

What Utility Analytics means to Exelon

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Exelon's Analytic Journey

- Exelon Utilities Overview
- T&D Grids
 - Data Visualization
 - Data Analytics/Notifications
- Where we're headed (Exelon's BI/DA Initiative)



Exelon® Utilities Overview

All three Exelon Utilities utilize PI-Historian and various other OSIsoft products

Chicago, Illinois

ComEd

- Employees: ~5,800
- Electric customers: 3.8 million
- Service Territory: 11,300 square miles
- All-Time Peak Load: 23,753 MW

BGE

Baltimore, Maryland

- Employees: ~3,400
- Electric customers: 1.2 million
- Gas customers: 0.7 million
- Service Territory: 2,300 square miles
- All-Time Peak Load: 7,616 MW

Philadelphia, Pennsylvania

PECO

- Employees: ~2,400
- Electric customers: 1.6 million
- Gas customers: 0.5 million
- Service Territory: 2,100 square miles
- All-Time Peak Load: 8,983 MW

Our Journey with PI Historian

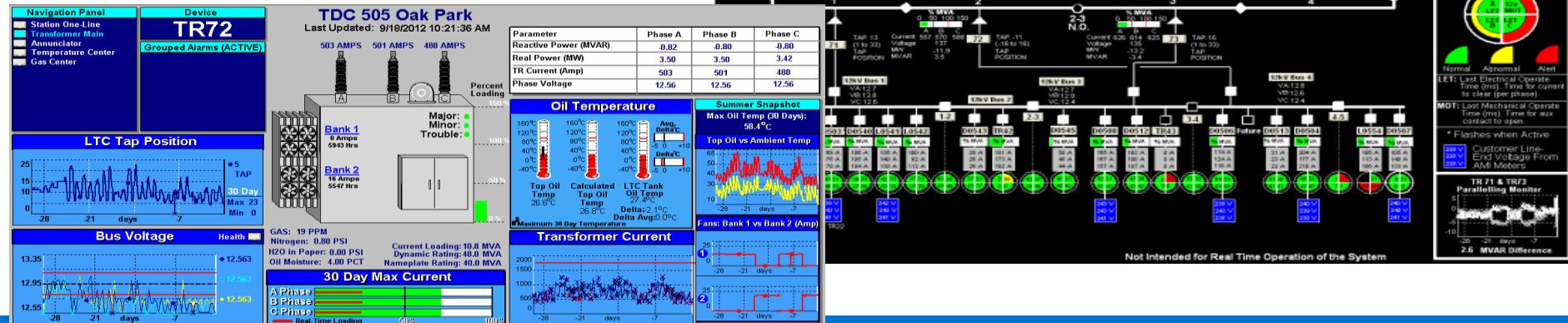
- Have been using PI Historian to store the Supervisory Control and Data Acquisition data since 1998. The collected data requires processing and analytics which is a major challenge.
- Engineers are familiar with using the OSIsoft solutions, PI ProcessBook and PI DataLink, to analyze field data, generate displays and reports.
- Now with the surfacing of Analytics and Data Visualization, it has become easier to monitor health of the assets, diagnose and predict problems, assist the company with prioritizing and planning the maintenance needs.



Intelligent Substation

Substation Dashboard – Data Visualization

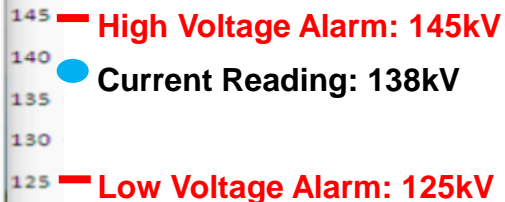
- Joint effort between Engineering and IT to create a Station Health Dashboard that would consolidate a vast amount of information in a visualized fashion.
- Interprets and provides a visual display of advanced equipment monitoring information into an easy to read and understand fashion.
- Ability to drill down to detailed asset information and historical information.
- Trending of key metrics that are interrelated. Paralleling health monitor identifies issues with transformer paralleling by comparing real time VAR flow.
- Advanced Continuous Transformer DGA
- High level overview of station health



Looking at Data Differently – Trend, Analyze, Notify & Respond

Traditional Voltage Alarming

Transmission Source Voltage

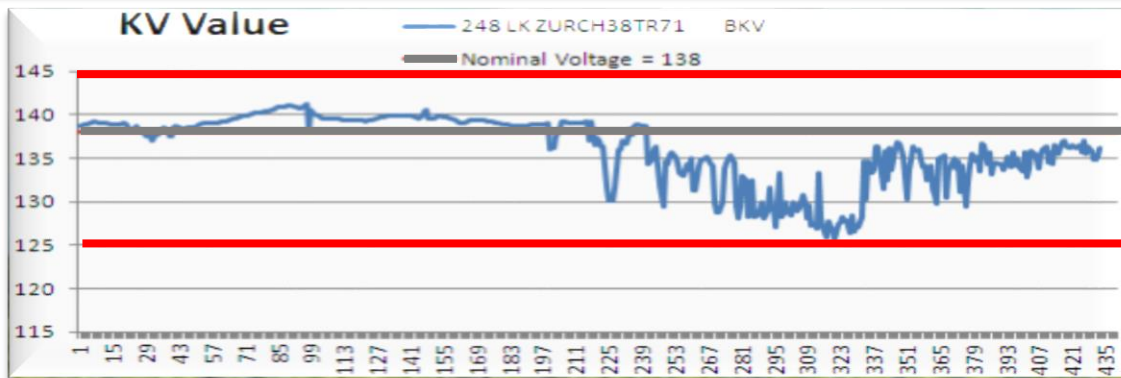


- Only ALARM if current reading exceeds High and Low set points
- Sudden, abnormal changes in voltage are not seen
- Impending failures go un-noticed

One Data
Point Doesn't
Tell the Whole
Picture



TRENDING & Advanced Alarming



See the Big Picture
Trending over time
reveals hidden issues
that traditional
alarming can't see

Signs of Failure



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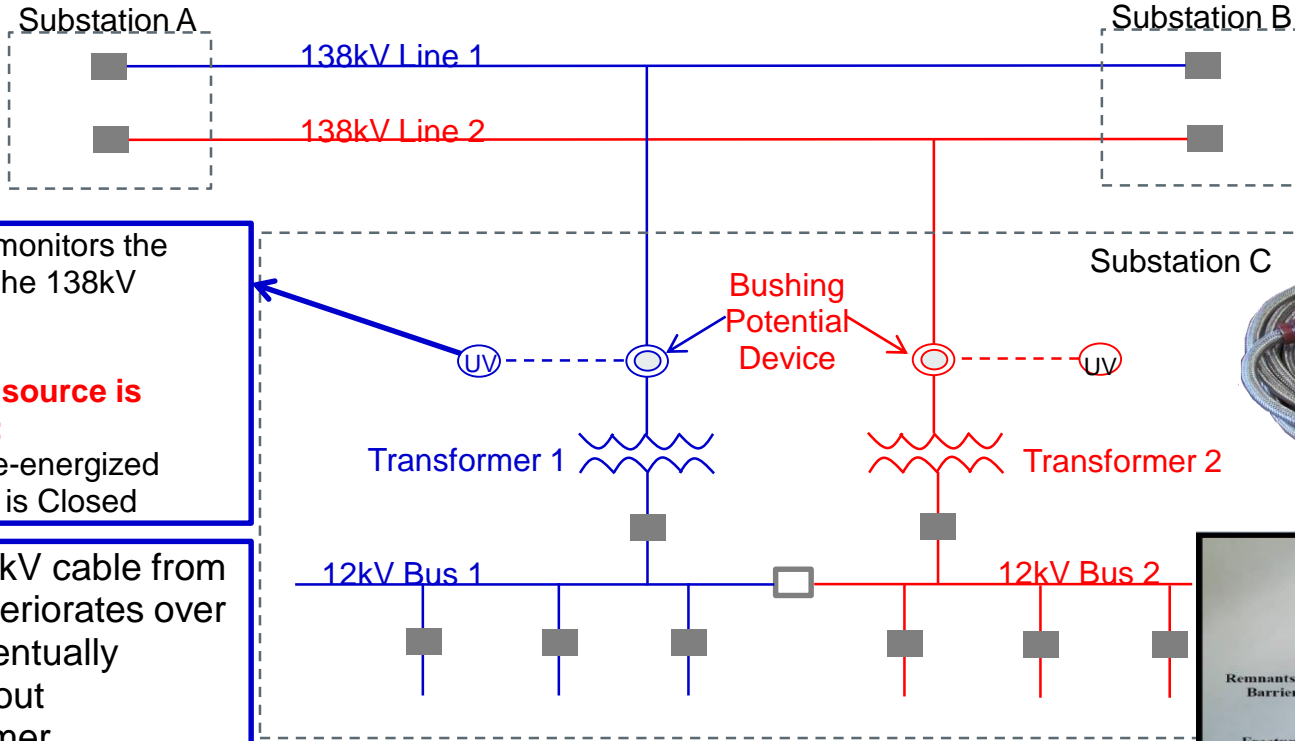
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Analytic Roadmap (Bushing Potential Device Monitoring)

Simplified Station One-Line

LEGEND

- Open Breaker
- Closed Breaker
- TR Bushing
- Ⓢ Under Voltage Relay

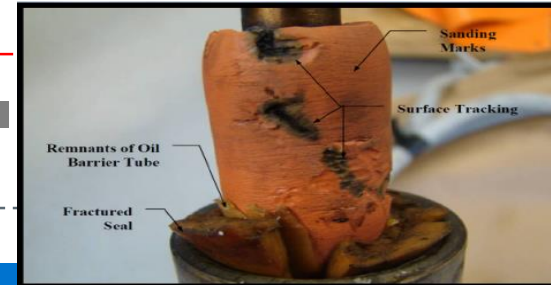


UV relay monitors the health of the 138kV Source.

If loss of source is detected:

- TR is de-energized
- Bus Tie is Closed

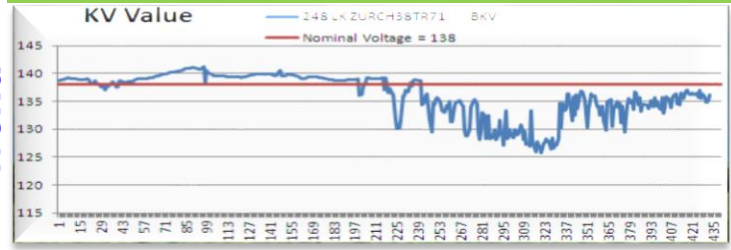
Issue: 5kV cable from BPD deteriorates over time, eventually tripping out transformer



Analytic Roadmap (Bushing Potential Device Monitoring)

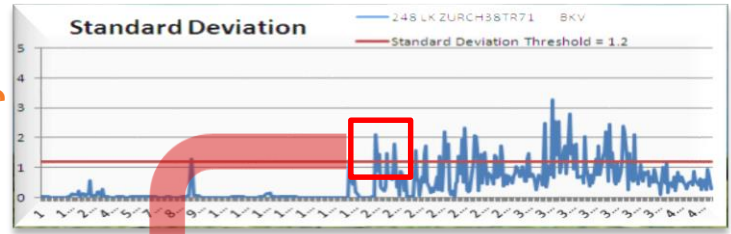
Analytic Development

Trend



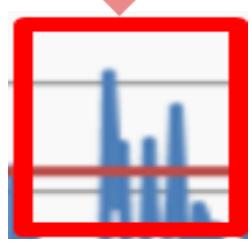
- Rather than look at data from a singular standpoint, trend over time
- Look for variations undetectable by traditional alarming

Analyze



- Develop Analytics that can assess data trends
- How is the data changing over time
- How should the data change over time.

Alarm



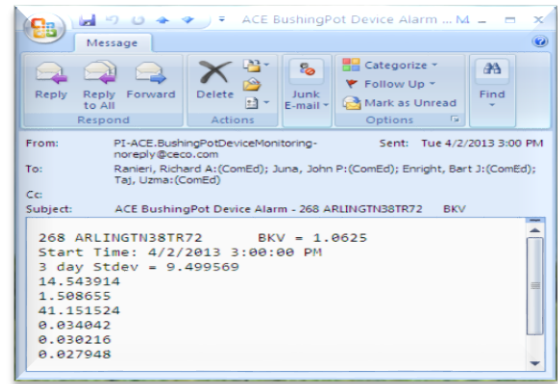
- ☒ Standard Deviation of 1.2 or greater?
- ☒ Occurred 3 or more times in a 1 hr period?
- ☒ Transformer High Side Closed?

- Eliminate nuisance alarms & provide "Trust" in the Analytic
- Tie in data points to supervise alarming
- Evaluate Failures for pre-cursor trends

Alarm

Deployment

Notify & Respond



- **Current State:** Email sent to engineering when condition satisfied. TG Dispatched to isolate UV/OV Trips.
- **Future State:** Incorporate into Ranger as a Major Alarm that is immediately responded to and addressed.

Implemented on all Transformers with monitored BPD's (238 of 561)

HPFF Cable Leak Detection

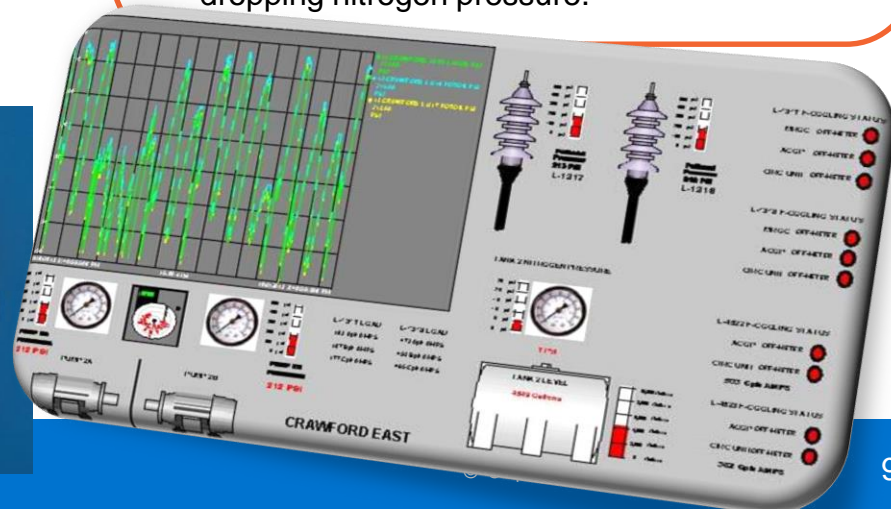
High Pressure Fluid Filled Cable Pumping Plant

Maintains fluid pressure on high voltage underground transmission cables. Used to accommodate expansion and contraction under various loading conditions. Traditional alarming triggers when low oil is detected (reservoirs hold between 5,000-10,000 Gallons)



Analytic Development

- SCADA recently installed on 33 Pumping Plants and 43 circuits.
- Postmortem investigation of a failed HPFF cable identified a signature that could detect a failed cable.
- One of the analytics detecting this condition is if there are high pump counts in conjunction with dropping nitrogen pressure.



Transformer Paralleling Health

Tools Used: PI Historian, PI Notifications

Identify Pre-Cursor Trends

Build a Sandbox to Identify the Condition

Analyze the Results

Automate & Improve

Transformer Paralleling

We detect excessive circulating VAR's between transformers which cause operational inefficiencies.

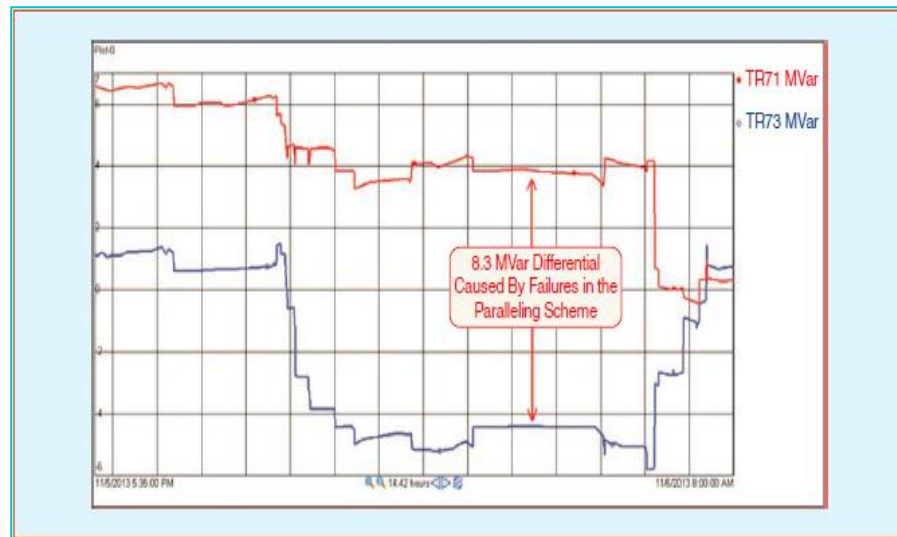
STATUS: Analytic running at 53 substations.

Transformers in Alarm - Weekly Detail Report

Report Period: 1/30/2014 - 2/6/2014

Date & Time	Substation Name	Type	Transformer Pairs in Parallel	Maximum MVAR Difference
1/30/2014 12:10:00 AM	SUBSTATION 1	A-2	TR71 - TR73	7.125
1/30/2014 7:40:00 AM	SUBSTATION 1	A-2	TR71 - TR73	7.625
1/30/2014 11:40:00 PM	SUBSTATION 1	A-2	TR71 - TR73	7.125

Report Created at: 2/13/2014 2:06:14 PM]



OUTLOOK: Paralleling issues identified at numerous locations. Taught us about the benefits of weekly reports rather than instantaneous notifications.



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- ComEd



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APPENDIX

Bushing Pot Device Overview

Other Grid Analytics Deployed...

APPENDIX: Contingency Analysis

Tools Used: PI Historian, PI AF

Identify Pre-Cursor Trends

Build a Sandbox to Identify the Condition

Analyze the Results

Automate & Improve

Special Protection Schemes

Created contingency displays for complex scenarios for dispatchers. Zooming feature allows engineers to view the logic behind the schemes.

STATUS: The concept has been proven.

The following conditions initiate a trip of one of the Generating Station Units:

- I. With Generating Station Unit 2 operating while Unit 1 is out of service,
NORMAL 1) ☐ Any multi-phase fault on LINE 3 close to Generating Station
- II. With Generating Station Unit 1 operating while Unit 2 is out of service,
NORMAL 1) ☐ Any multi-phase fault on LINE 3 close to Generating Station
ARMED 2) ☐ Any multi-phase fault on Bus 1 at Generating Station and a

```
[[if (A and B and not(C)) then W else X]]
```

A= \SUBSTATION\ Data Points\ STATION UNIT 1\ IsClosed	TRUE
B= \SUBSTATION\ Interrupted Paths \ LINE 3	TRUE
<input type="checkbox"/> C= \SUBSTATION\ Interrupted Paths \ LINE 6	FALSE
W= \SUBSTATION\ Data Points\ ARMED	ARMED
X= \SUBSTATION\ Data Points\ NORMAL	NORMAL

OUTLOOK: Provide immediate situational awareness to contingency events.



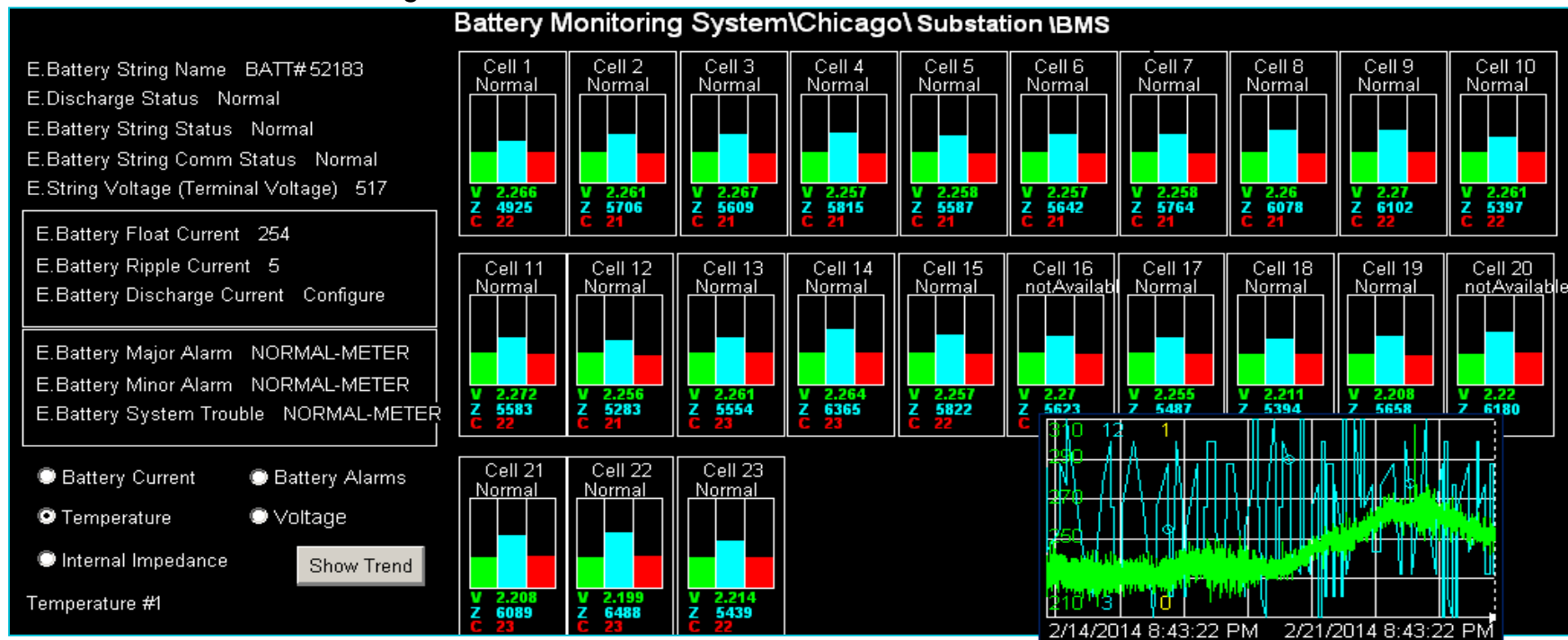
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APPENDIX: Battery Monitoring Visualization

Detailed Battery Monitoring System Data providing measured information on cell by cell basis.

These displays are used by the T&S Equipment Standards to track component level trends that may lead to reliability issues and premature failures. Also to troubleshoot issues without having to immediately send resources onsite to investigate.



APPENDIX: Pipeline Analytics

Identify Pre-Cursor Trends

Build a Sandbox to Identify the Condition

Analyze the Results

Automate & Improve

Bushing Pot Device

Identify failing bushing pot devices by identifying erratic voltage measurements

STATUS: In production. 238 transformer's monitored.

OUTLOOK: Promising. Nuisance alarms eliminated by supervising notification. System identified two failing BPD's since implementation in March of 2013.

T-Line Cable Leak

Detect oil leaks on fluid filled transmission line cables by monitoring pumping plants

STATUS: In production. 33 Pumping Plants and 43 Transmission lines monitored

OUTLOOK: Promising. Alarms have been received based on pre-set conditions. Additional fine tuning of analytic required to eliminate nuisance alarms.

Transformer Paralleling

Identifies Transformers that are not paralleling properly and are pushing VAR's out on the system. Causes wear and tear on transformer

STATUS: In Production.

OUTLOOK: Complex algorithm that is site specific.

Voltage Collapse Detection

Identifies voltage collapse condition when picking up load at station. Used to detect if station is susceptible to voltage collapse.

STATUS: Pilot analytic running at existing Intelligent Substation.

OUTLOOK: Complex algorithm that is site specific. DVR running at station causes many nuisance alarms.

Battery Monitoring

Identify when battery cell impedance is 25% higher than base impedance level.

STATUS: In Development.

OUTLOOK: Limited to stations with battery monitoring installed.



APPENDIX: Pipeline Analytics (continued...)

Transformer Oil Leak Detection

Identifies oil leaks by comparing a decline in transformer oil pressure with the time the pump starts.

STATUS: In Development.

OUTLOOK: Will be difficult to quantify based on frequency of detectable leaks.

Bad Telemetry Monitoring

Detects broken RTU's that are not detected by Ranger. Alarm is sent if data point reports "Bad Quality" for a select period of time.

STATUS: In Development

OUTLOOK: Promising. Would have identified an issue that was present at Dundee TDC.

Cap Bank Current Imbalance Detection

Monitor deviations in current balance between phases of cap banks to identify blown Caps.

STATUS: In Development

OUTLOOK: This is manually performed for Summer Readiness. This algorithm would perform the analytic 24/7

Transformer Tap Change Monitoring

Identify transformers whose (Tap Changes per Day) change drastically from one day to the next.

STATUS: Concept under development.

OUTLOOK: Can be implemented on transformers without TR Monitoring. May also be able to detect run through neutral.

SPOG Monitoring

Create a system Planning Operating Guide (SPOG) Status indication that provides the Control Room Dispatcher with the current status of the system

STATUS: In Development - Analytics Created

OUTLOOK: Promising. First system monitoring of it's kind.

Static Analog

Identifies stagnant analog points based on standard deviation calculation

STATUS: In Development