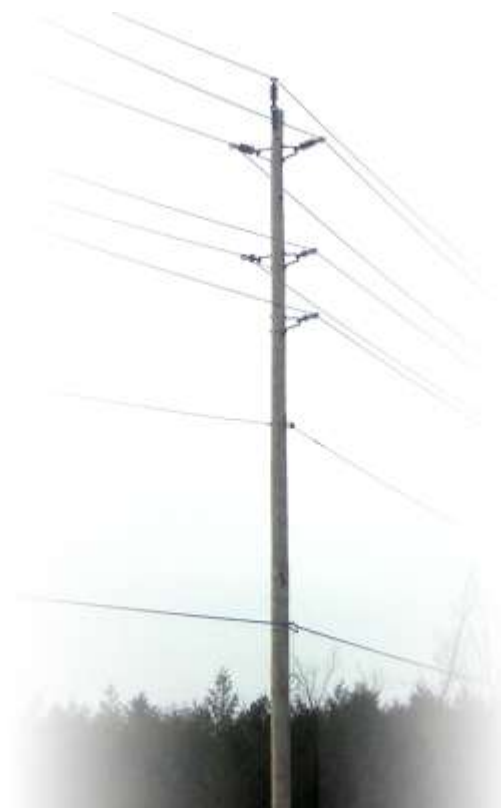


# Using ION Meters as an Asset Management Tool.

Power Logic User's Group Meeting  
October 18, 2013  
Toronto Ontario, Canada

Presented by: Gary MacLeod,  
Project Manager, Power Quality Enhancement Program



# Objectives - Demonstrate how Hydro Ottawa use their fleet of ION meters, ION Enterprise and PQView to:



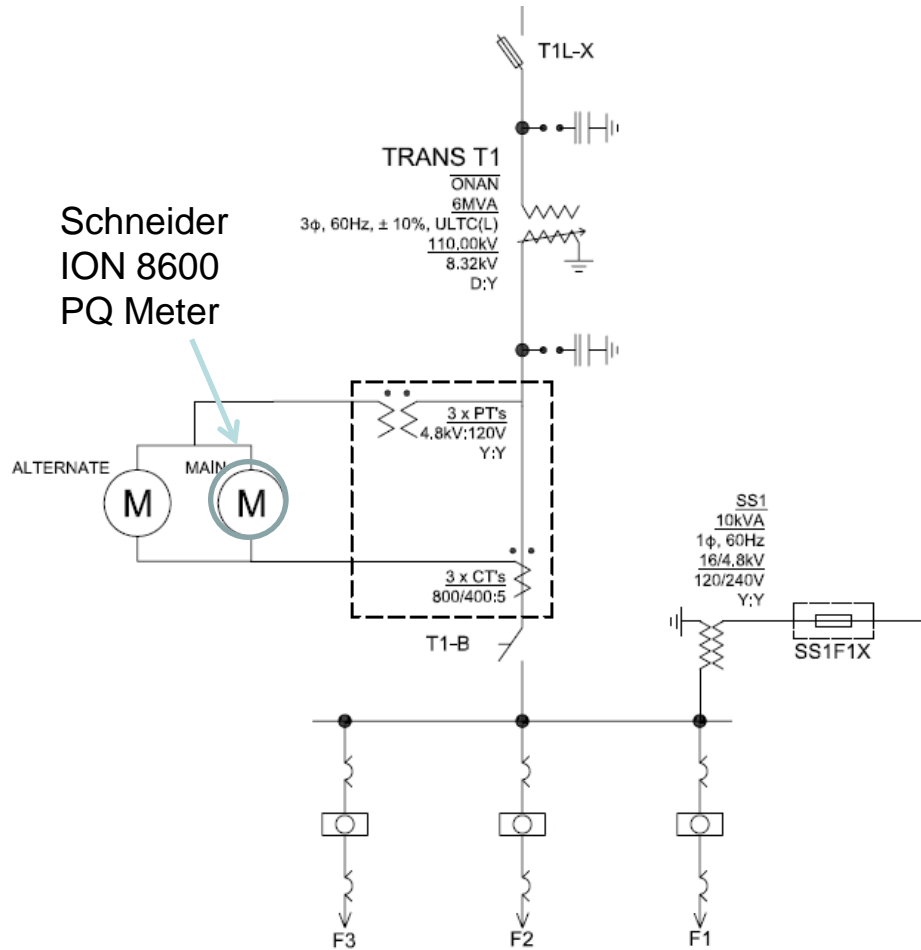
- Detect defective equipment before catastrophic failure
- Verifying Protection and Control settings
- Fault locate
- Provide better customer service
- Reduce customer PQ investigations
- Benchmarking PQ indices before installation of DG or new LRT



# Hydro Ottawa Power Quality Monitoring

- Full-time Power Quality monitoring Using Electrotek Concept's “PQView” software and Schneider ION meters and ION Enterprise software
- We started in 2002 with a small numbers of ION 8500 meters at some of our IESO Revenue Meter Points.
- We currently have 123 PQ meters installed or planned for this year and 10 more planned to monitor all buses except 4.16kV
- Current project underway to acquire PQ data and waveform events from our SEL relays and import it into PQView
- Current project underway to use PQView and CYME for fault locating

# Typical Metering Single-line Drawing



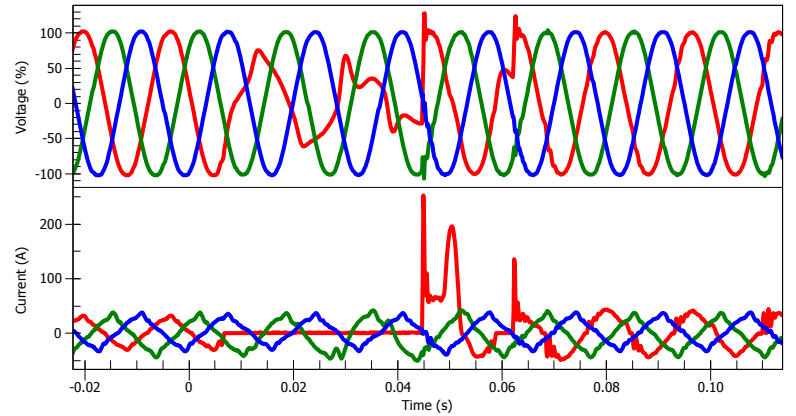
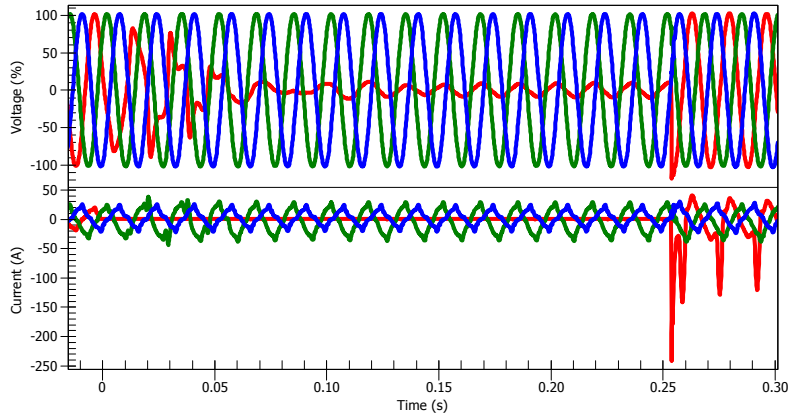
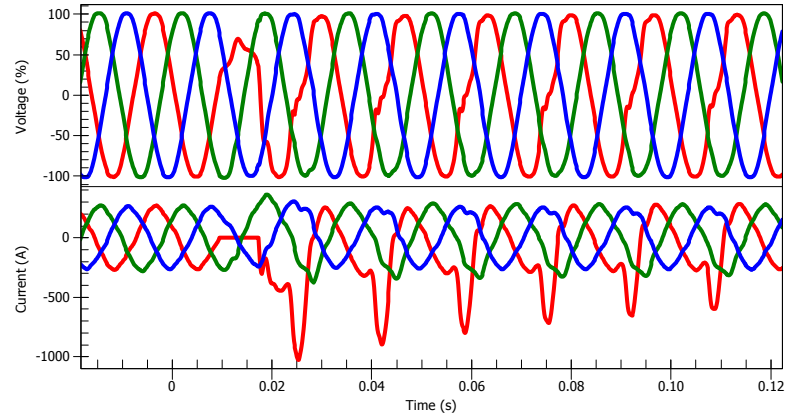
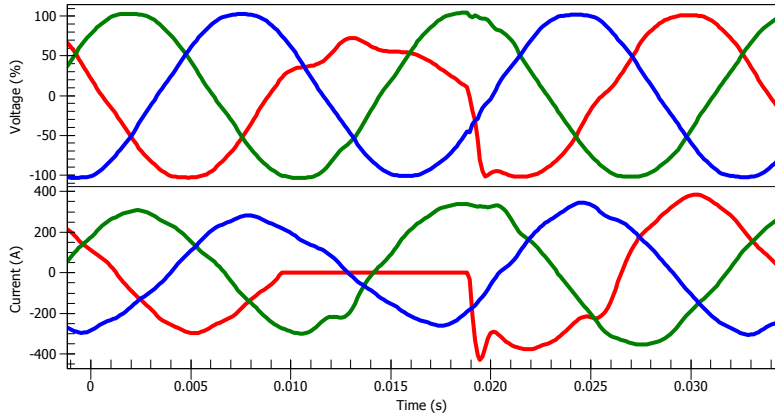


# History of Recent Tapchanger Failures

- We had three on-load tap-changers fail in past 36 months
- Transformer 1 was a 115kV – 16/27.6kV 33 MVA
- Transformer 2 was a 115kV – 16/27.6kV 37 MVA
- Transformer 3 was a 115kV – 4.8/8.3kV 6 MVA
- Different transformer manufacturers
- Two different tapchangers



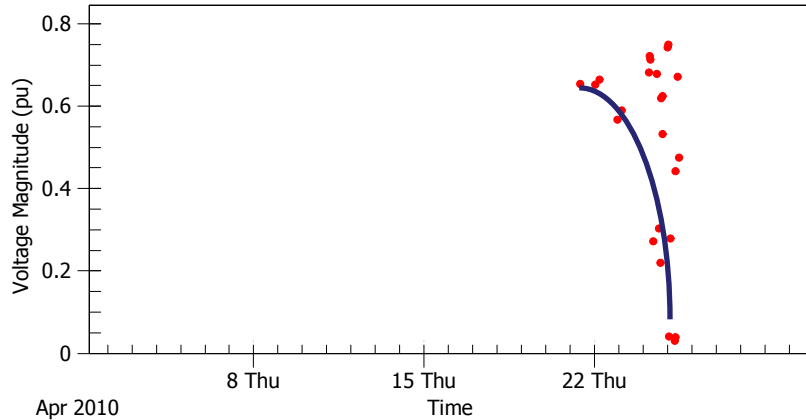
# Waveforms from 1<sup>st</sup> defective tapchanger





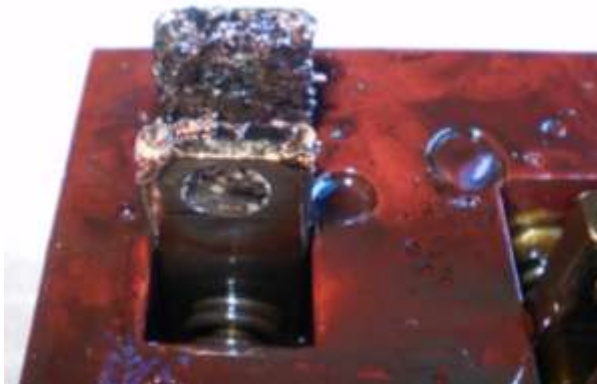
# Transformer 1 RMS Variations and Damage

RMS Variation Magnitude Time Scatter Plot  
Transformer 1



Apr 2010  
Hydro Ottawa - Technical Services

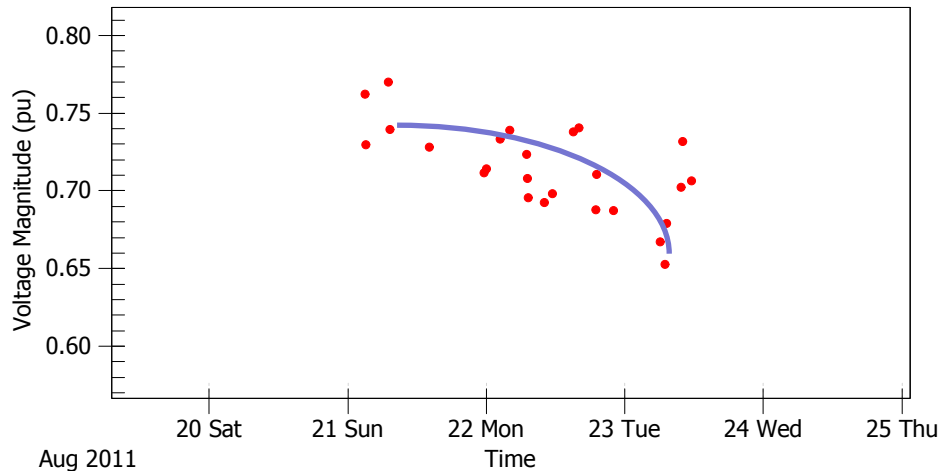
PQView®





# Transformer 2 RMS Variations

RMS Variation Magnitude Time Scatter Plot  
Transformer 2



Aug 2011

Hydro Ottawa - Technical Services

PQView®

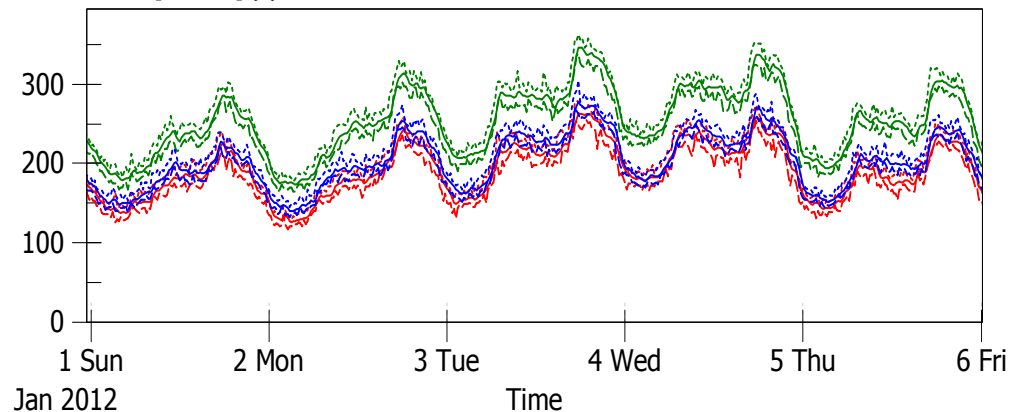
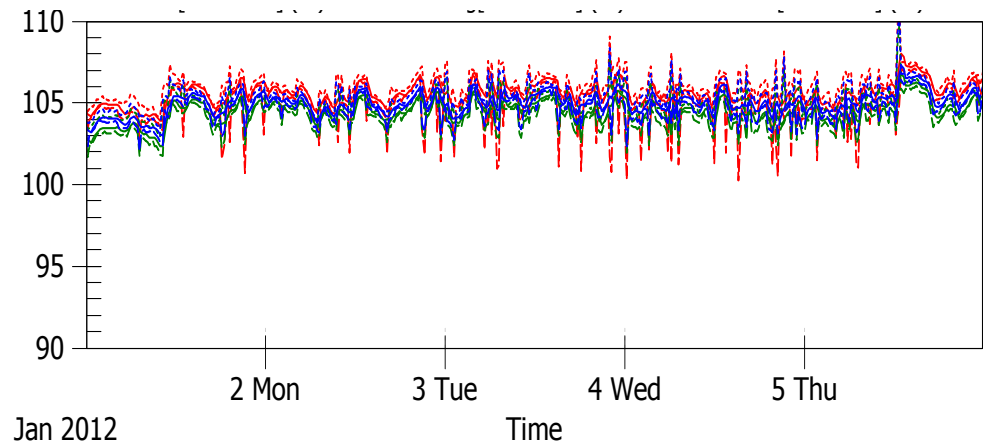




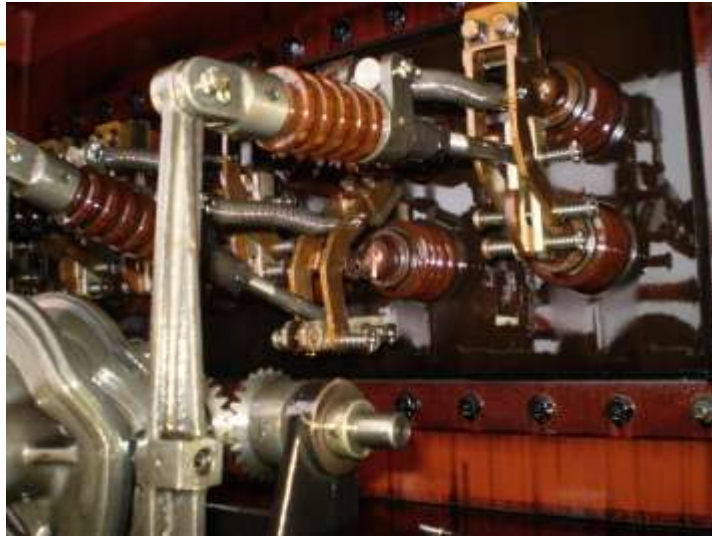


# Transformer 3 “No Events”

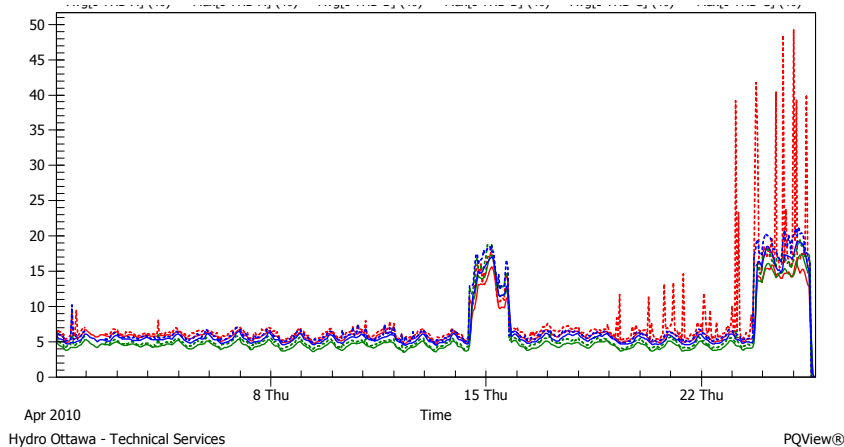
- There were no waveshape events recorded during this period.
- Voltage Trend data showed a frequent number of red phase minimum values that were not associated with current inrush or faults.
- Transformer was taken out of service and inspected and damage was found.



# Transformer 3 Tapchanger Damage

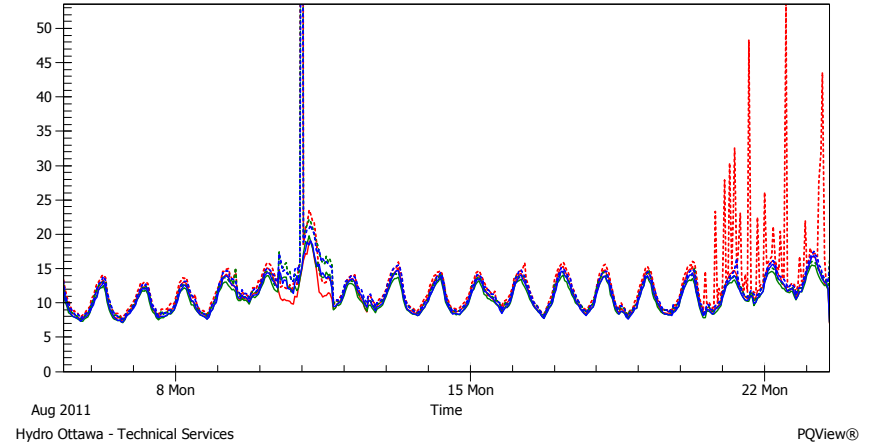


# Current THD Trends

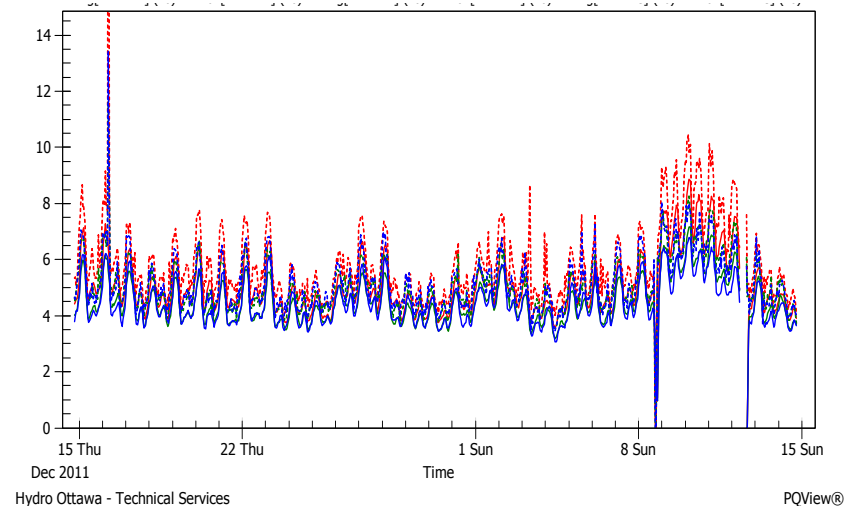


Transformer 1

Current THD did clearly identify an anomaly on T1 & T2 but it would be challenging to setup a threshold to capture a possible failure before significant damage occurred.



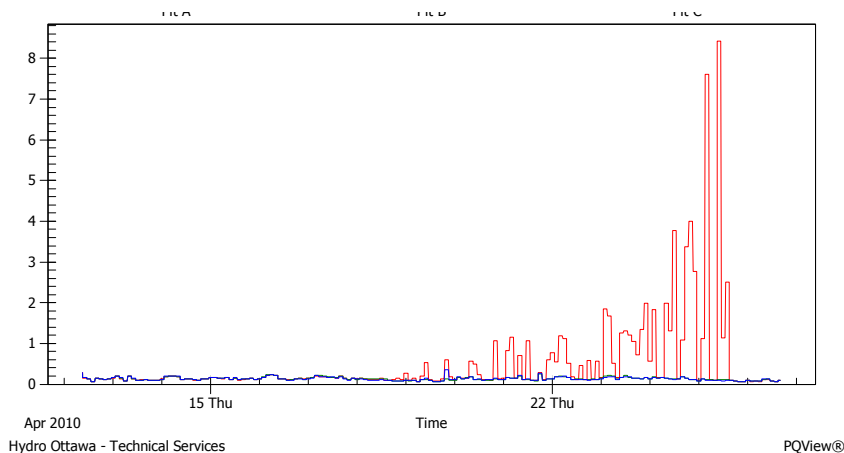
Transformer 2



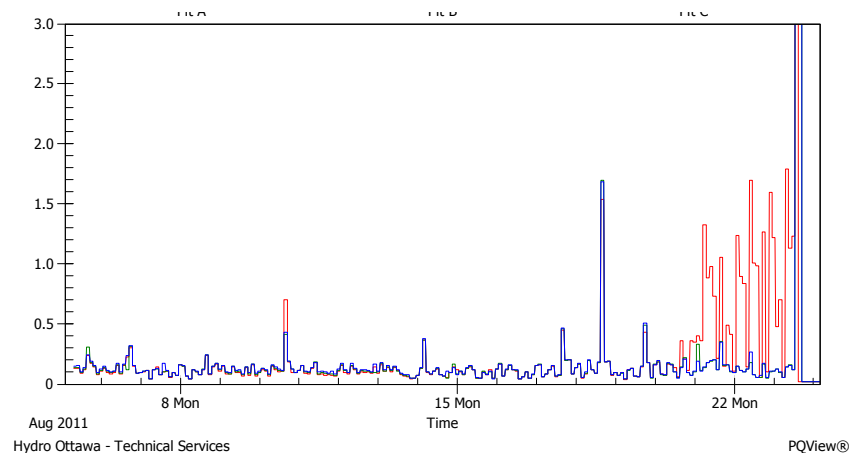
Transformer 3



# Voltage PLT Flicker Trends

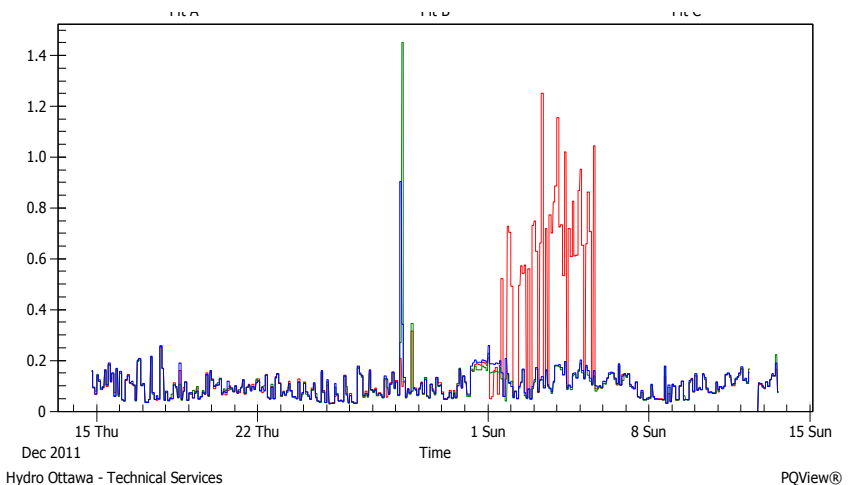


Transformer 1



Transformer 2

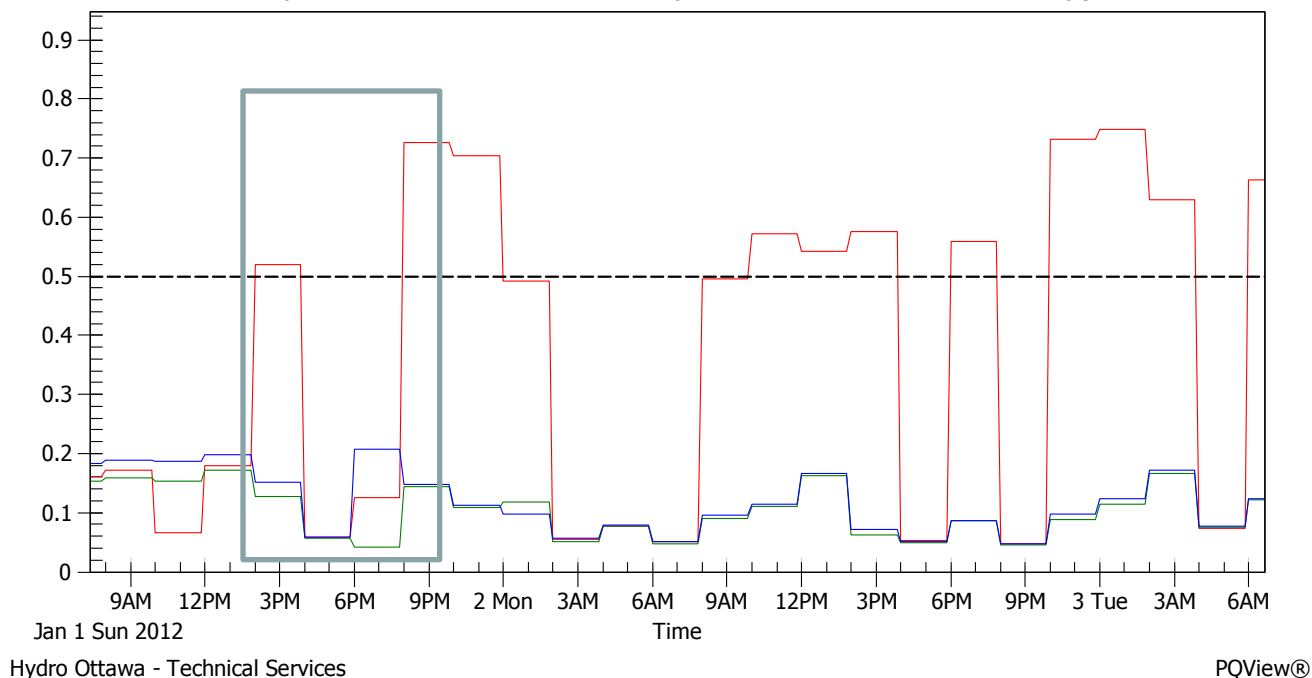
PST and PLT flicker data identified the start of the **serious** damage to the tapchanger within hours on all three transformers.



Transformer 3



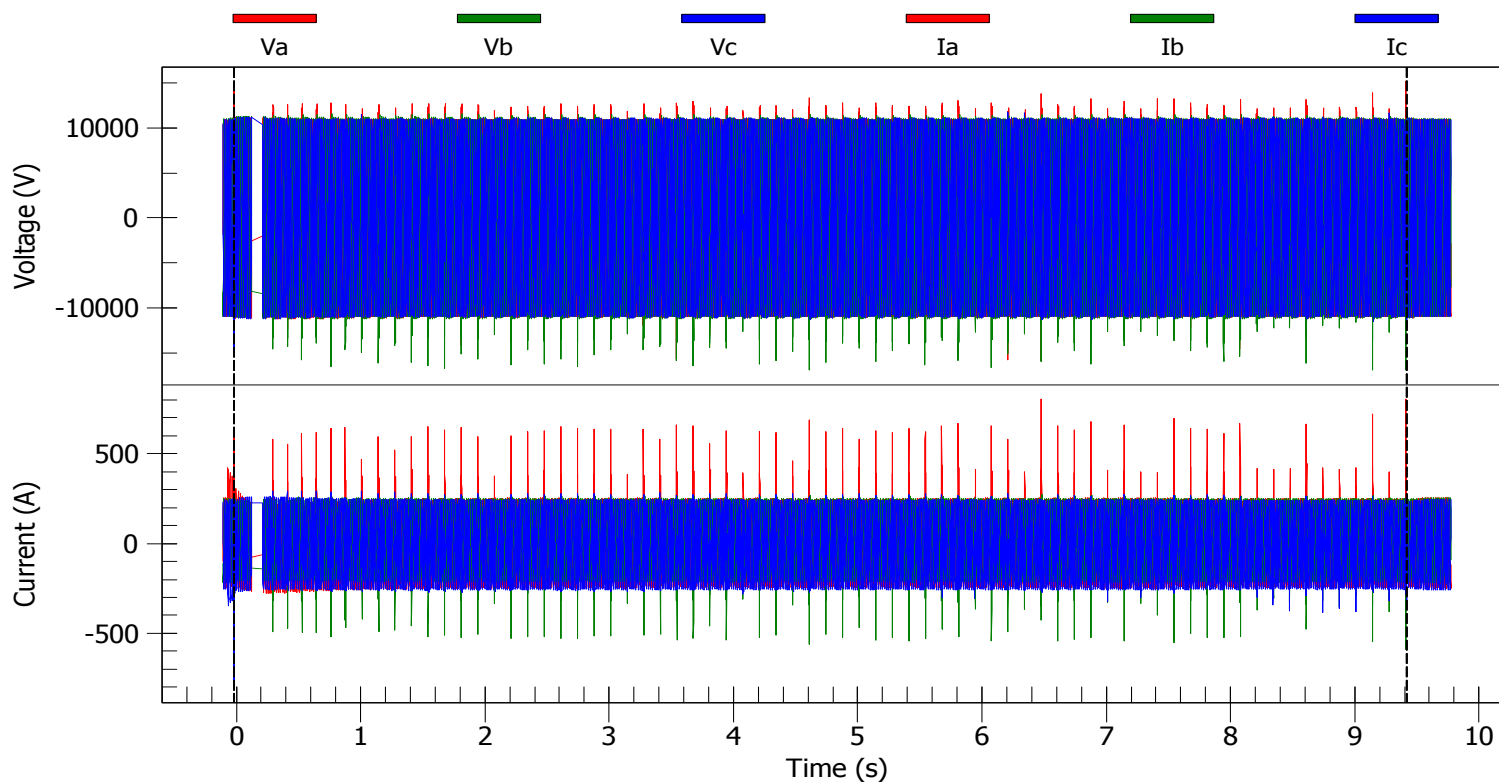
# Voltage PLT Analysis Tool



- 0.5% Voltage PLT threshold
- 3-hour limit above threshold in 24 hour sliding window.
- Email notification would have gone out on Jan 1 at 9:00 PM indicating a possible problem with transformer and it should be investigated.

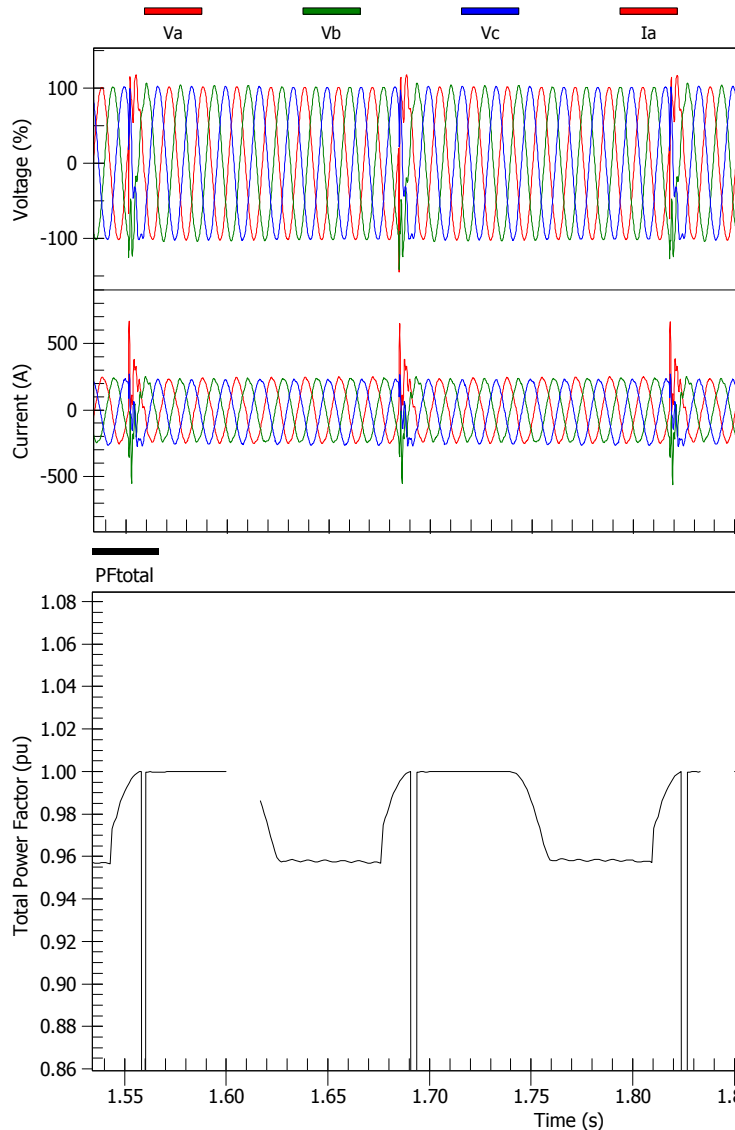


# Failed Operation of New Capacitor Bank



The Capacitor Bank energized and de-energized seventy times in ten seconds. Engineering staff and control manufacturer believed this could not happen and the meter was erroneous.

# Failed Operation of New Capacitor Bank Confirmed

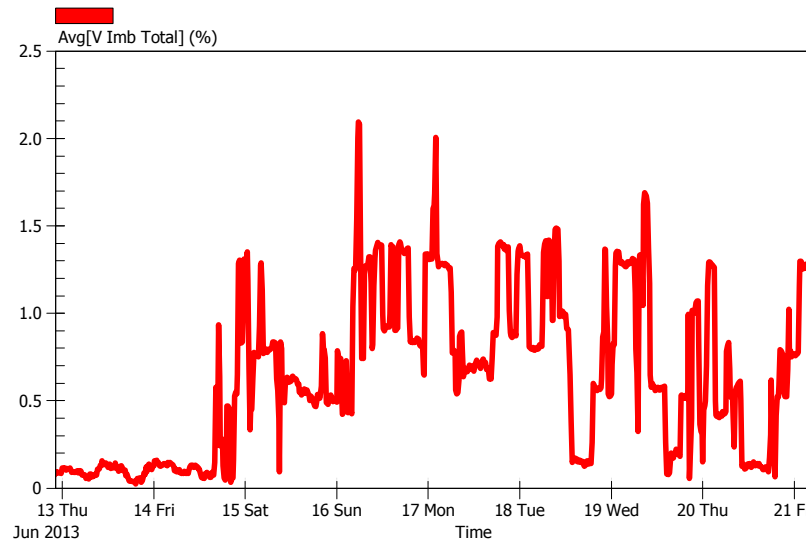


In this substation, both buses are in parallel and both ION meters saw the same event and SCADA told us the breaker operated a number of times

The graph below is shows the power factor is fluctuating between events and leading for a few cycles after the event and then dropping back to 0.96

Our engineering staff and the manufacturer are now investigating further to determine the cause

# Transformer Voltage Imbalance Problem

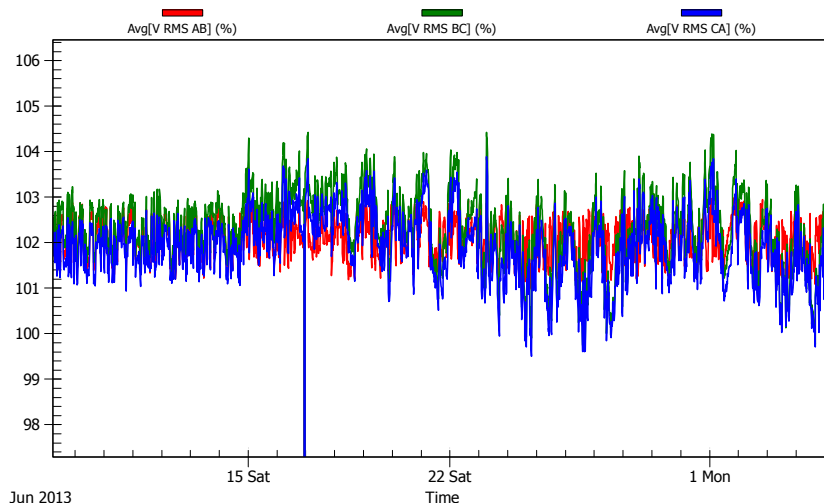


In June this year, a substation ION started to indicate increased voltage imbalance on a transformer bus.

The phase-to-phase voltage graph below did not indicate anything significantly abnormal

Problem was a broken chain on one phase in a tap-changer only allowing two phases to be regulated and the over fluctuated with the 115kV supply

**Recommendation: Setup 3 phase- 4 wire wye ION meters to measure phase-to-neutral voltages rather than phase-to-phase. This can be done after a meter is locked and sealed as well.**



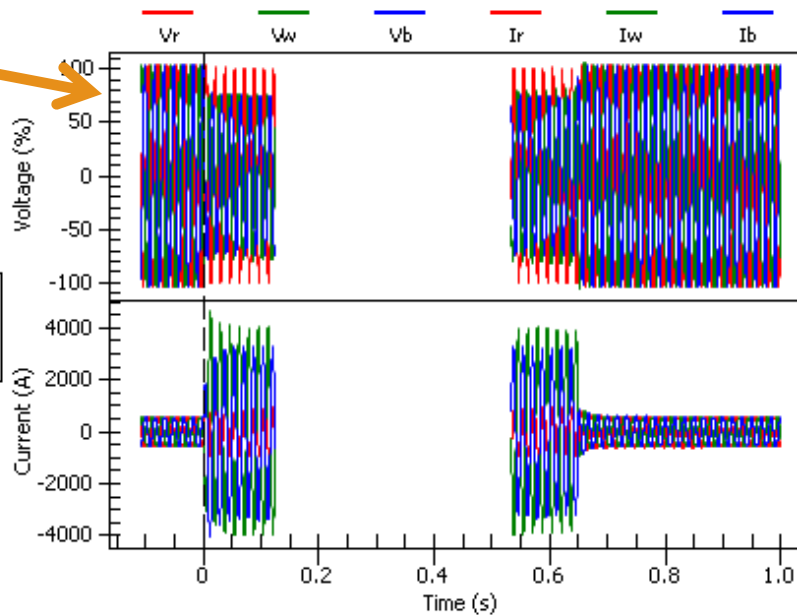


# Integrated with SCADA PI Historian to correlate breaker events with PQView event captures



HO\_Nepean\_TS.T4 - 05/01/2013 01:22:02.6034

Start Time: 0.001202s



Use this form to add, edit, and delete system event records.

System EventID	51391
Date and Time	05/01/2013 6:22:02 AM
Cause Code	Adverse Weather
Weather Code	
Isolating Device Code	
Failed Equipment Code	
Failed Equipment ID	Not Coded
Failed Line ID	22M27
Source Code	Hydro Ottawa Circuit
Impact to Power Provider	
Impact to End User	
Related Database ID	
System Event Details	

Sag event captured by ION meter

Operation  
 Point Name: NEP\_M27\_CB  
 Time Stamp: 05/01/2013 01:22:13.0000  
 Value: Nepean M27 Breaker Status  
 Description: CLOSE-OPEN

Breaker Operation imported from SCADA

Event ID = 287484  
 Hydro Ottawa

22M27 auto-reclosed. Heavy snow squall in the area.

System Event ID = 51391  
 PQView®

Event Cause added and available to all users and characteristics added for future analysis

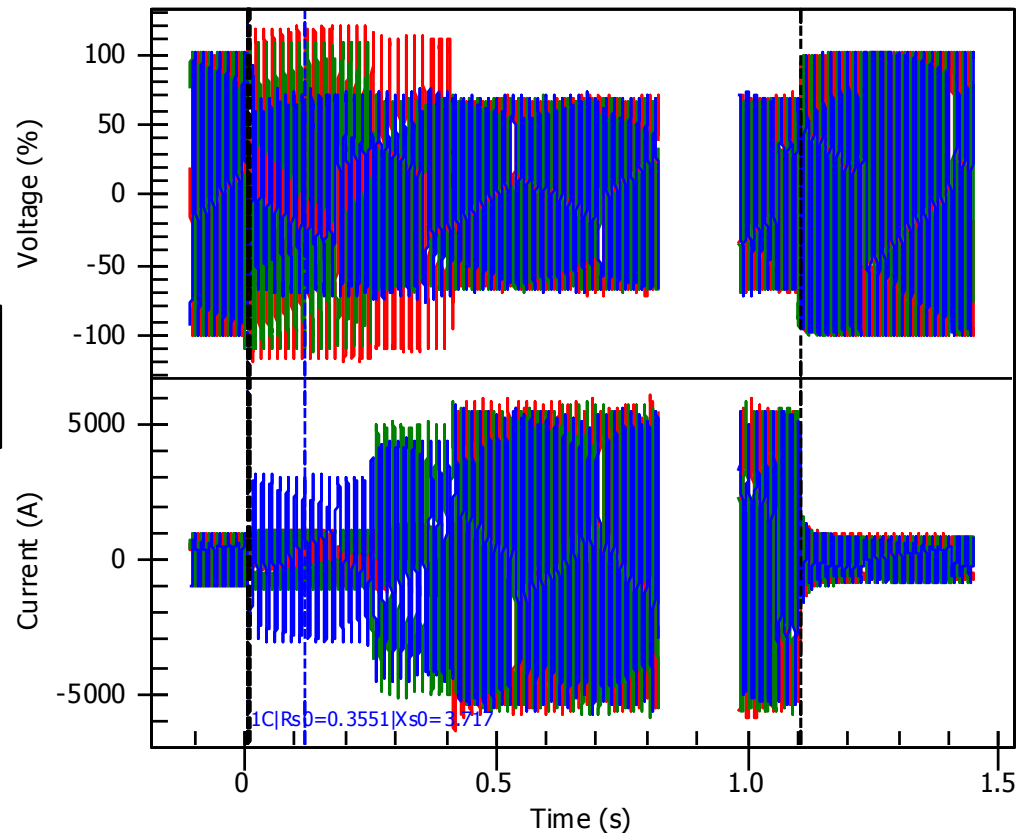
# Using PQView and CYME for Fault Locating



HO\_Overbrooke.T1\_J2 - 10/7/2013 11:49:38.6471

Duration: 1.099s

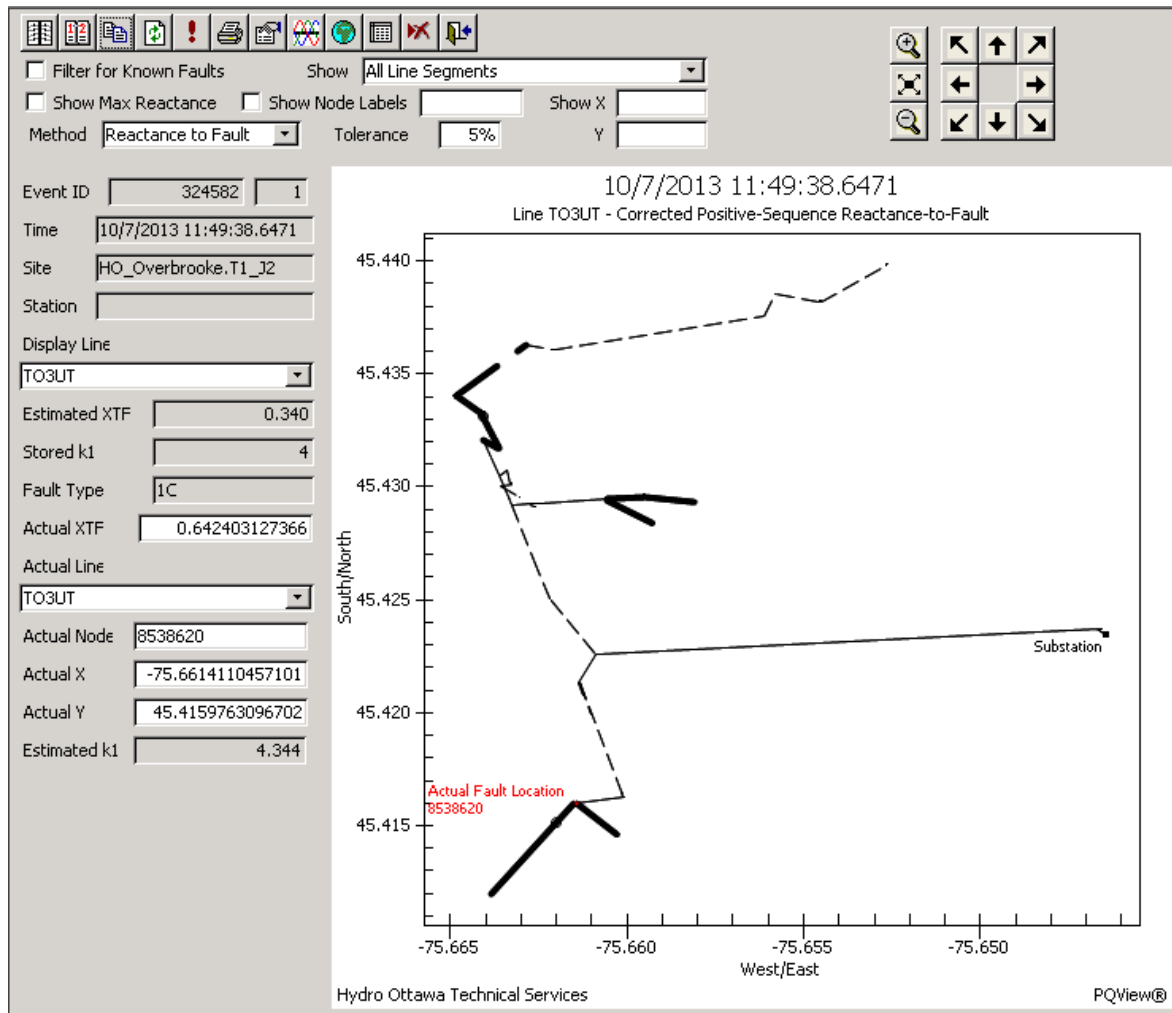
Va Vb Vc Ia Ib Ic



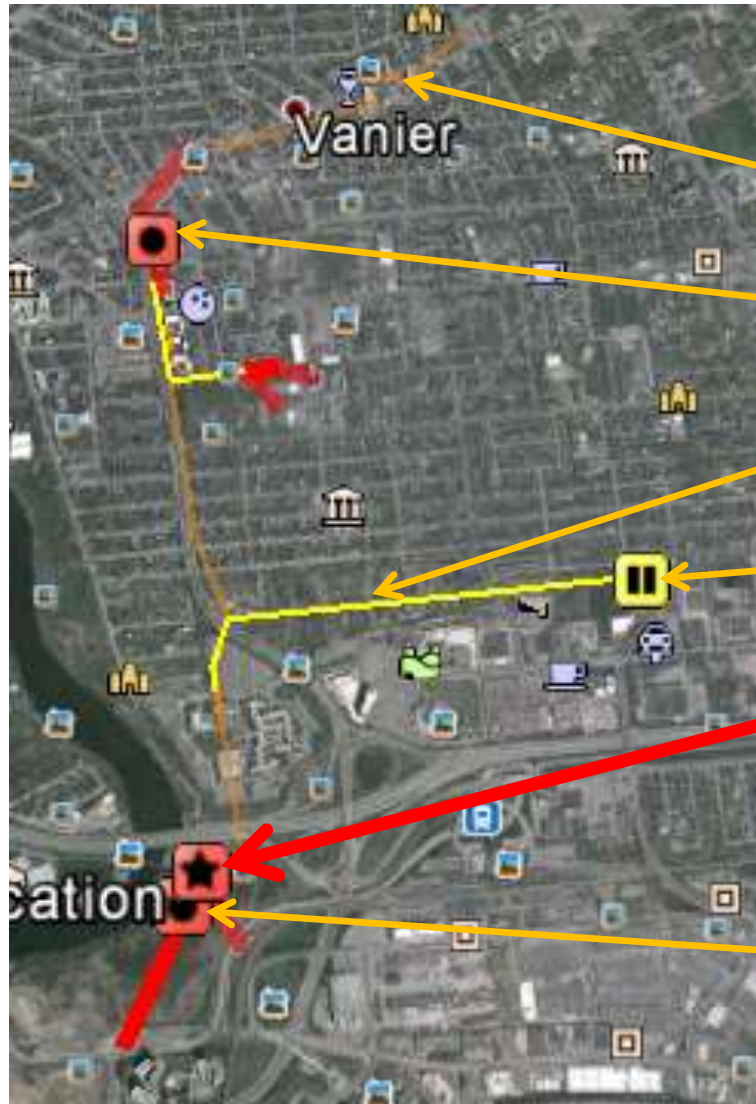
Operation

Point Name	TO_TO30_CB
Time Stamp	10/7/2013 11:49:57.0000
Value	Overbrook TO30 Breaker Status
Description	CLOSE-OPEN

# Using PQView and CYME for Fault Locating



# Using PQView and CYME for Fault Locating



As Shown on Google Earth

Orange line is UG cable

Predicted fault locations

Yellow line is overhead section

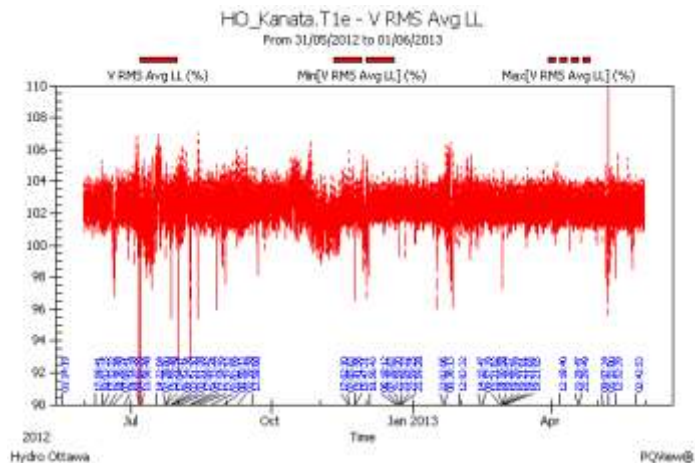
Substation

**ACTUAL FAULT LOCATION**

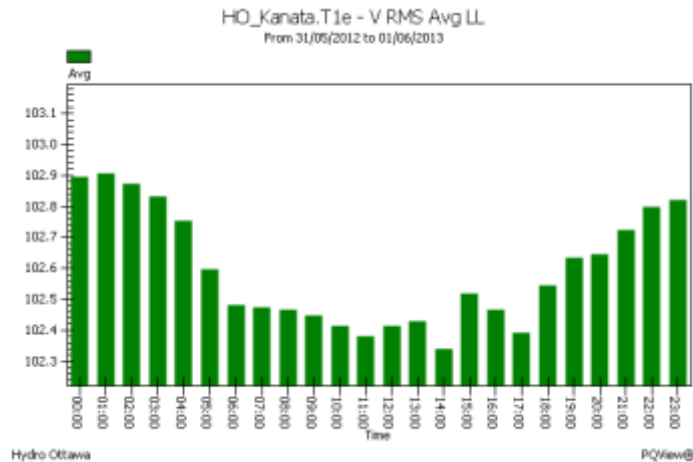
Predicted fault location



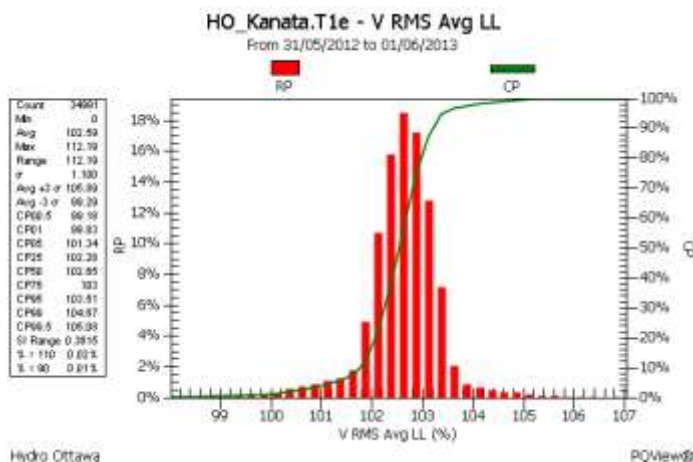
# PQView Trend Data Analysis



Trend Chart with Hyperlinks to PQ Events



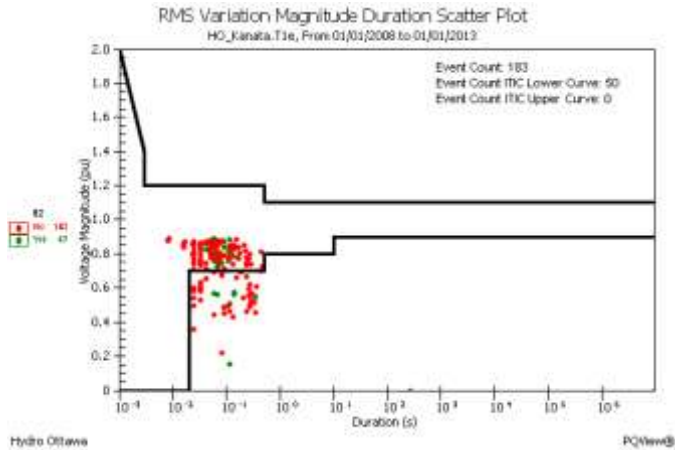
Profile Charts (this example is hourly)



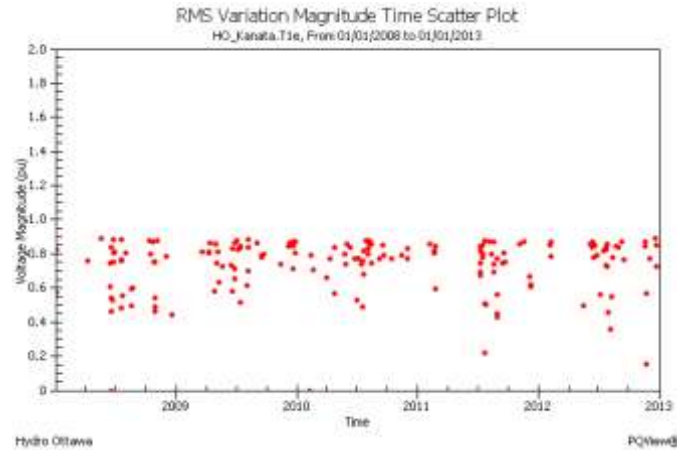
Histogram Chart with Statistics



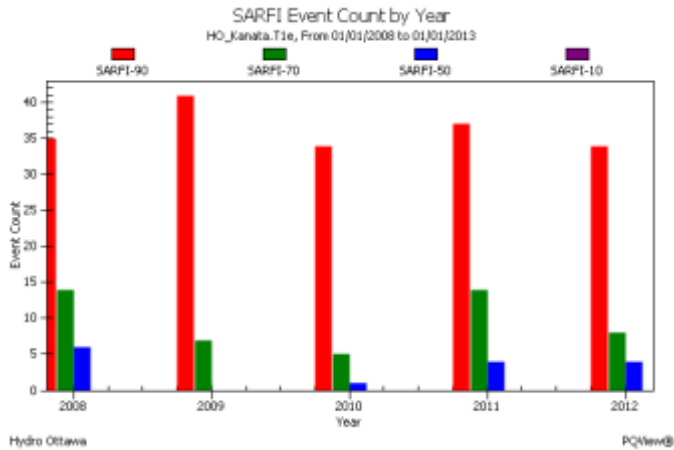
# Sag/Swell Analysis (5-Year period)



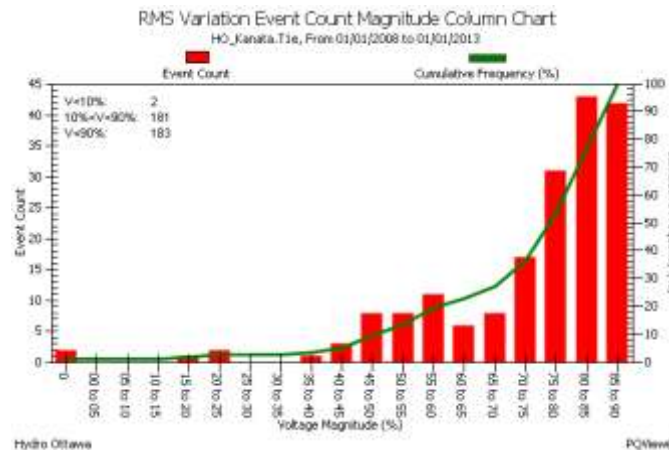
Events plotted on ITIC Chart



Events plotted on Time Scatter graph



SARFI Event Count



Sag Magnitude Column Chart

# “Big Data”



Meter Location	V RMS Avg LL			V Imbalance		V THD A		Flicker PLT A			I THD A		I Imbalance		SARFI Count by Site				
	Min	Avg	Max	CP95	CP99.5	CP95	CP99.5	CP95	StdDev	Max	CP95	CP99.5	Avg	CP95	ITIC	SARFI-90	SARFI-70	SARFI-50	SARFI-10
Meter 1	100.2	101.0	101.9	0.4	0.4	1.2	1.6	0.3	0.5		4.0	4.9	1.1	1.4	0	1	0	0	0
Meter 2	99.5	100.4	101.5	0.4	0.4	1.7	1.9	0.3	0.5		4.5	5.1	1.4	1.7	0	1	0	0	0
Meter 3	100.1	101.0	101.9	0.3	0.3	1.2	1.6	0.3	0.5		4.3	5.2	1.4	1.8	0	1	0	0	0
Meter 4	99.5	100.4	101.5	0.4	0.4	1.7	1.9	0.3	0.5		4.7	5.2	1.8	2.2	0	1	0	0	0
Meter 5	98.7	99.9	101.0	0.6	0.6	2.0	2.9	0.2	0.5		1.6	1.7	1.0	1.7	0	1	0	0	0
Meter 6	98.7	99.9	101.0	0.4	0.5	1.9	2.8	0.2	0.5		1.4	1.6	1.7	2.5	0	1	0	0	0
Meter 7	98.5	99.7	101.0	0.2	0.3	1.9	2.1	0.2	1.9		2.5	3.0	2.1	2.7	1	3	1	1	0
Meter 8	99.5	100.8	102.0	0.4	0.4	1.8	2.2	0.2	0.5		4.3	5.8	0.7	1.2	0	1	0	0	0
Meter 9	98.5	99.7	101.0	0.2	0.3	1.9	2.1	0.2	1.9		2.5	3.0	0.9	1.4	1	3	1	1	0
Meter 10	99.5	100.8	102.0	0.4	0.5	1.8	2.2	0.2	0.5		4.2	5.7	0.7	1.2	0	1	0	0	0

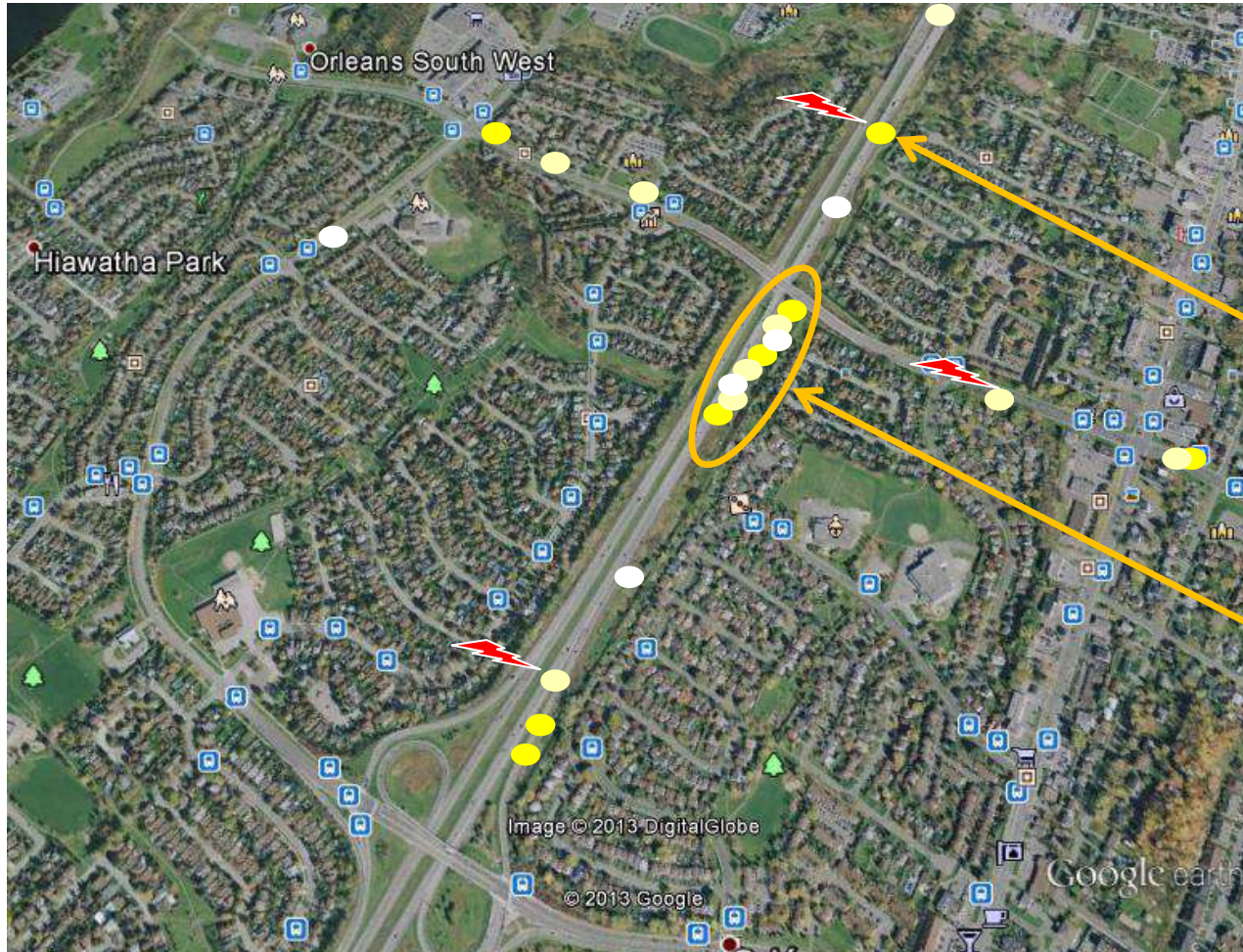
Databases now contain large amounts of data and the challenge is to be able to use the data to find and repair trouble spots quickly.

This spreadsheet shows 10 sample sites with monthly critical statistics for August 2013. The cells are condition formatted and quickly highlight trouble spots that should be reviewed.

I reviewed the two Flicker measurements highlighted in red and found that they only exceeded normal limits during a storm event and therefore deemed these anomalies acceptable and highlighted the cells with a green box



# Using Big Data...



Fault locations shaded by age. Brightest are the most recent

Recent lightning strike correlates with known fault location and auto-relocate

Rash of events in same area  
Trees?  
Bad insulators?  
Large population of squirrels?



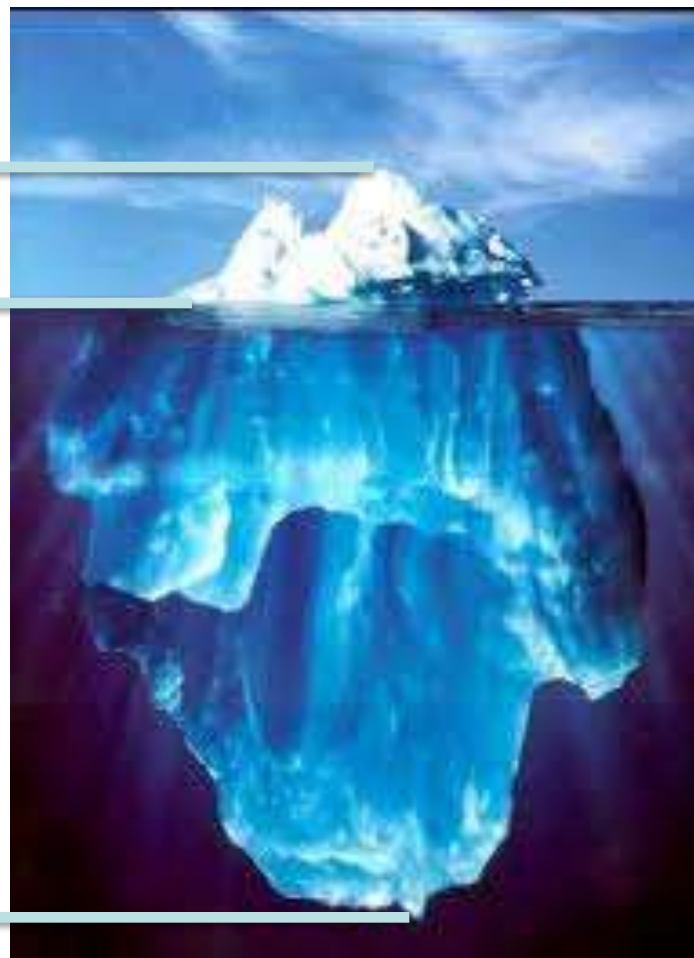


# PQ Data Use and Future Potential

## Basic Functionality Now

### Future Potential

- Relay Integration
- OMS Integration
- Automated Reporting
- Standards Compliance
- Predictive Maintenance
- Fault Locating
- Event Alert



# Questions?



Contact:

Gary MacLeod, Project Manager, Power Quality Enhancement Program

Tel: 613 738-5499 ext 7108

[garymacleod@hydroottawa.com](mailto:garymacleod@hydroottawa.com)