cable housing The DGA analysis indicated a Thermal Fault(300-700 degC) in the Bottom Chamber.CONDITION Code 4

Findings: Burnt connections in the Bottom Chamber due to non-conforming quality control during installation

Savings: By accurately diagnosing the fault type and location the manufacturer saved significant time and equipment to effect repairs. The smelter saved minimum down time on production

The savings achieved were in R Millions Range

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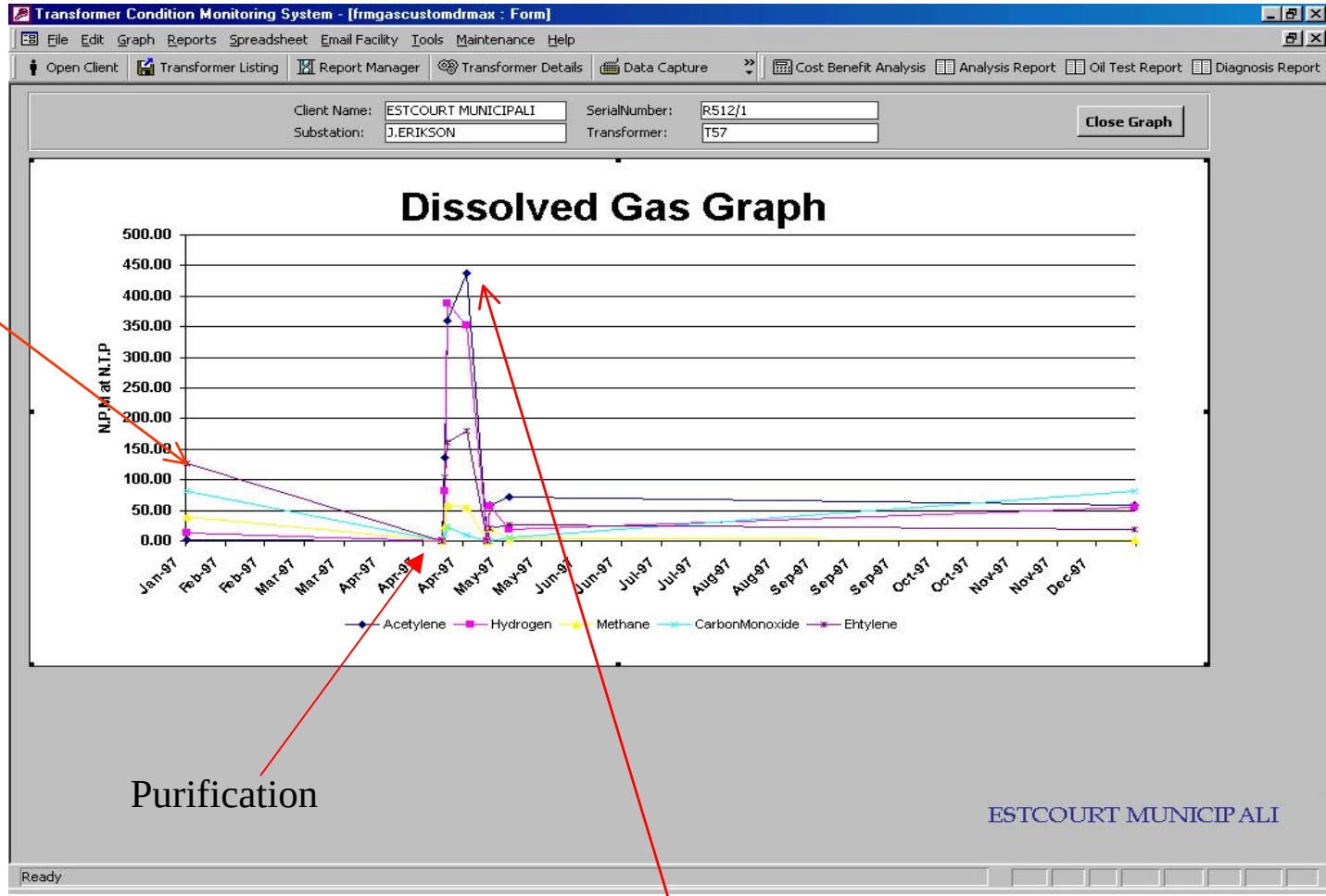
ESTCOURT TLC

Voltage: 33/11/6.6 kV Rating: 15 MVA

Analysis/Diagnosis

The DGA analysis at 21/07/1997 indicated a Thermal Fault
The maintenance contractor recommended Power-on oil purification. i.e *highly dangerous and irresponsible as further damage is likely, with additional costs to the transformer owner*



The DGA analysis 30/04/1997 indicated a Discharge of High Energy(Arcing)
The transformer was having Power-On oil purification at the time of the Buchholz Alarm

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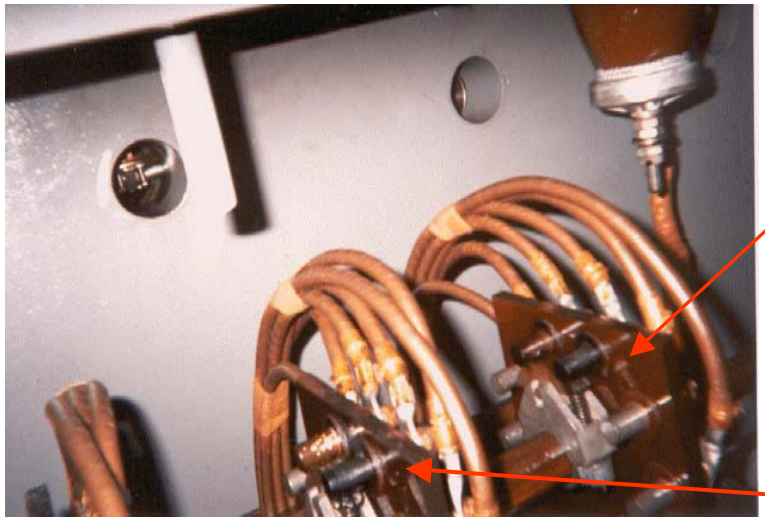
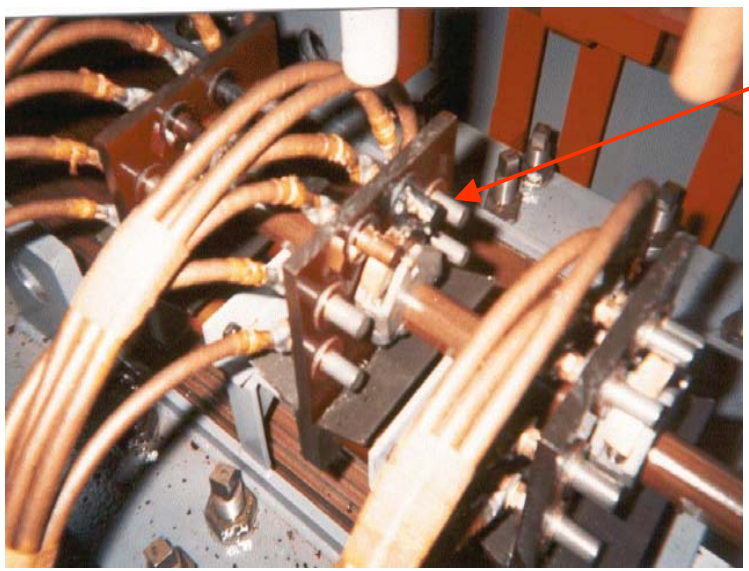
ESTCOURT TLC





Voltage: 33/11/6.6 kV Rating: 15 MVA

Analysis/Diagnosis

Discharge of High Energy due to failed Off-load Tap changer

Findings

All phases had burning

The inner contact ring of the center phase had failed.

Note: The center phase of the tap changer was directly below the pipe from the conservator tank. i.e. Flow of oil was over this point

Savings: In excess >R 300 000

The transformer was repaired on site and returned to service

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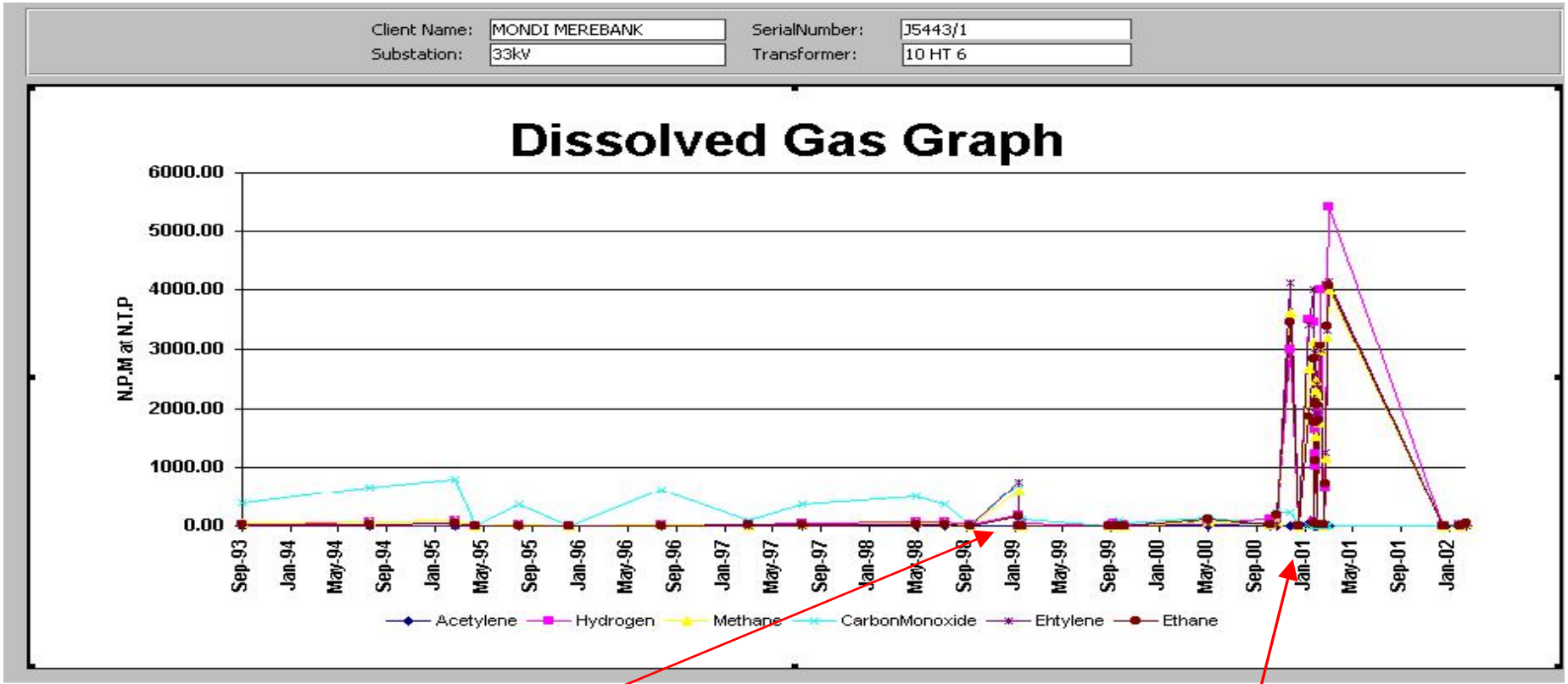
Case Study 3 Faults: Mondi Merebank

Voltage: 33kV Rating: 30 MVA



Unit Trip 11/01/1999
DGA: Thermal Fault High Temperature
Sent to works facility for repairs

DGA: 27/11/2000 Indicates Thermal Fault
CONDITION CODE 4
See DGA graph range

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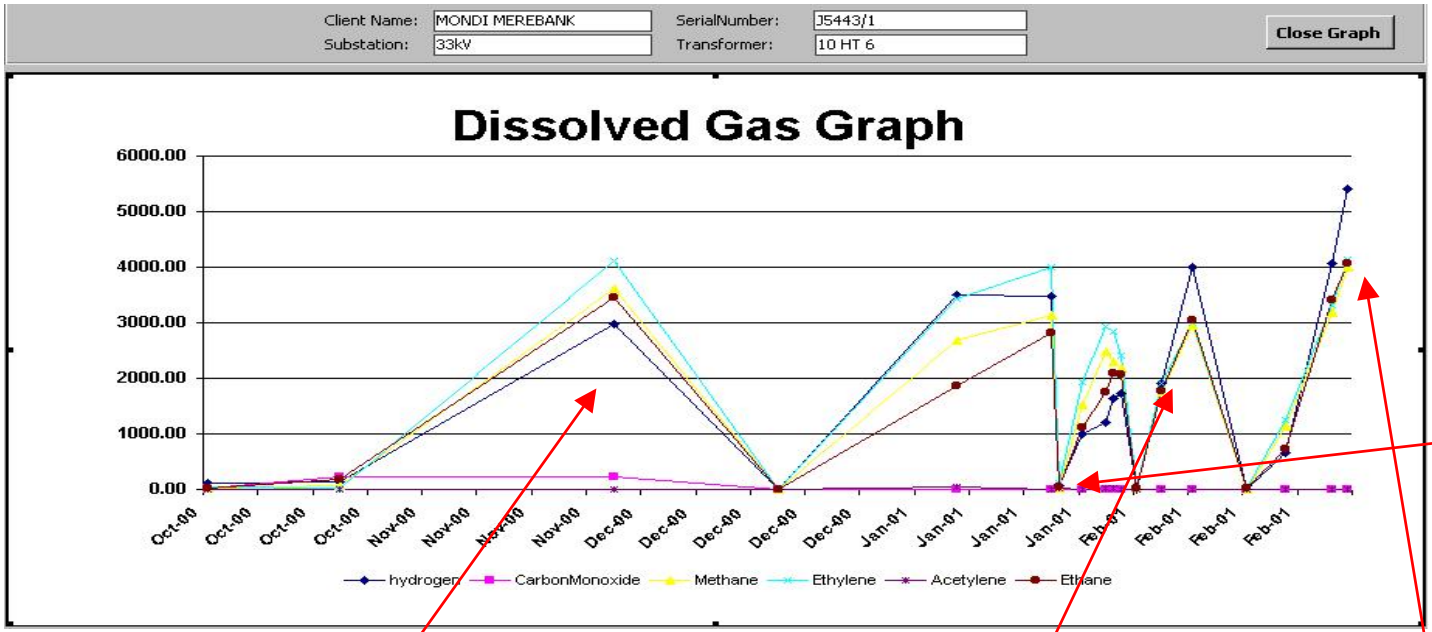

Purification
To Degas

Burnt CT

Burning HT

Burnt Internal
Connection

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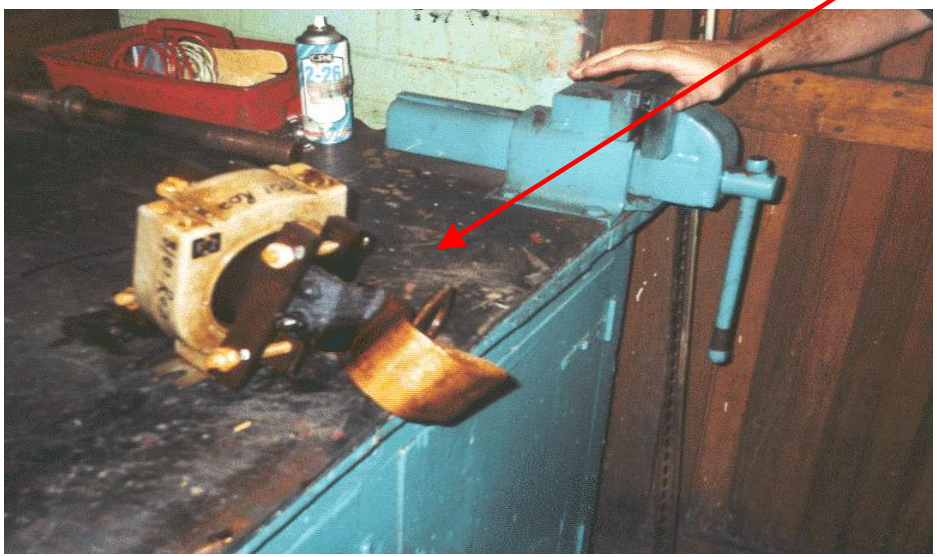

BURNT CURRENT
Transformer

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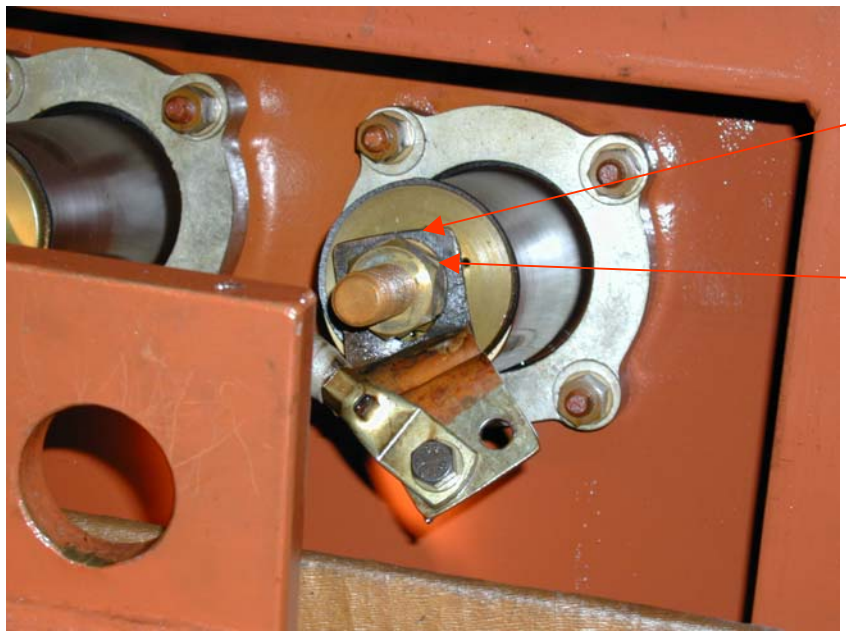
Analysis/ Diagnosis:

The oil was sampled to monitor the internal condition following energizing after repairs of a previous fault.
The DGA analysis indicated a Thermal Fault in the main tank.

Findings:



The center and outside connections were burnt due to bad contact between the copper bar and the bushing stud. Closer inspection shows that stud/hole diameter of the copper bar was oversized so that only the points of the connection nut were making contact. This reduced the area of contact required for normal current flow conditions.

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Transformer sent to Works Facility

Burnt connection found
Within the windings.
Note: Windings removed at
Repair facility

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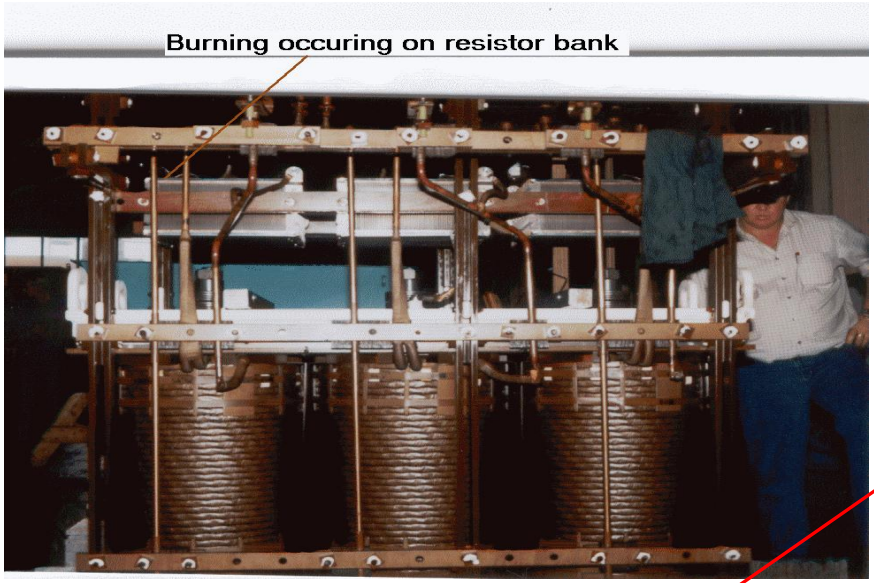
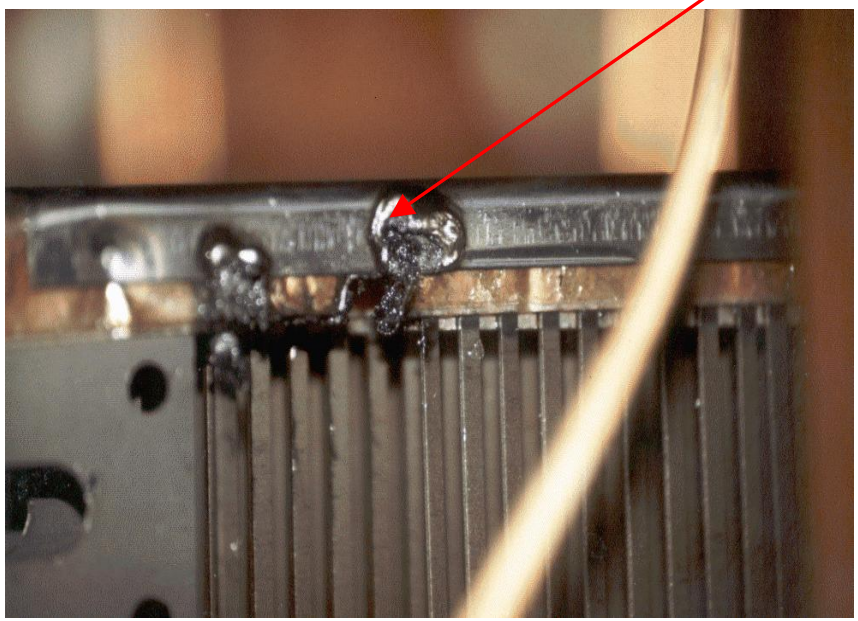
Hillside Aluminum





22 kV Reactor 1075 KVAR

ANALYSIS/DIAGNOSIS

THERMAL FAULT OF OF HIGH TEMPERATURE RANGE>700 Deg C

IEC 599: GAS PRODUCTION RATES

CONDITION 4 -Ethylene(C2H4)-Significant

FINDINGS: Burning on the Resistor

CAUSES: Fourth Harmonic being amplified causing the transformer to be subjected to 10 times its rated current(milli seconds) i.e Design Fault System

SAVINGS IN THE MILLION RANGE

or in the Billion Range due the knock on effect

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