REFCOMM
GALVESTON
MAY 2-6 2016

CASE STUDY
DISTRIBUTION TRANSFORMER AND PD DETECTION

Charlie Smith, IAE Subject Matter Expert
Charlie@refiningcommunity.com


1804
15-1804 XFMR

INFORMAL RELIABILITY SURVEY

How old is your facility?

Less than 5 years old? 10 years? 20 years? Greater than 20 years?

Is your facility configured with single transformers supplying production critical loads?

Are your distribution transformers typically oil-filled or dry?

INFORMAL RELIABILITY SURVEY

Which technologies does your facility use to determine health of your distribution transformers?

- Dissolved Gas Analysis of Oil
- Off-line insulation quality measurements
- Infrared Scan
- On-line partial discharge detection
- Other?

Are you confident that someone in your facility understands the condition of your distribution transformers?

CASE STUDY

1 MVA oil-filled transformer

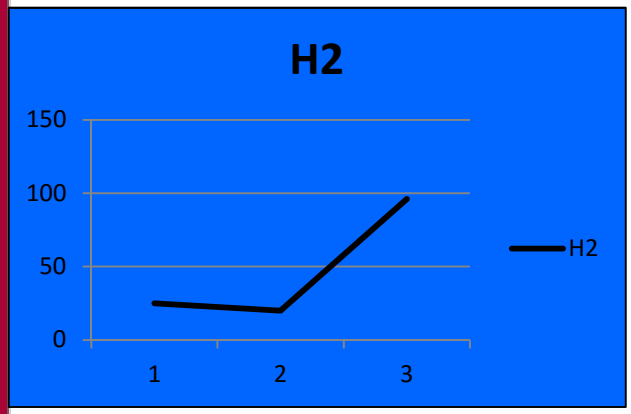
2400 volt primary 480 volt secondary

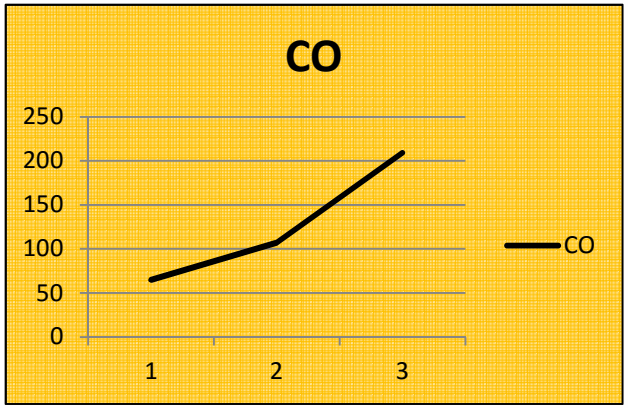
Sole power supply for refinery Nitrogen production plant

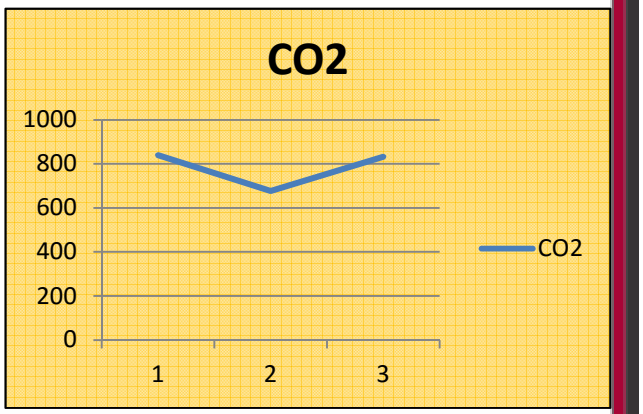
Installation date August 2008

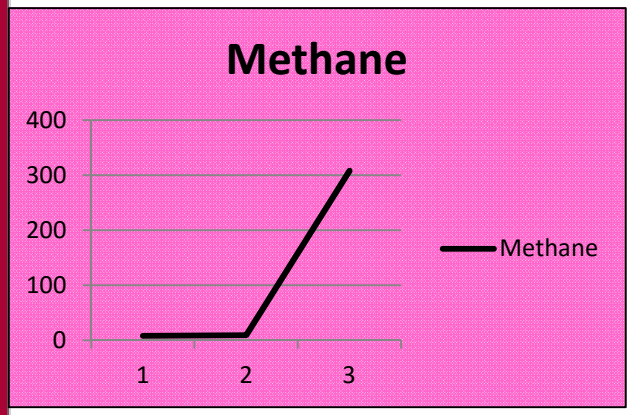
First indication of problem June 2010 in DGA

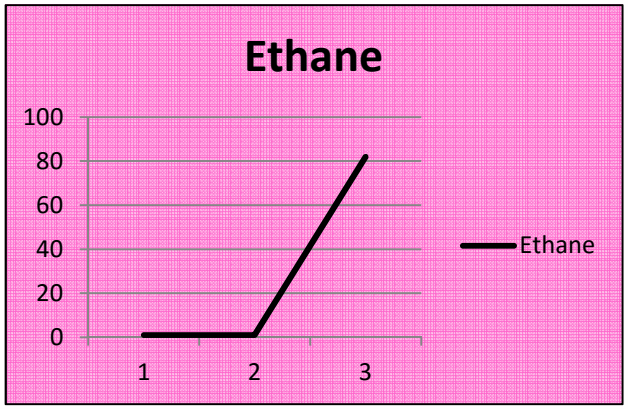
CASE STUDY

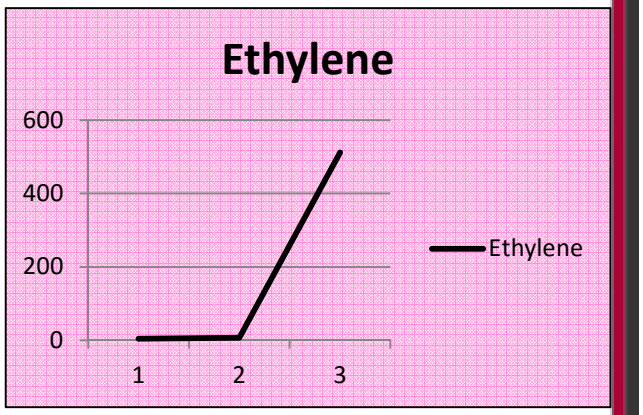






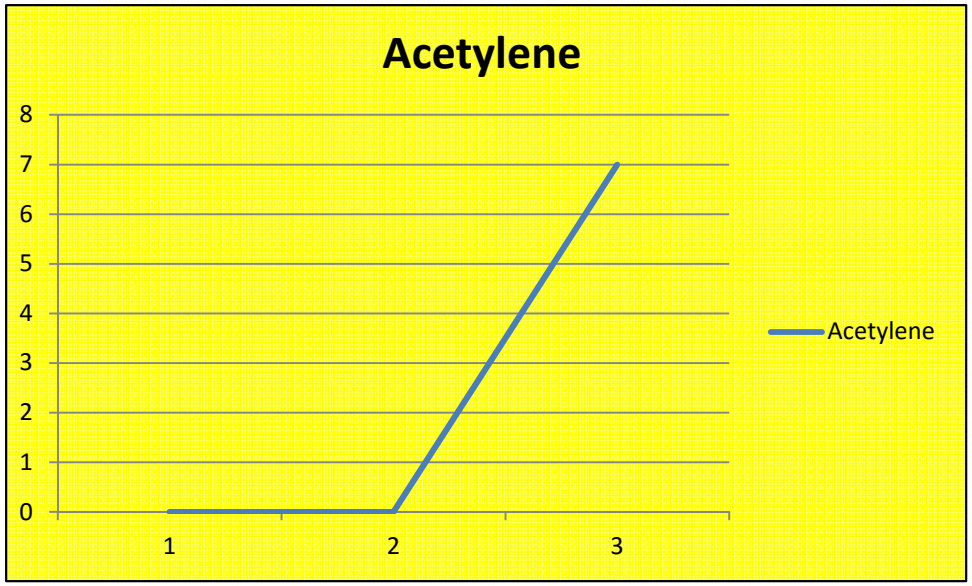






JUNE 2010 DGA RESULTS

CASE STUDY



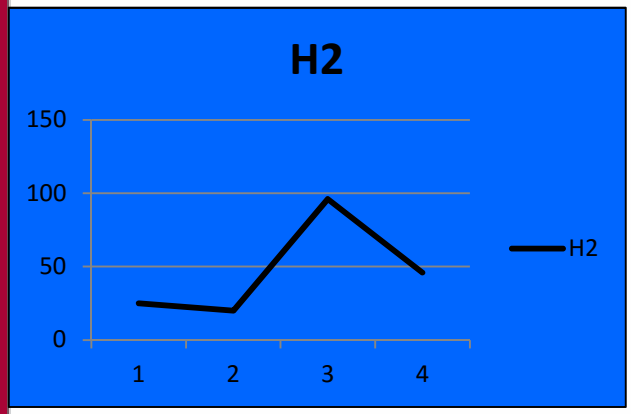
JUNE 2010 DGA RESULTS

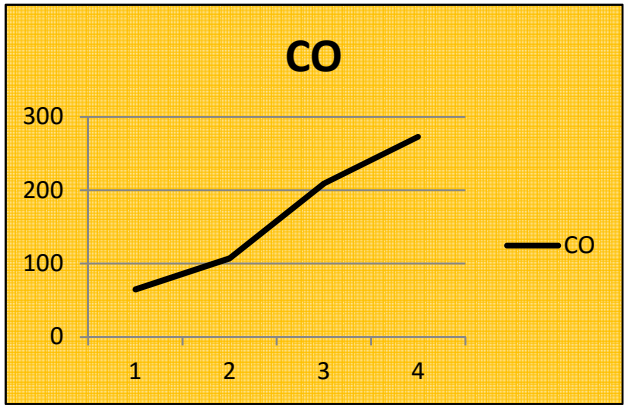
CASE STUDY

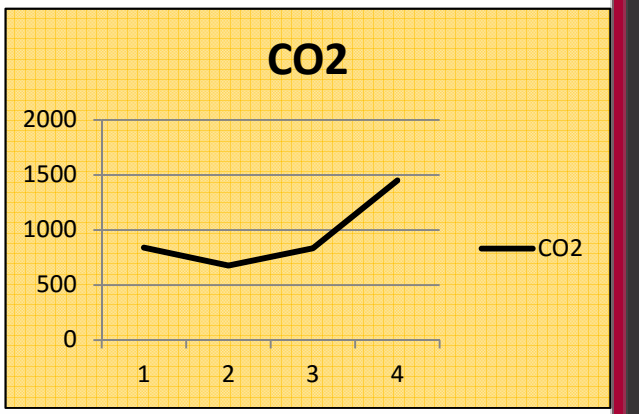
#1 Suspect – Tap Changer

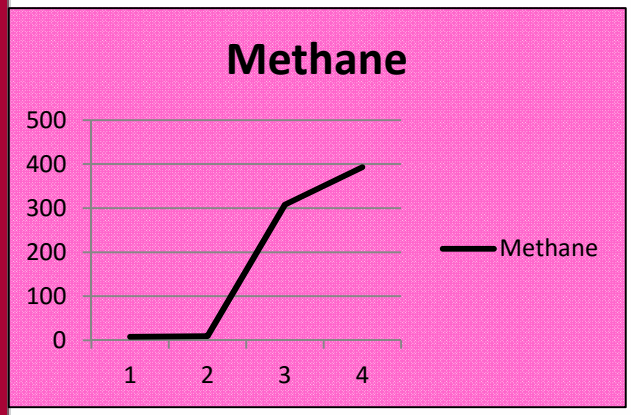
1. Electrical field service contractor was on-site for TAR
2. Took transformer off-line
3. Opened upper inspection port and found a loose tap changer connection that showed signs of overheating
4. Fixed connection and placed transformer back into service
5. Problem solved - We thought

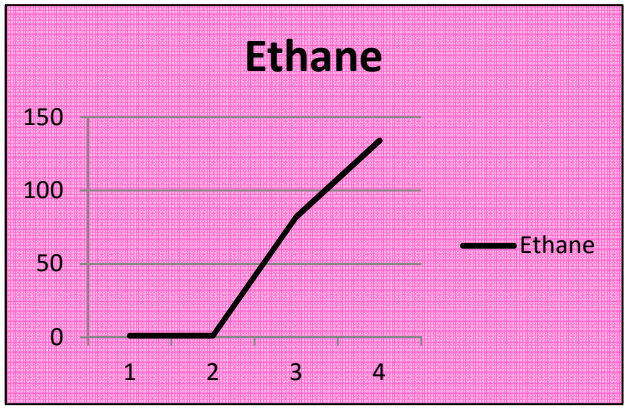
CASE STUDY

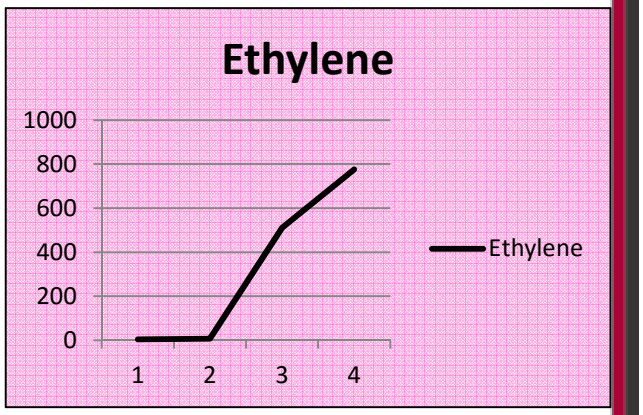






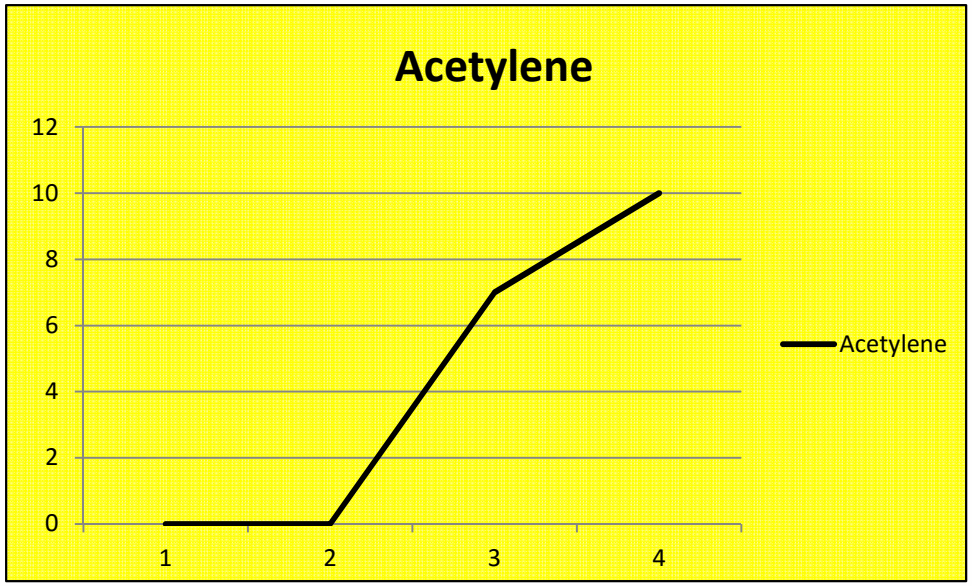






JUNE 2011 DGA RESULTS

CASE STUDY



JUNE 2011 DGA RESULTS

CASE STUDY

Tested a new technology (new to the refinery):

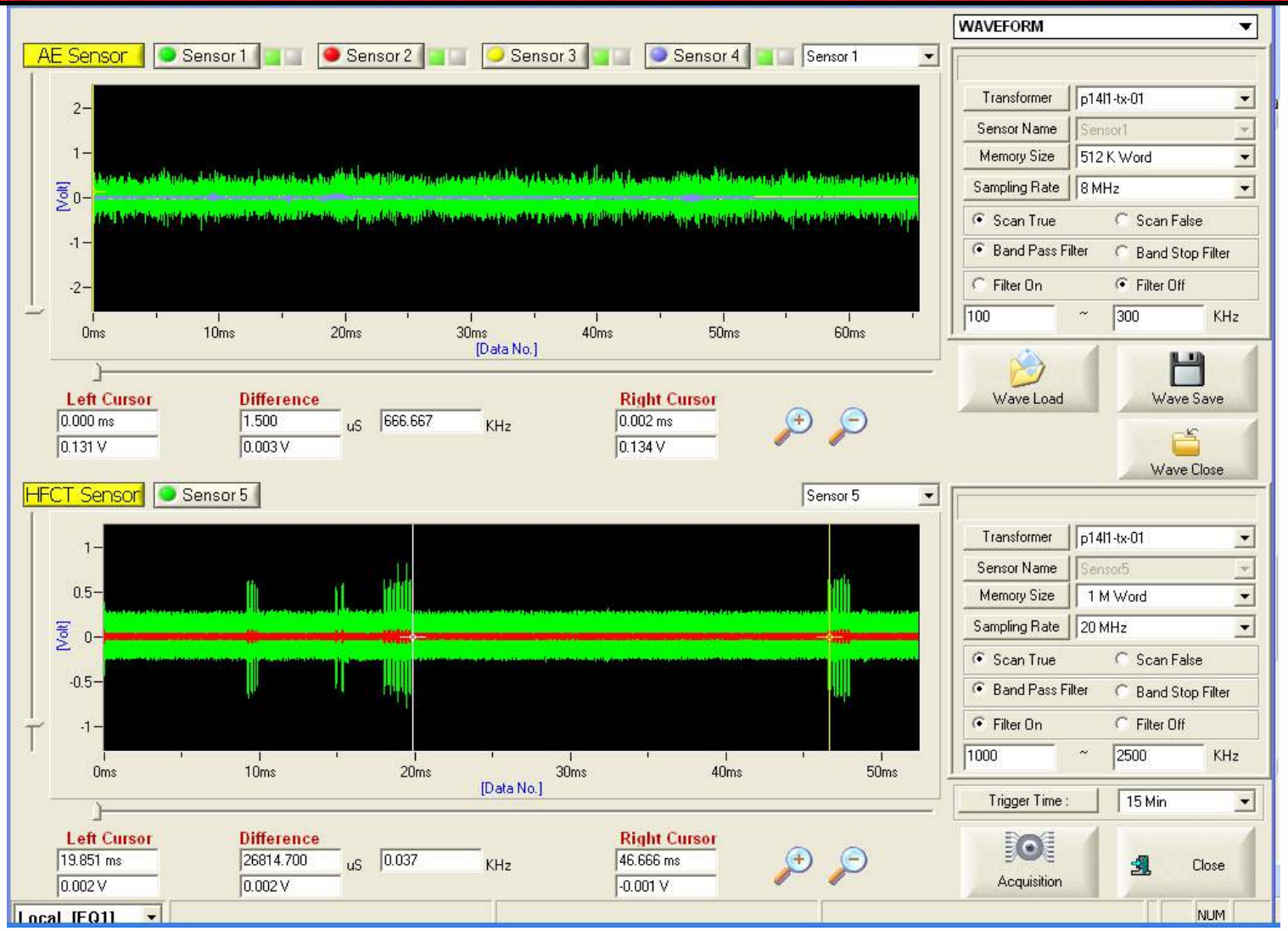
In-Service Partial Discharge Tester

Uses a High Frequency Current Transformer clamped around the tank ground connection to detect PD

Test setup took about 10 minutes at the transformer

Immediately detected a waveform indicating arcing, not PD

CASE STUDY


AE Sensor
Sensor 1
Sensor 2
Sensor 3
Sensor 4
Sensor 1
[Volt]
[Data No.]
0ms
10ms
20ms
30ms
40ms
50ms
60ms
Left Cursor
0.000 ms
0.131 V
Difference
1.500
uS
666.667
KHz
0.003 V
Right Cursor
0.002 ms
0.134 V
HFCT Sensor
Sensor 5
Sensor 5
Left Cursor
19.851 ms
0.002 V
Difference
26814.700
uS
0.037
KHz
0.002 V
Right Cursor
46.666 ms
-0.001 V
WAVEFORM
Transformer
p14l1-tx-01
Sensor Name
Sensor1
Memory Size
512 K Word
Sampling Rate
8 MHz
Scan True
Scan False
Band Pass Filter
Band Stop Filter
Filter On
Filter Off
100
300
KHz
Wave Load
Wave Save
Wave Close
Transformer
p14l1-tx-01
Sensor Name
Sensor5
Memory Size
1 M Word
Sampling Rate
20 MHz
Scan True
Scan False
Band Pass Filter
Band Stop Filter
Filter On
Filter Off
1000
2500
KHz
Trigger Time :
15 Min
Acquisition
Close
Local [EQ1]
NUM

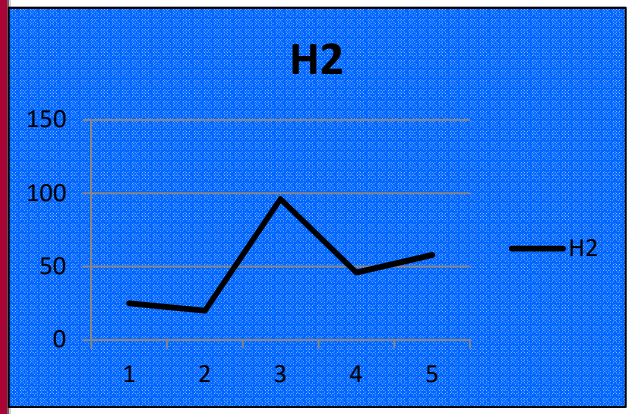
CASE STUDY

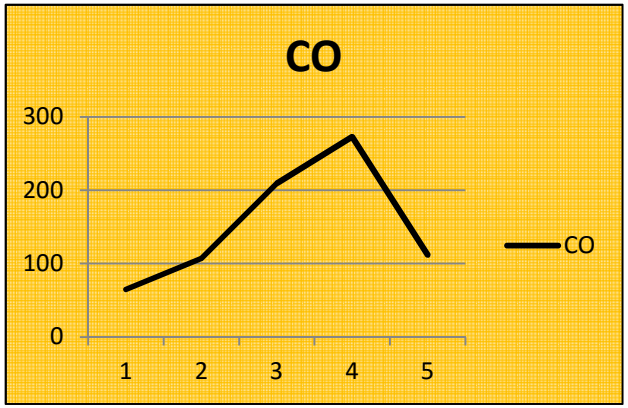
Electrical field services contractor re-inspection two months later in October

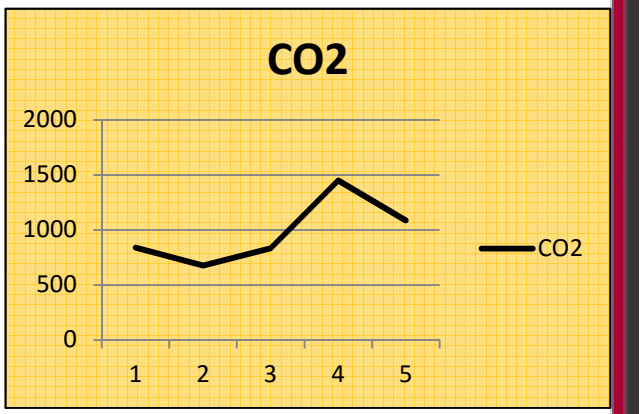
Testing and a thorough visual inspection (included borescope) – nothing found

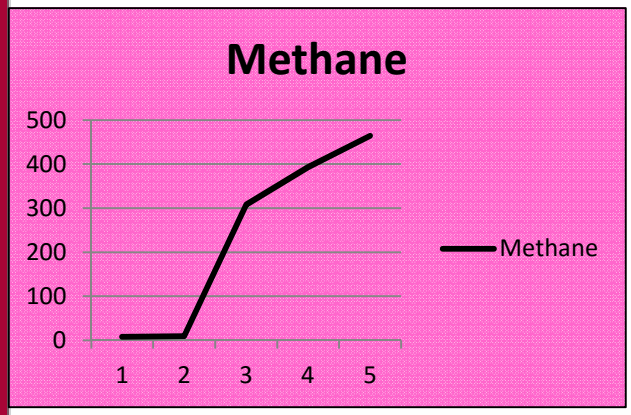
December DGA testing results were inconsistent

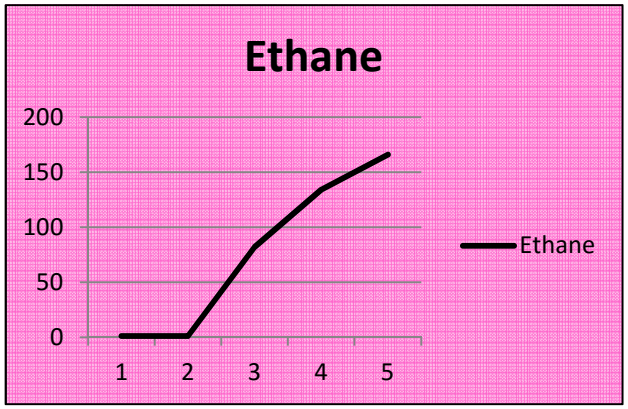
CASE STUDY

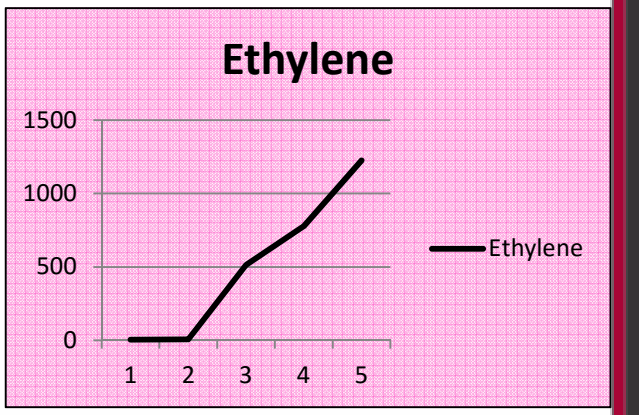






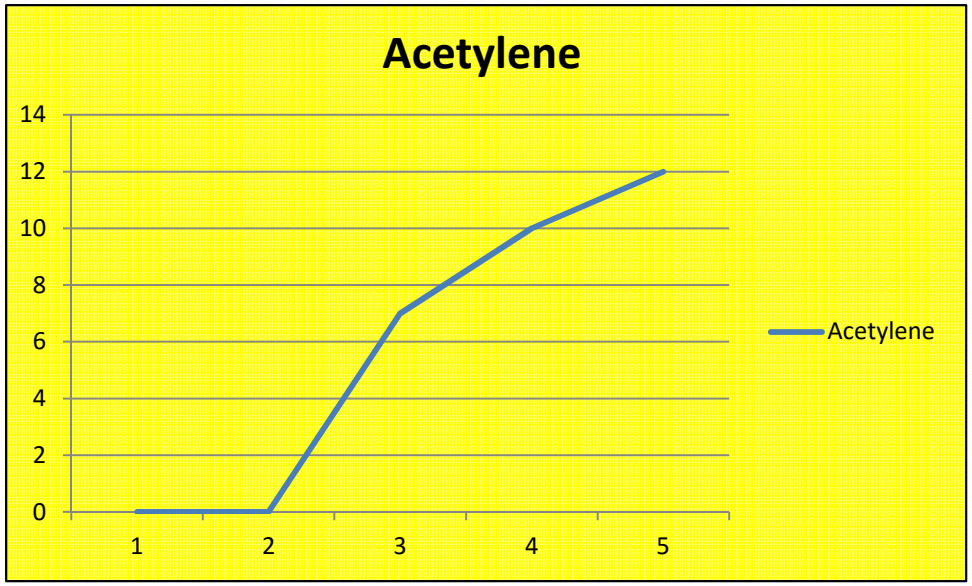






DEC 2011 DGA RESULTS

CASE STUDY

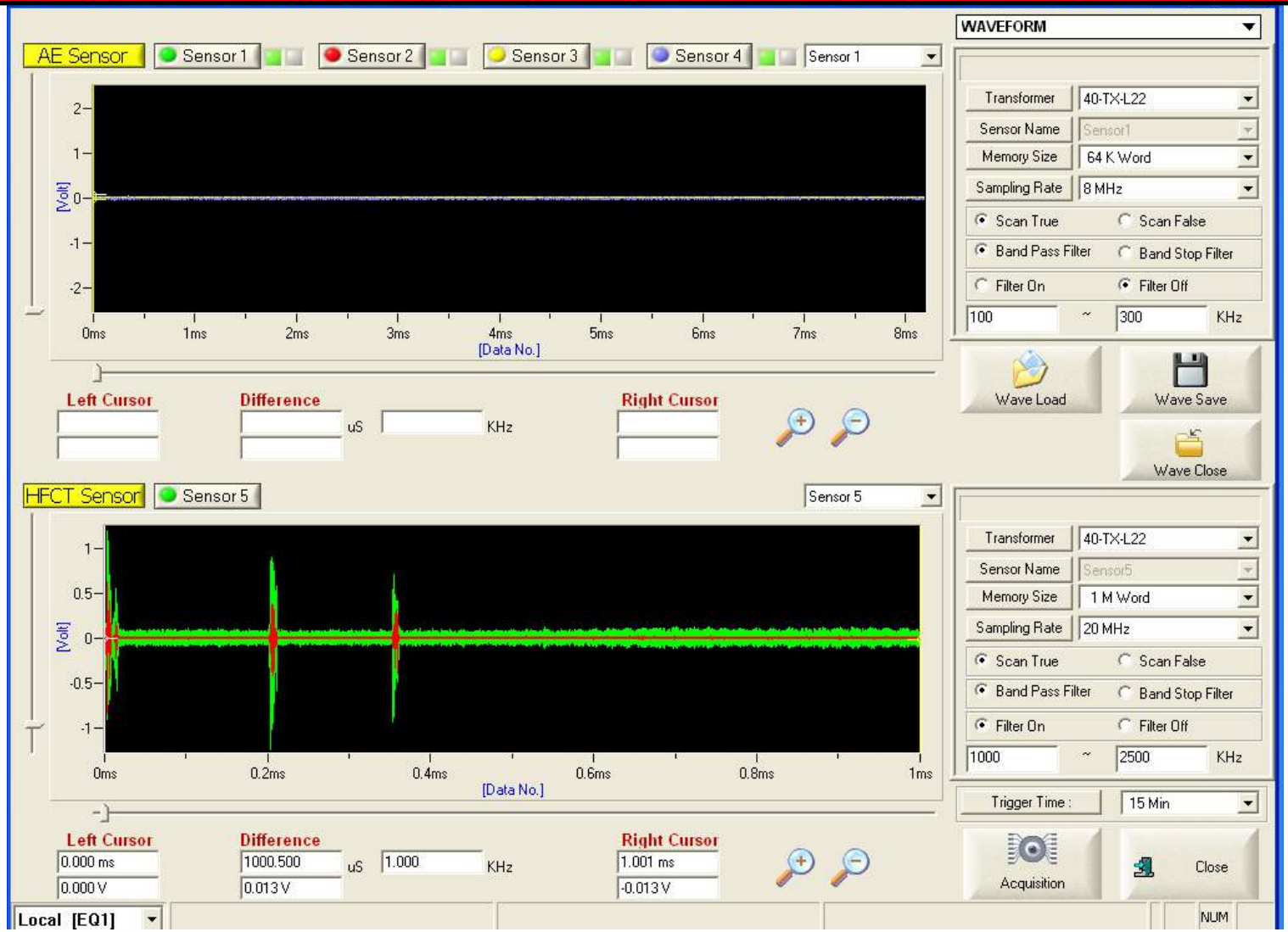


DEC 2011 DGA RESULTS

CASE STUDY

However, PD tests immediately following the inspection clearly detected the problem

CASE STUDY


AE Sensor
Sensor 1
Sensor 2
Sensor 3
Sensor 4
Sensor 1
[Volt]
2
1
0
-1
-2
0ms
1ms
2ms
3ms
4ms
5ms
6ms
7ms
8ms
[Data No.]
Left Cursor
Difference
uS
KHz
Right Cursor
HFCT Sensor
Sensor 5
Sensor 5
[Volt]
1
0.5
0
-0.5
-1
0ms
0.2ms
0.4ms
0.6ms
0.8ms
1ms
[Data No.]
Left Cursor
0.000 ms
0.000 V
Difference
1000.500
0.013 V
uS
1.000
KHz
Right Cursor
1.001 ms
-0.013 V
Local [EQ1]
NUM
WAVEFORM
Transformer
40-TX-L22
Sensor Name
Sensor1
Memory Size
64 K Word
Sampling Rate
8 MHz
Scan True
Scan False
Band Pass Filter
Band Stop Filter
Filter On
Filter Off
100
~
300
KHz
Wave Load
Wave Save
Wave Close
Transformer
40-TX-L22
Sensor Name
Sensor5
Memory Size
1 M Word
Sampling Rate
20 MHz
Scan True
Scan False
Band Pass Filter
Band Stop Filter
Filter On
Filter Off
1000
~
2500
KHz
Trigger Time :
15 Min
Acquisition
Close

CASE STUDY

Conversations with the manufacturer were un-productive

- They were unfamiliar with field PD testing
- The gas levels did not yet concern them

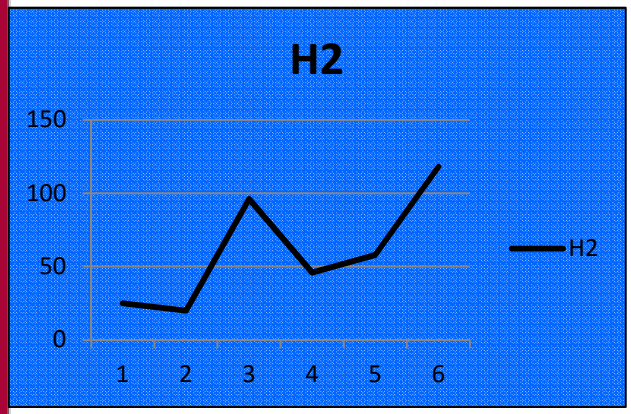
Refinery personnel disagreed with them, and purchased a new transformer as an ‘insurance policy’

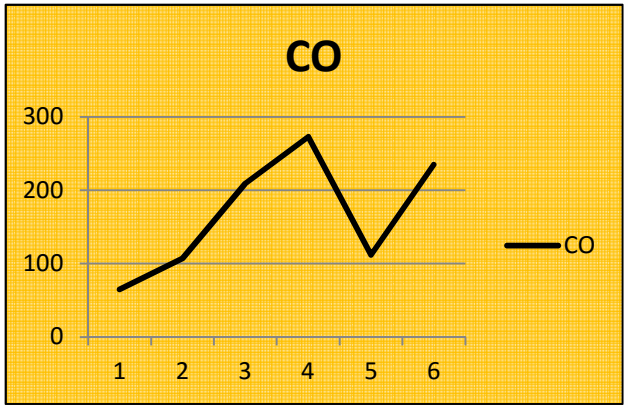
No drop-in spare on site, and lead time a few months

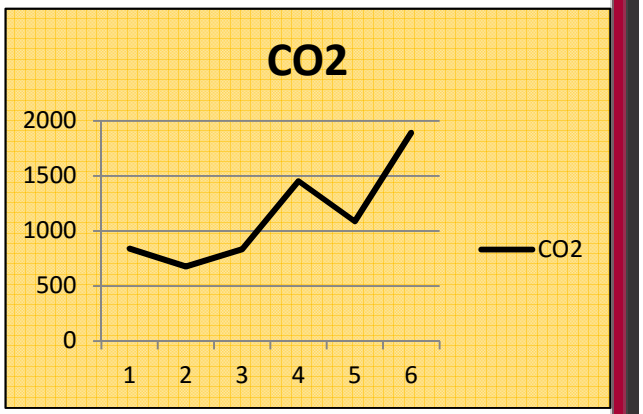
CASE STUDY

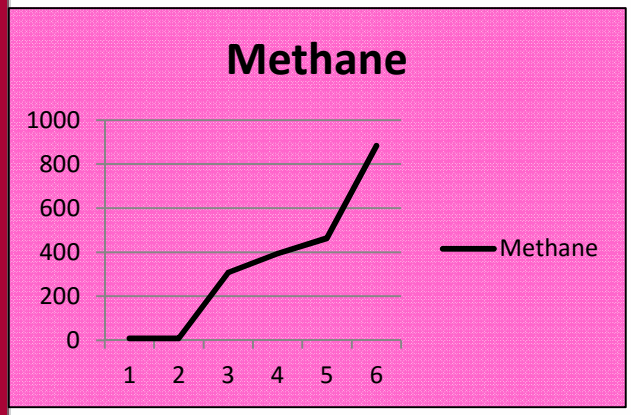
Subsequent DGA testing several months later also indicated the problem was still present.

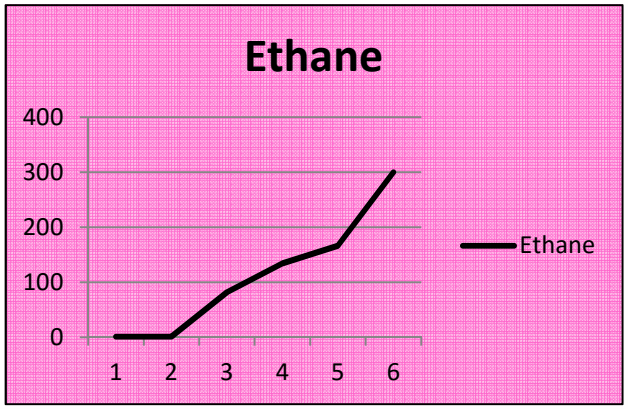
CASE STUDY

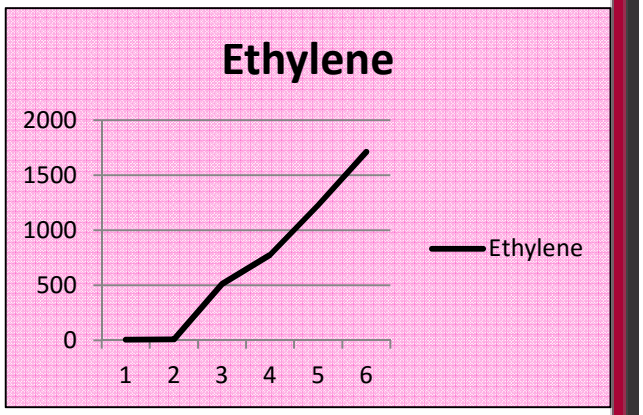






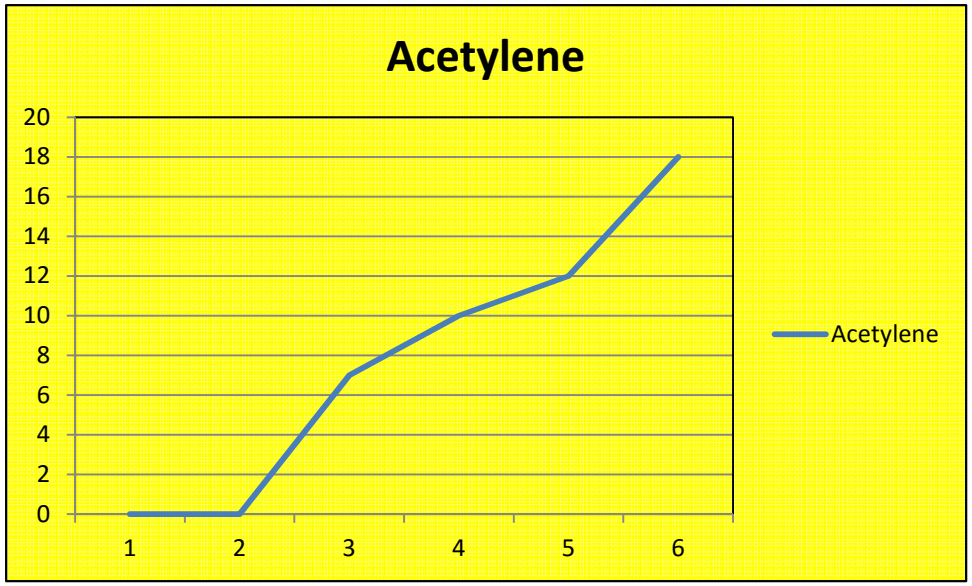






JUNE 2012 DGA RESULTS

CASE STUDY



JUNE 2012 DGA RESULTS

CASE STUDY

The new transformer arrived on site

A down-time window for the Nitrogen plant was a few months away.

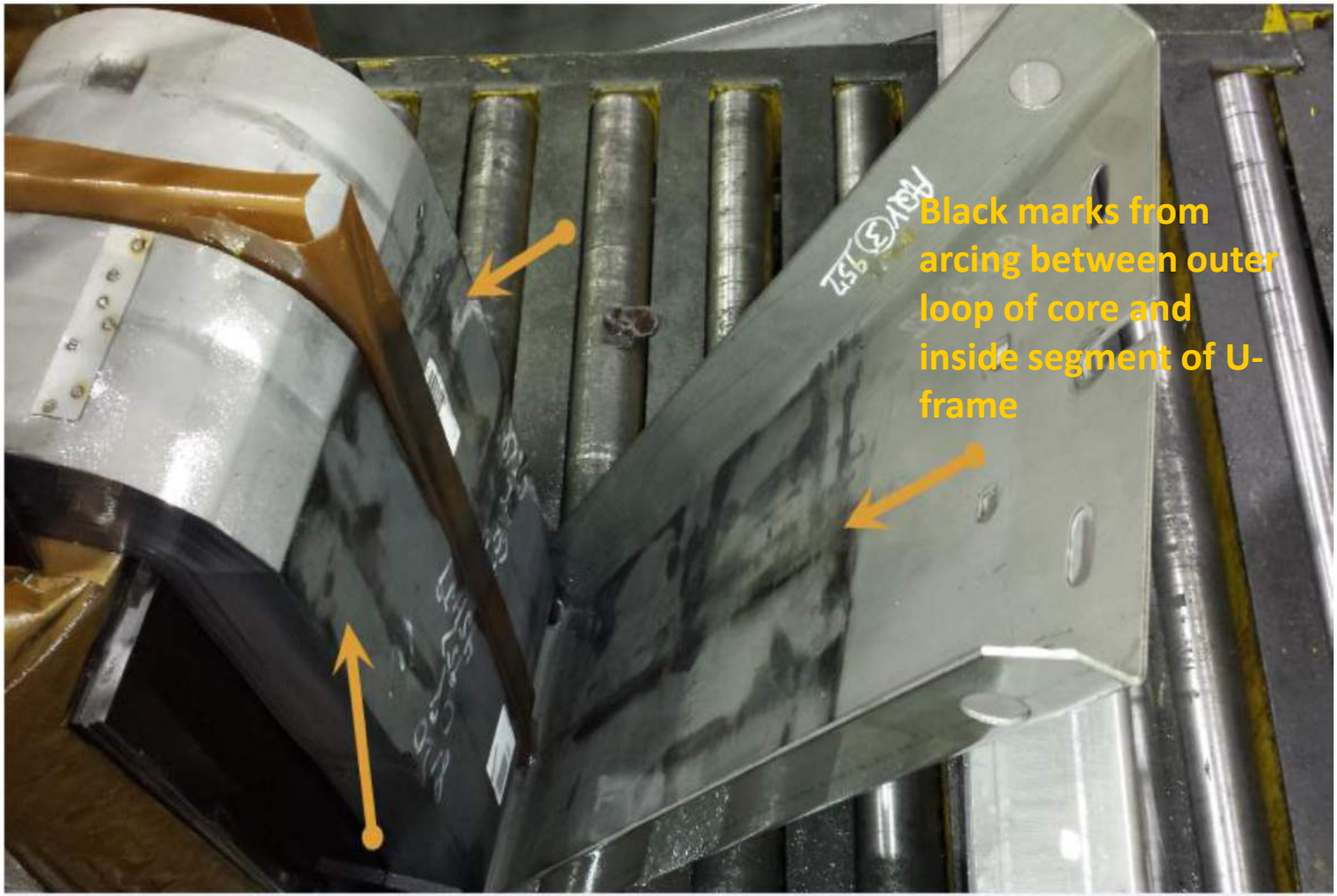
The transformer was replaced and sent back to the manufacturer for autopsy and possible repair

CASE STUDY

Factory Findings

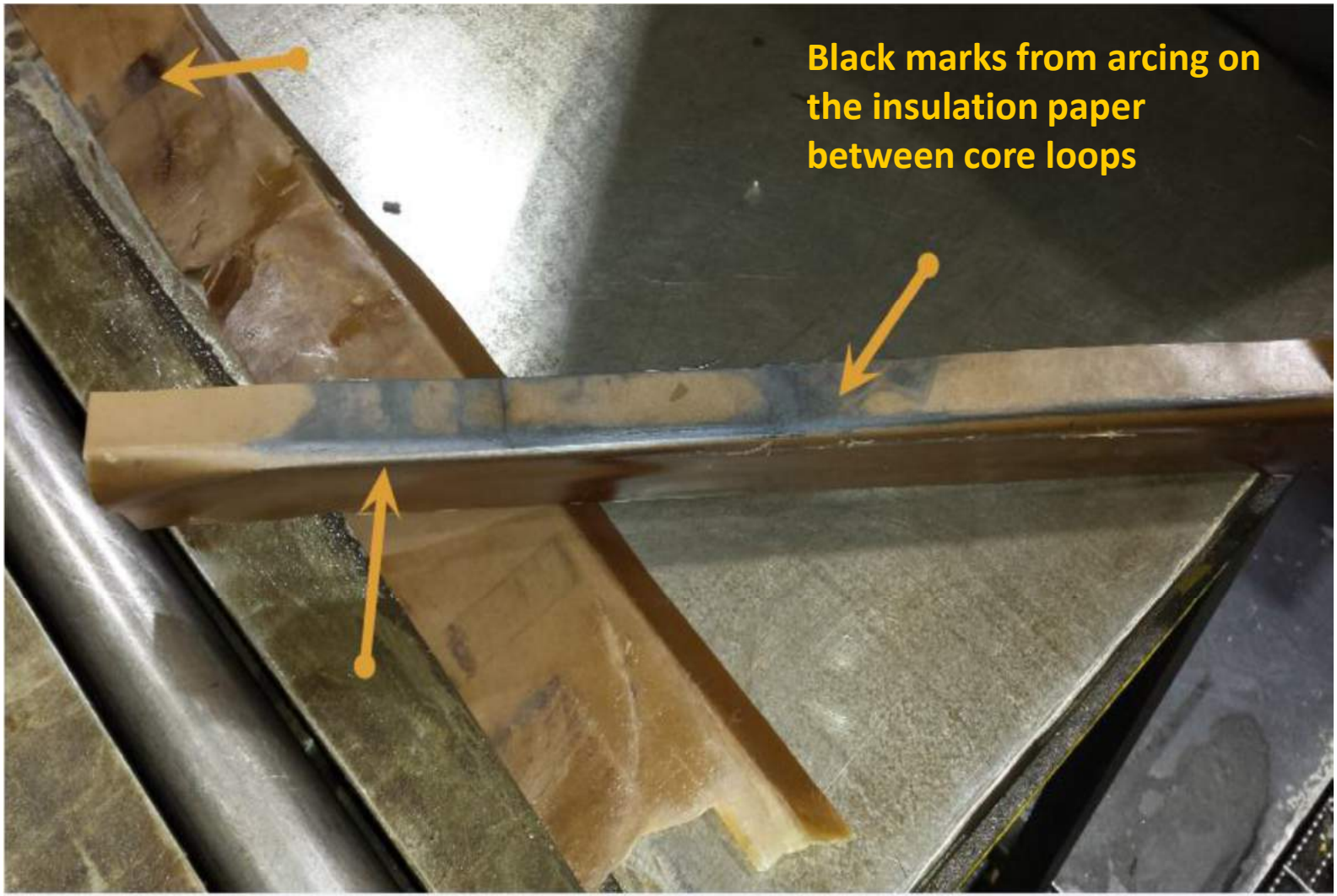
“multiple core ground points created different potentials, resulting in arcing between the core and frame, and from core to core across its insulation”

CASE STUDY

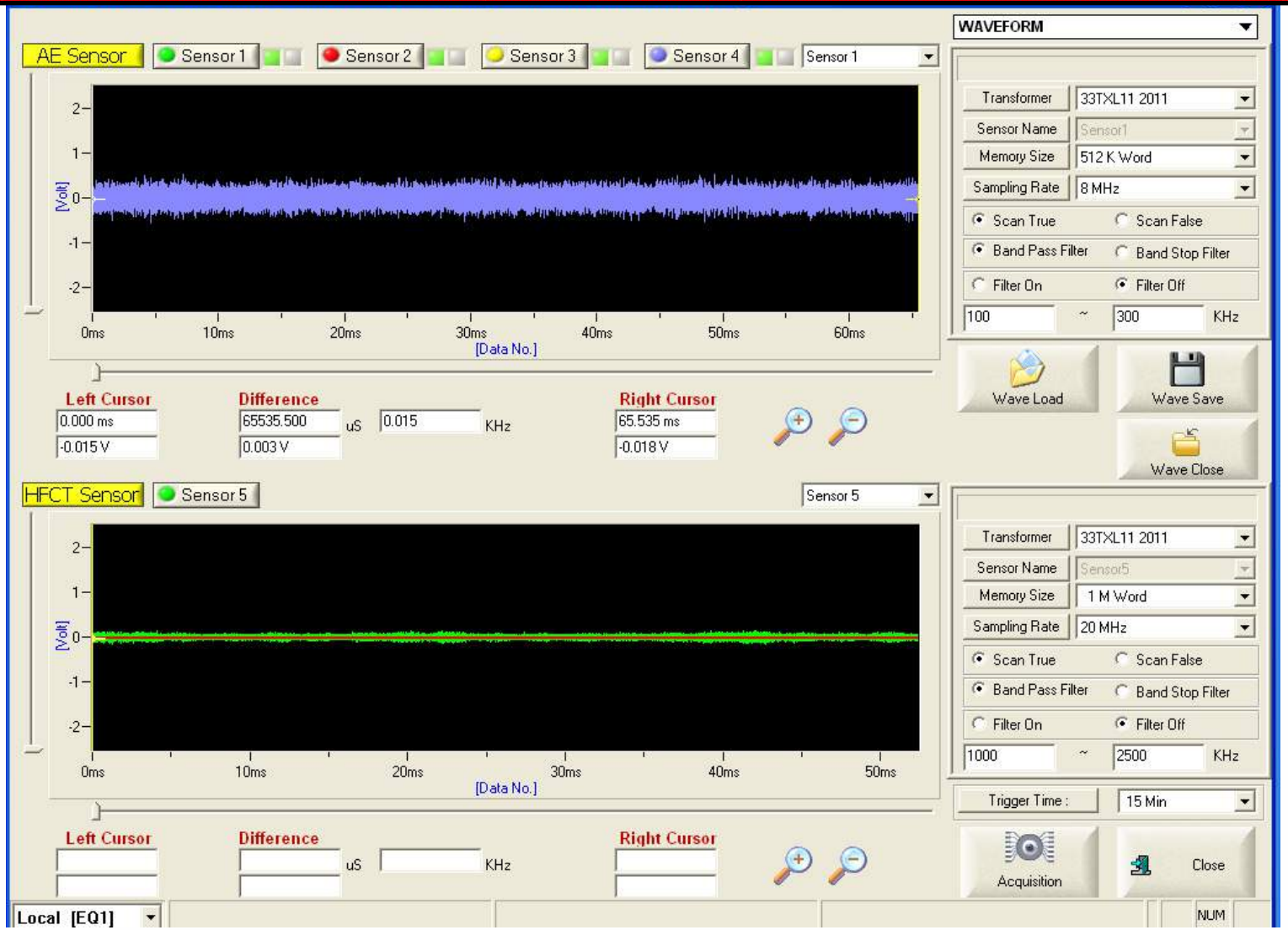

Black marks from arcing between outer loop of core and inside segment of U-frame

CASE STUDY

CASE STUDY


Black marks from arcing on
the insulation paper
between core loops

CASE STUDY


AE Sensor
Sensor 1
Sensor 2
Sensor 3
Sensor 4
Sensor 1
[Volt]
[Data No.]
0ms
10ms
20ms
30ms
40ms
50ms
60ms
Left Cursor
0.000 ms
-0.015 V
Difference
65535.500
uS
0.015
KHz
0.003 V
Right Cursor
65.535 ms
-0.018 V
HFCT Sensor
Sensor 5
Sensor 5
Left Cursor
Difference
uS
KHz
Right Cursor
Local [EQ1]
NUM
WAVEFORM
Transformer
33TXL11 2011
Sensor Name
Sensor1
Memory Size
512 K Word
Sampling Rate
8 MHz
Scan True
Scan False
Band Pass Filter
Band Stop Filter
Filter On
Filter Off
100
~
300
KHz
Wave Load
Wave Save
Wave Close
Transformer
33TXL11 2011
Sensor Name
Sensor5
Memory Size
1 M Word
Sampling Rate
20 MHz
Scan True
Scan False
Band Pass Filter
Band Stop Filter
Filter On
Filter Off
1000
~
2500
KHz
Trigger Time :
15 Min
Acquisition
Close

CASE STUDY

Lessons Learned

Being newer does not guarantee a transformer's health

No one else is as concerned about our equipment as we are

A robust transformer inspection program should include on-line Partial Discharge testing