CONSIDERATIONS AS TO: WHAT'S GOING TO HAPPEN WITH ALL THE DATA FROM THE SMART GRID?

Wieslaw Jerry Olechiw

VP of International Sales and System Sales

Dranetz and Electrotek Concepts

SMART GRID CONSIDERATIONS; WHAT ARE YOUR SMART GRID PLAN?

- The Smart Grid includes a very wide range of technologies and new initiatives.
  - Renewables - Wind, solar, etc.
  - Storage Capacity – pumped water storage, new battery technologies.
  - Electric Vehicles will create new loads at different times of day and in residential, commercial and industrial locations.
  - Smart metering for all residential consumers. Utilities begin to monitor the use of energy and appliances in your home.
  - Communication and data storage protocols – IEC61850, Common Information Model, Comtrade, PQDIF and more.
  - A “self healing” highly reliable power grid. How do we get there?

WHERE IS THE DATA COMING FROM?

A Waterfall of Data

What devices are providing data?

- SCADA Systems
- Operating Logs
- Microprocessor Relays
- Digital Fault Recorders
- PQ Monitors
- Demand and Energy Meters
- Recloser Controls
- Customer Smart Meters
- 61850 Compliant Devices
- Outage Management Systems

WHERE IS ALL THIS DATA BEEN GOING? WHERE WILL IT GO IN THE FUTURE.

- Existing Infrastructure
  - SCADA
  - Demand and Energy Meters
  - Digital Fault Recorders and Microprocessor Relays
  - Some PQ Meters

  - Most often Data is being stored in separate databases, and is being managed and utilized by different software packages. The data is not integrated into one database and analytics are most often being performed off-line and not correlations between different types of data are being made.

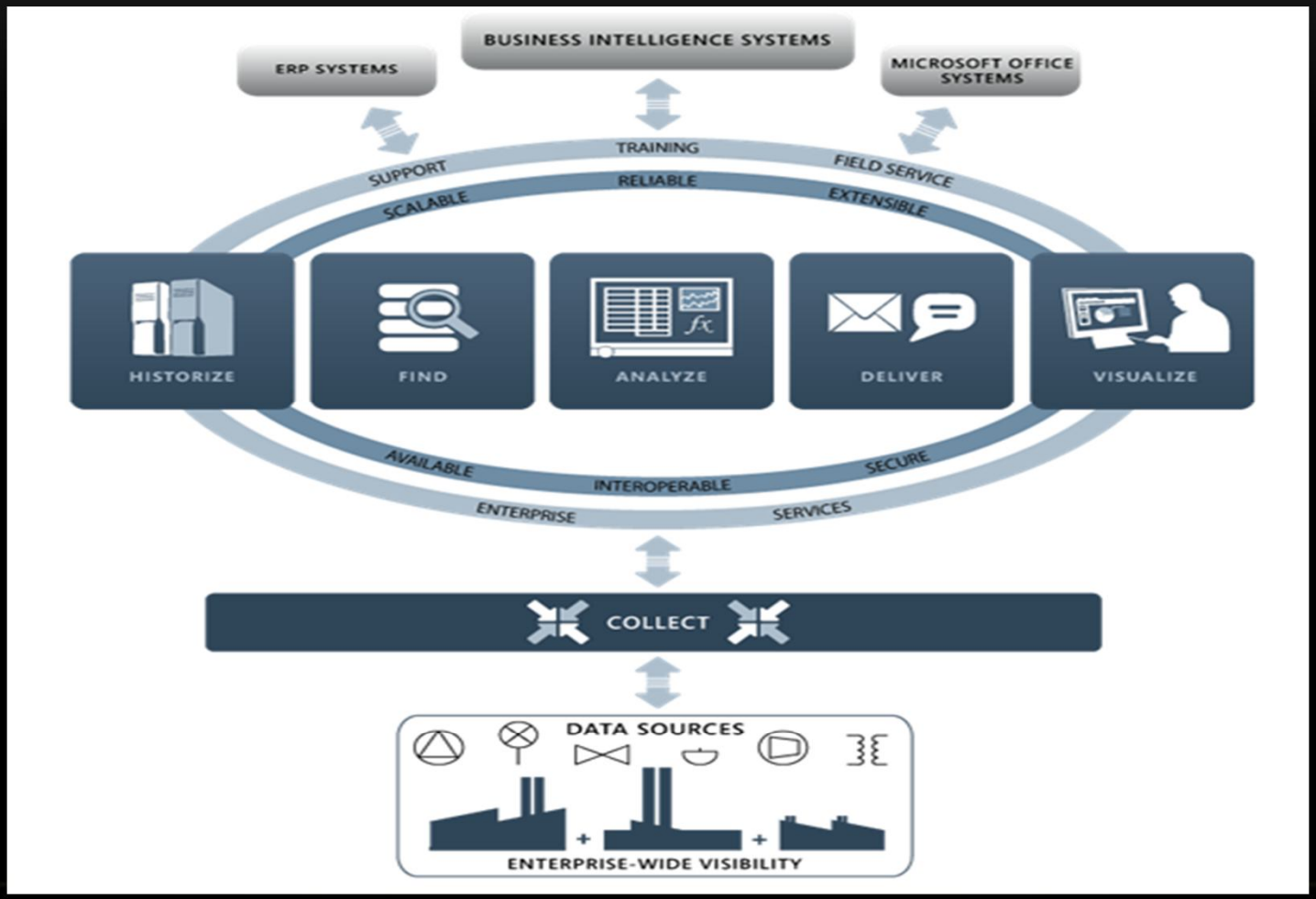
WHERE WILL SMART GRID DATA GO IN THE FUTURE?

- The industry trend that we seeing is the acquisition of Historian Database Systems.
- Where all of the data for the complete grid operations and business systems is put into a single database.

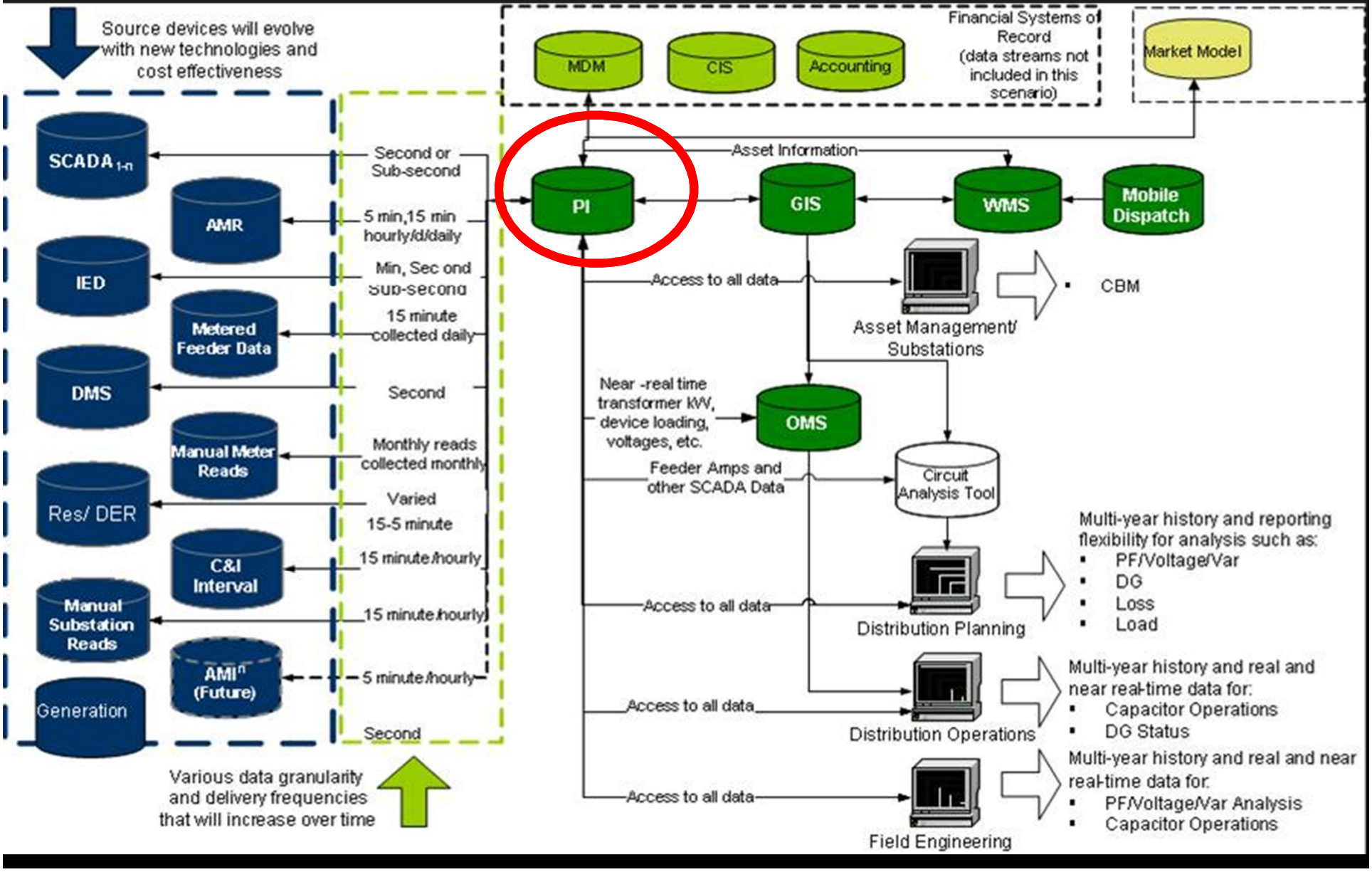
THE DEFINITION OF A HISTORIAN DATABASE

- **Historian**
- A historian is a type of database designed to archive automation and process data. Historians are designed to store high frequency data and data collecting on a regular basis. Historians are used to troubleshoot processes, optimize manufacturing, store data for regulatory compliance, etc. Historians are not designed to store transactional or relational data – this is the role of a relational database. Common historian's include OSIsoft PI and eDNA InStep
- http://www.abb.com/industries/ap/db0003db004333/c125739a0067cb49c1257026003c54bc.aspx

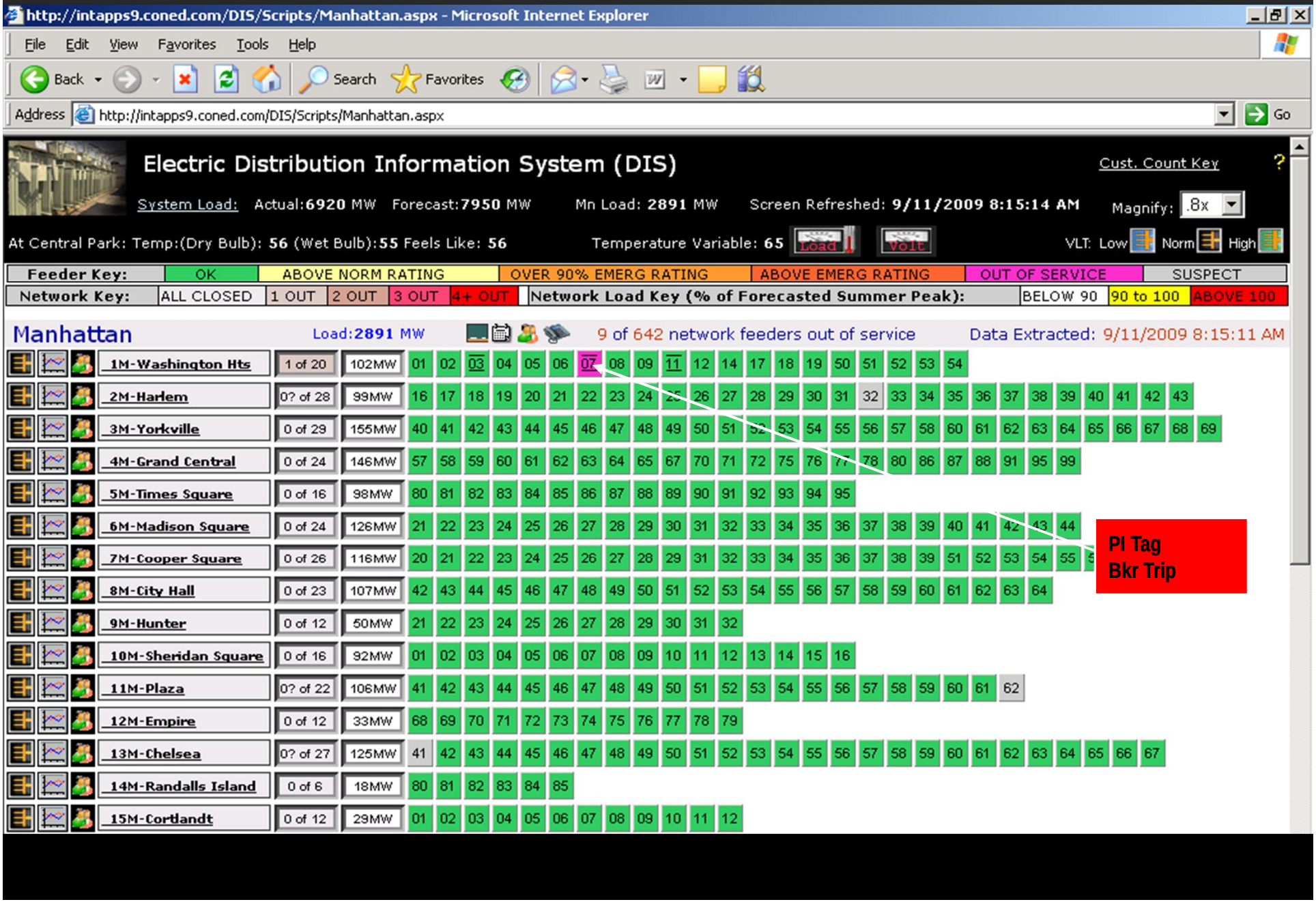
HISTORIAN DATABASE



The Road to the Smart Grid – ODM Operational Data Manager



PI DATA INTEGRATION



WHAT ABOUT THAT OLDER DATA?

- Two possible approaches;
  - Translate the data into a different file format and merge into one Historian database
  - Federate the data as needed.
- A **federated database system** is a type of meta-database management system (DBMS), which transparently maps multiple autonomous database systems into a single **federated database**. The constituent databases are interconnected via a computer network and may be geographically decentralized. Since the constituent database systems remain autonomous, a federated database system is a contrastable alternative to the (sometimes daunting) task of merging several disparate databases. A federated database, or **virtual database**, is a composite of all constituent databases in a federated database system. There is no actual data integration in the constituent disparate databases as a result of data federation.

WHAT ABOUT THAT OLDER DATA?

- Data federation technology is software that provides an organization with the ability to aggregate data from disparate sources in a virtual database so it can be used for business intelligence (BI) or other analysis.
- The virtual database created by data federation technology doesn't contain the data itself. Instead, it contains information about the actual data and its location (see metadata). The actual data is left in place.
- This approach is especially useful if some of an organization's data is stored offsite by a third-party cloud service provider. It allows the person performing the analysis to aggregate and organize data quickly without having to request synchronization logic or copy the data until it's absolutely necessary.
- Data federation technology can be used in place of a data warehouse to save the cost of creating a permanent, physical relational database. It can also be used as an enhancement to add fields or attributes that are not supported by the data warehouse application programming interface (API).
- Making a single call to multiple data sources and then integrating and organizing the data in a middleware layer is also called data virtualization, enterprise information integration (EII) and information-as-a-service, depending on the vendor

NOW THAT WE HAVE THE DATA WHAT ARE WE GOING TO DO WITH IT?

USE IT!

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  - Electric Vehicles will create new loads at different times of day and in residential, commercial and industrial locations.
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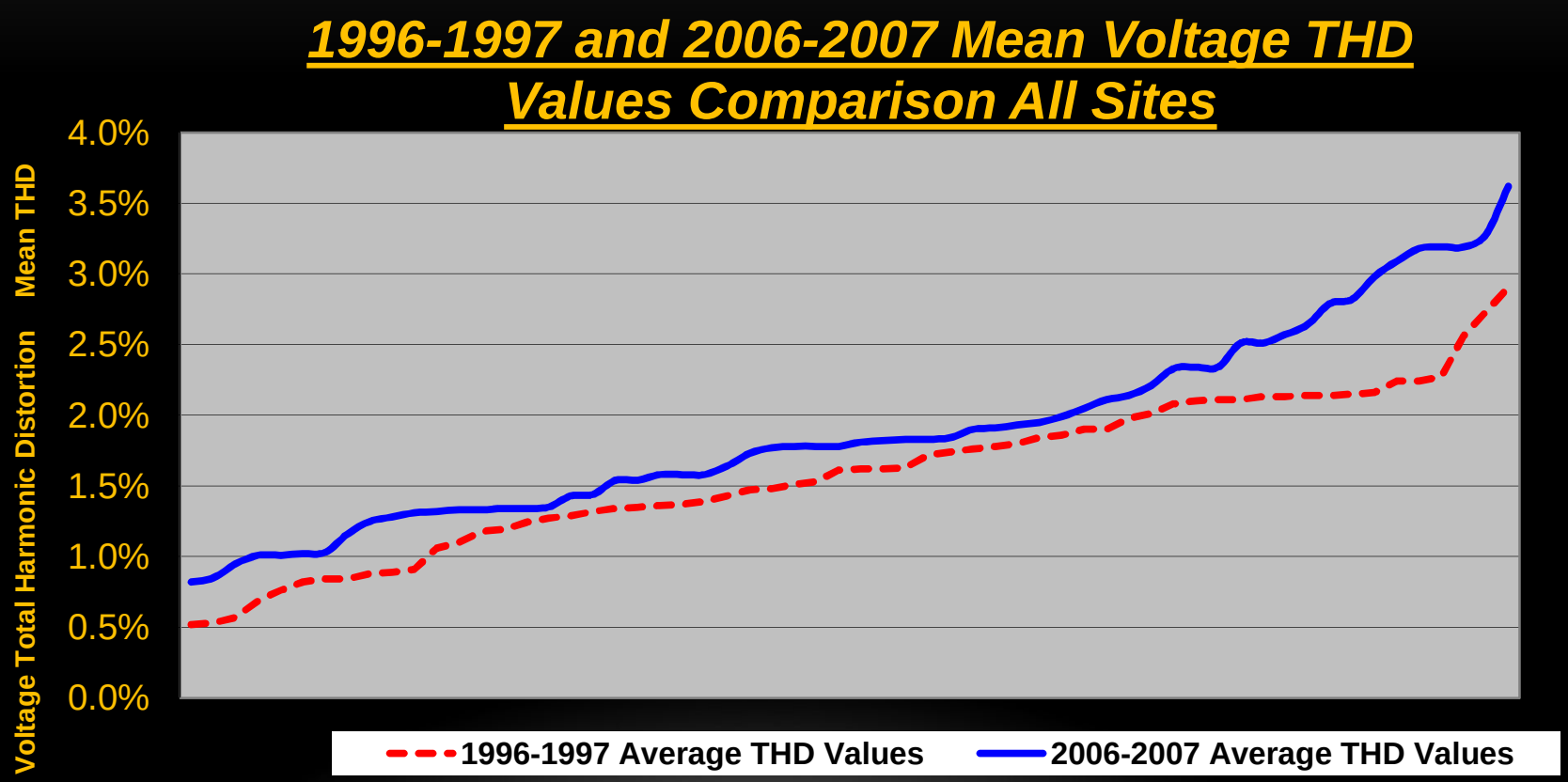
CHANGE THE PARADIGM

- Think of a Paradigm Shift as a change from one way of thinking to another. It's a revolution, a transformation, a sort of metamorphosis. It just does not happen, but rather it is driven by agents of change.
- The number one change is that now all the data is in one place, it can be shared across departments and it can be used to improve overall grid operations.

THE BASIC WAYS TO USE THE DATA

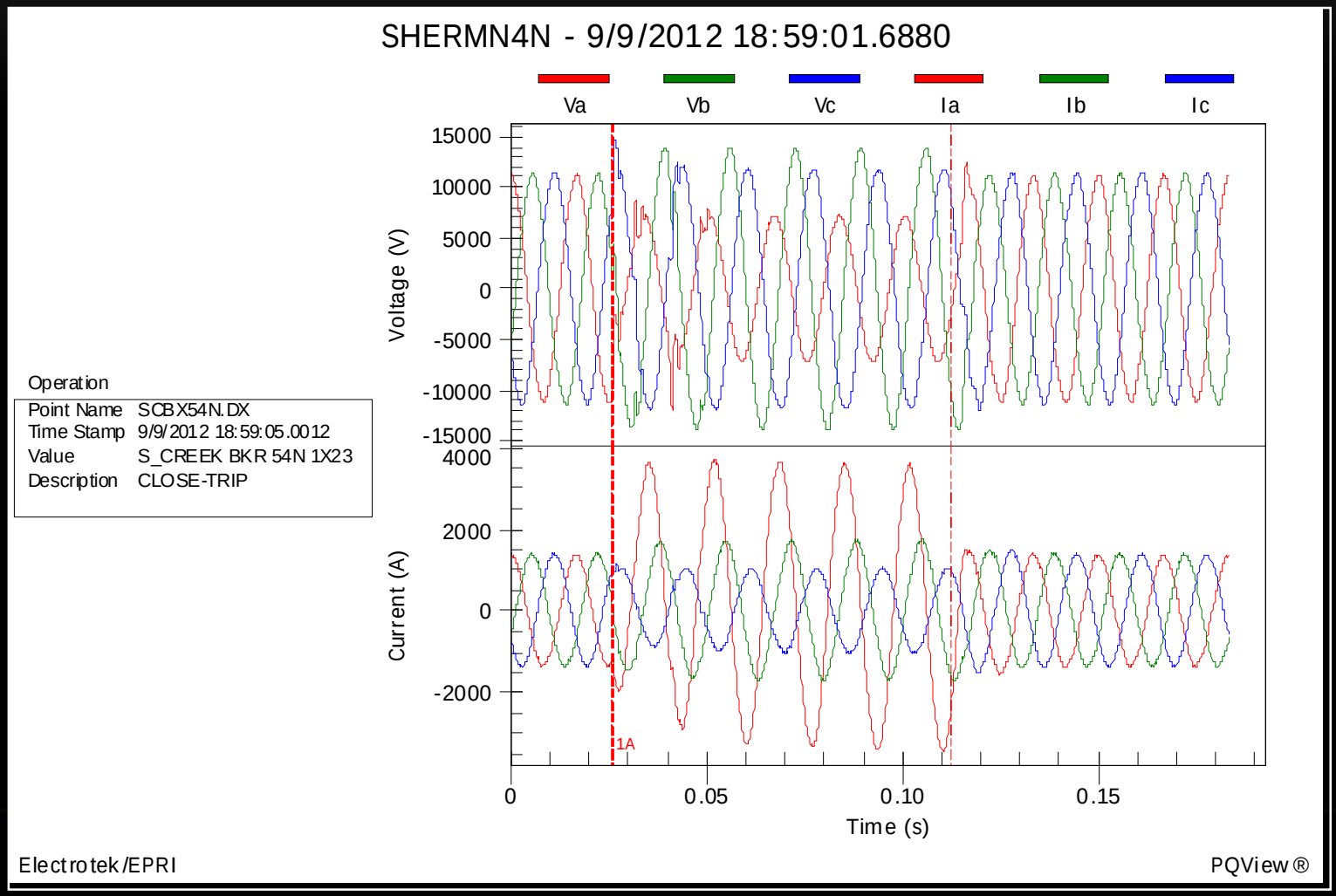
AN EXAMPLE OF BENCHMARKING



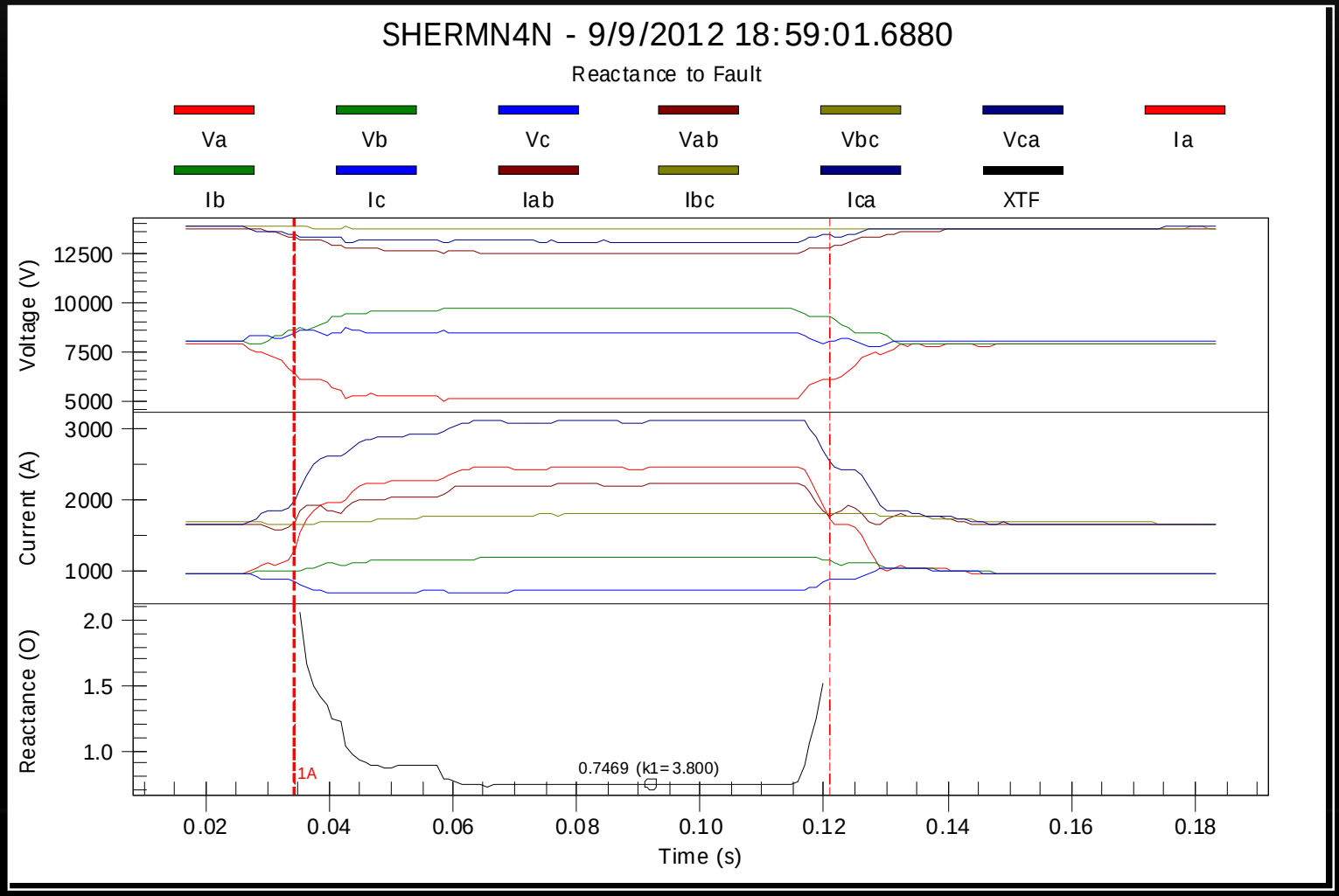
ANALYTICS

- **Analytics** is the discovery and communication of meaningful patterns in data. Especially valuable in areas rich with recorded information, analytics relies on the simultaneous application of statistics, computer programming and operations research to quantify performance. Analytics often favors data visualization to communicate insight.

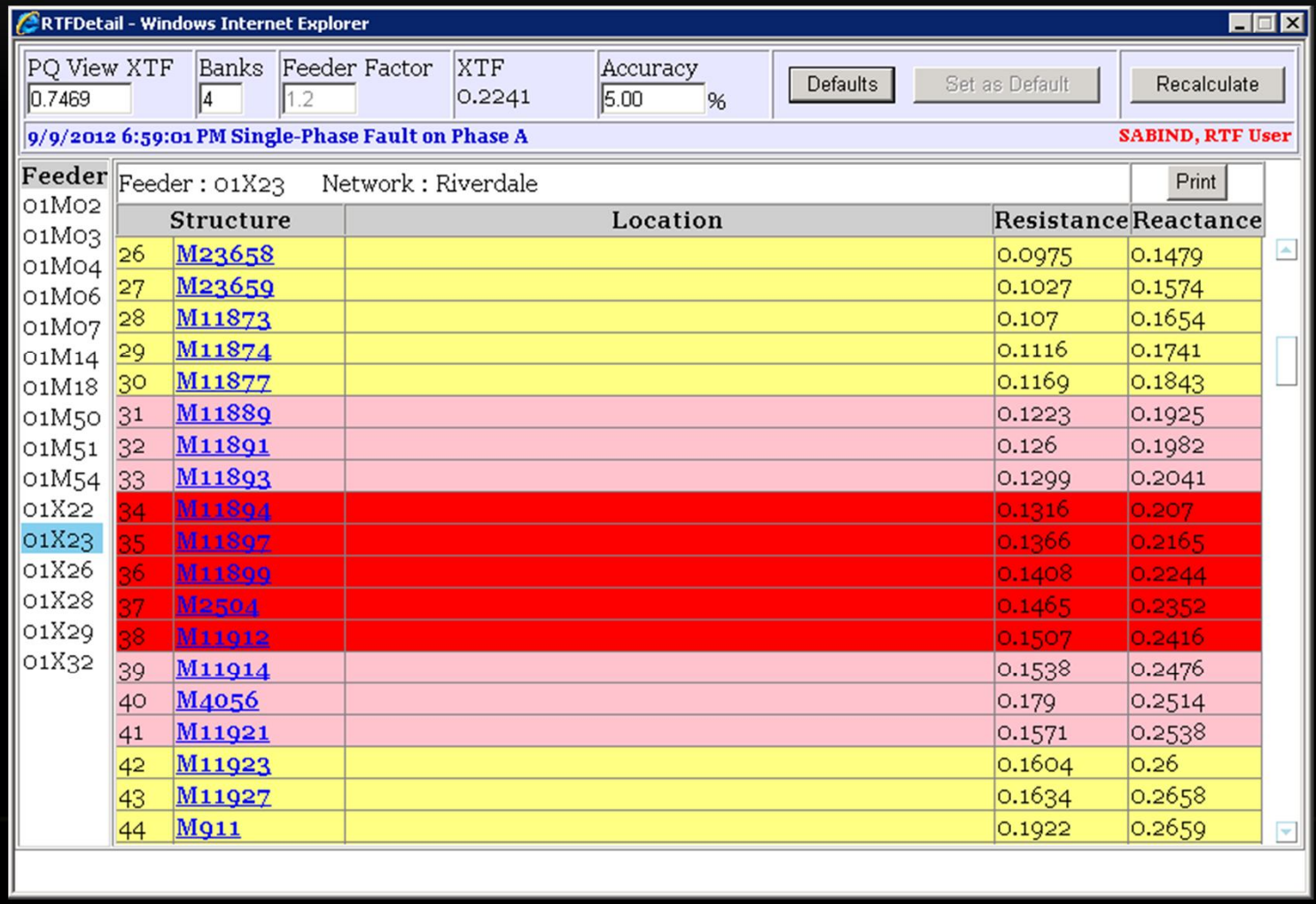
EXAMPLE SINGLE-PHASE FAULT ON FEEDER



REACTANCE-TO-FAULT CALCULATIONS BY PQVIEW SOFTWARE

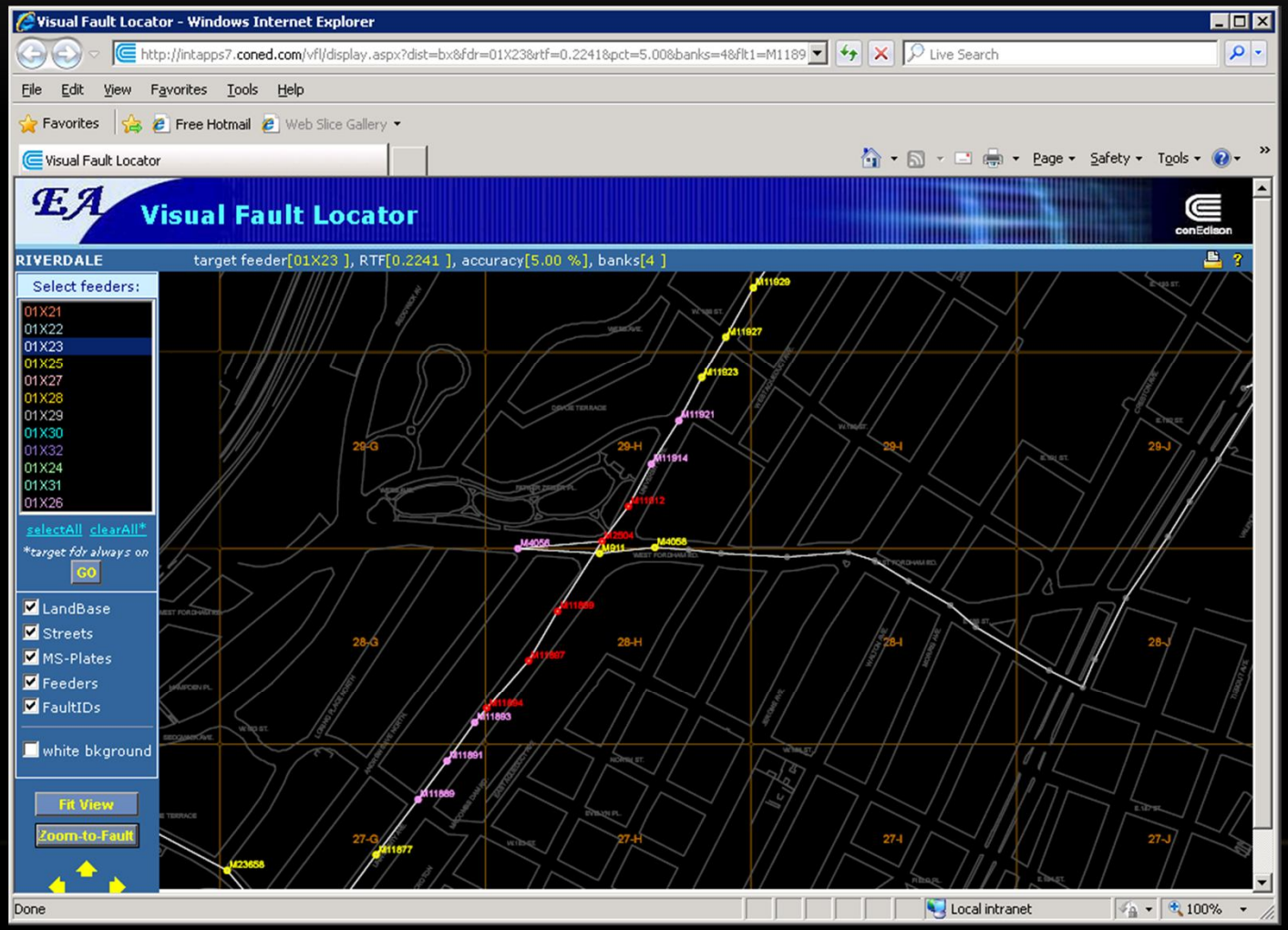


ESTIMATED LOCATION OF FAULT BY MATCHING MEASURED REACTANCE TO REACTANCE PROVIDED BY POWER FLOW MODELING SOFTWARE

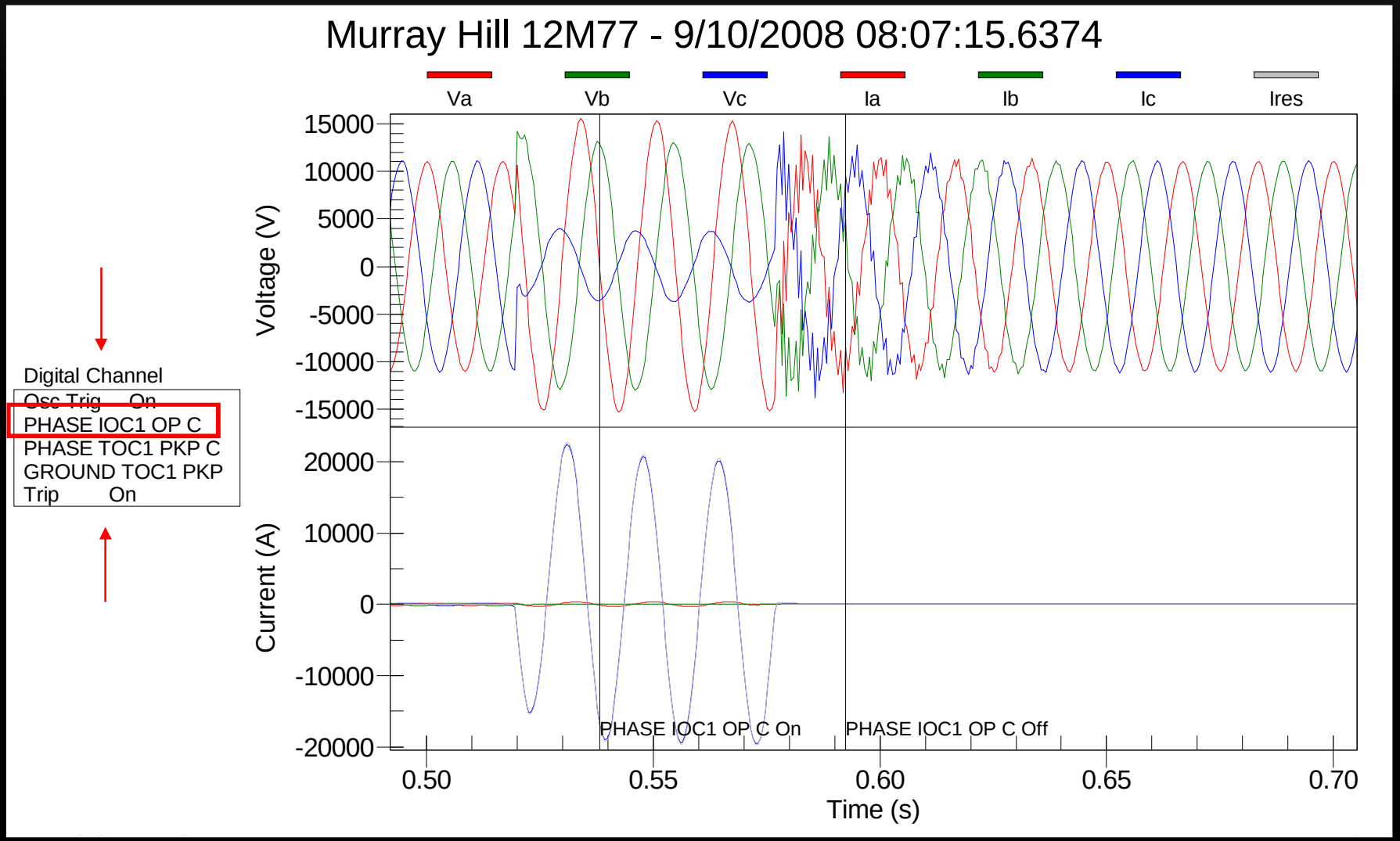


	Structure	Location	Resistance	Reactance
26	M23658		0.0975	0.1479
27	M23659		0.1027	0.1574
28	M11873		0.107	0.1654
29	M11874		0.1116	0.1741
30	M11877		0.1169	0.1843
31	M11889		0.1223	0.1925
32	M11891		0.126	0.1982
33	M11893		0.1299	0.2041
34	M11894		0.1316	0.207
35	M11897		0.1366	0.2165
36	M11899		0.1408	0.2244
37	M2504		0.1465	0.2352
38	M11912		0.1507	0.2416
39	M11914		0.1538	0.2476
40	M4056		0.179	0.2514
41	M11921		0.1571	0.2538
42	M11923		0.1604	0.26
43	M11927		0.1634	0.2658
44	M911		0.1922	0.2659

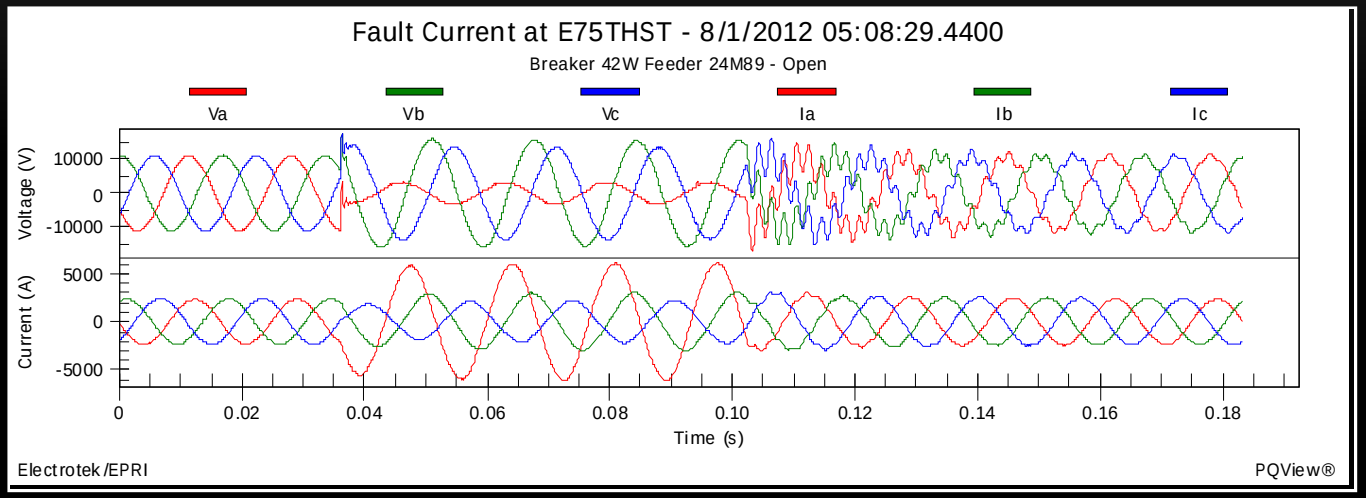
ESTIMATED LOCATION OF FAULT

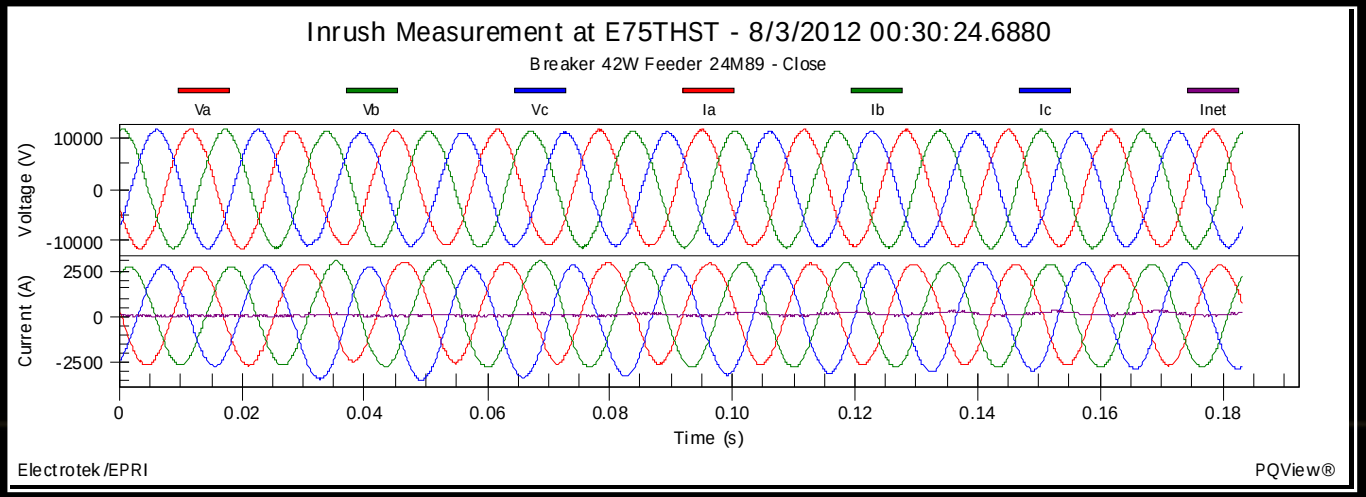


FEEDER FAULT WITH GE RELAY TARGETS



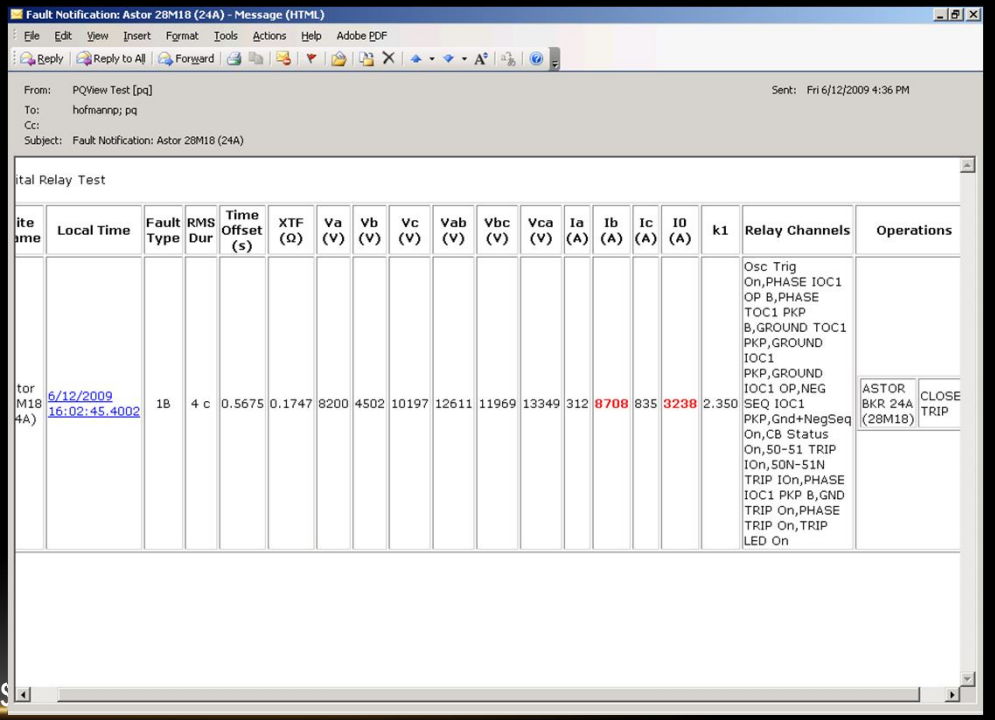
FAULT CURRENT VERSUS INRUSH



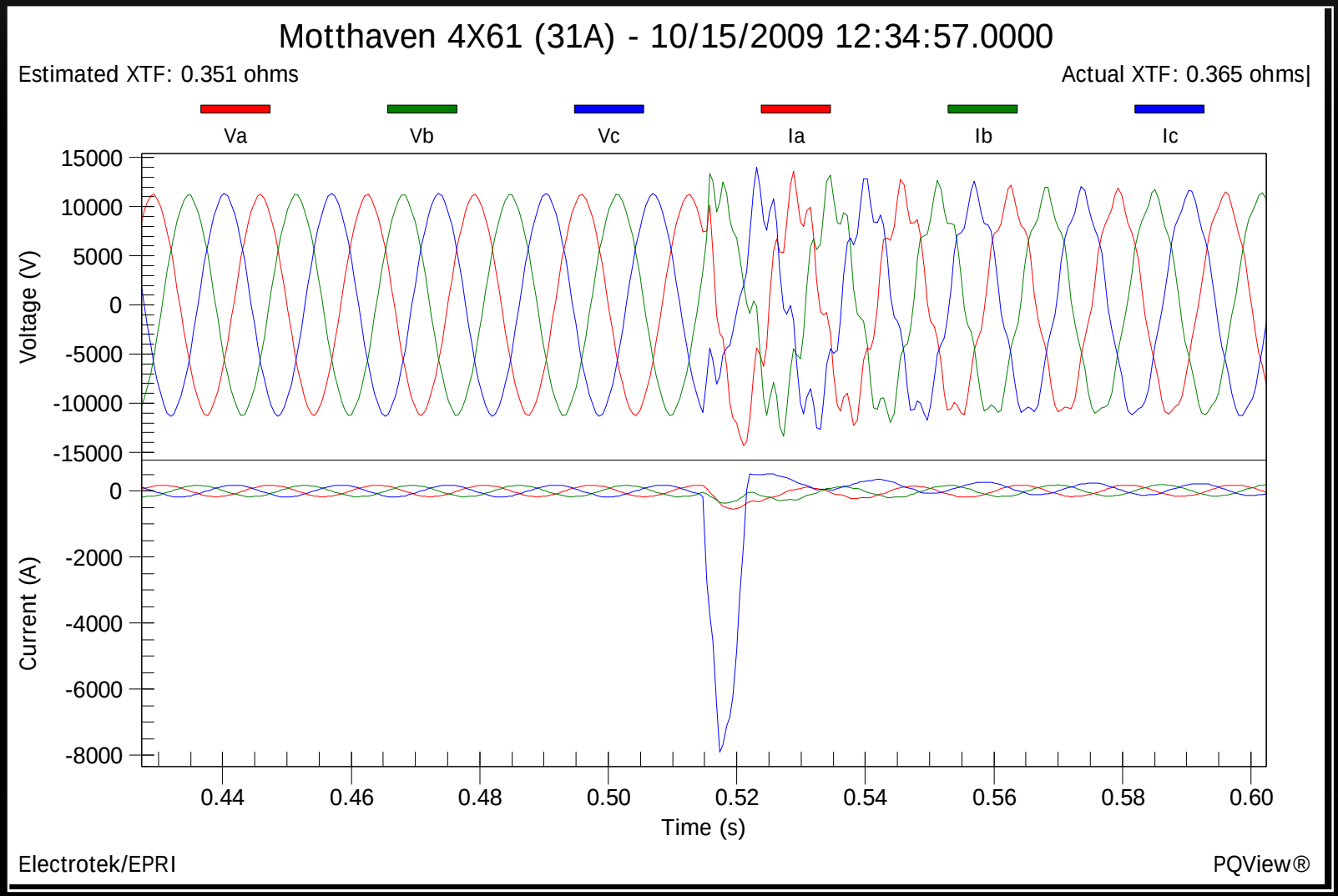


AUTOMATIC E-MAIL NOTIFICATIONS AVAILABLE FROM PQ MONITORING DATA

- Include hyperlinks to waveform and rms samples, relay targets and/or pickups that change, and breaker operation events
- E-Mail Notifications Available from Area Substation Monitors
  - Any Fault
  - Three-Phase Fault
  - Inrush Events
  - Subcycle Faults
  - Long Events
  - Voltage Sag/Swell Events
  - Overcurrent Events
  - Incipient Faults
- E-Mail Notifications Available from Transmission Feeders
  - Fault Events with Waveform Attachments



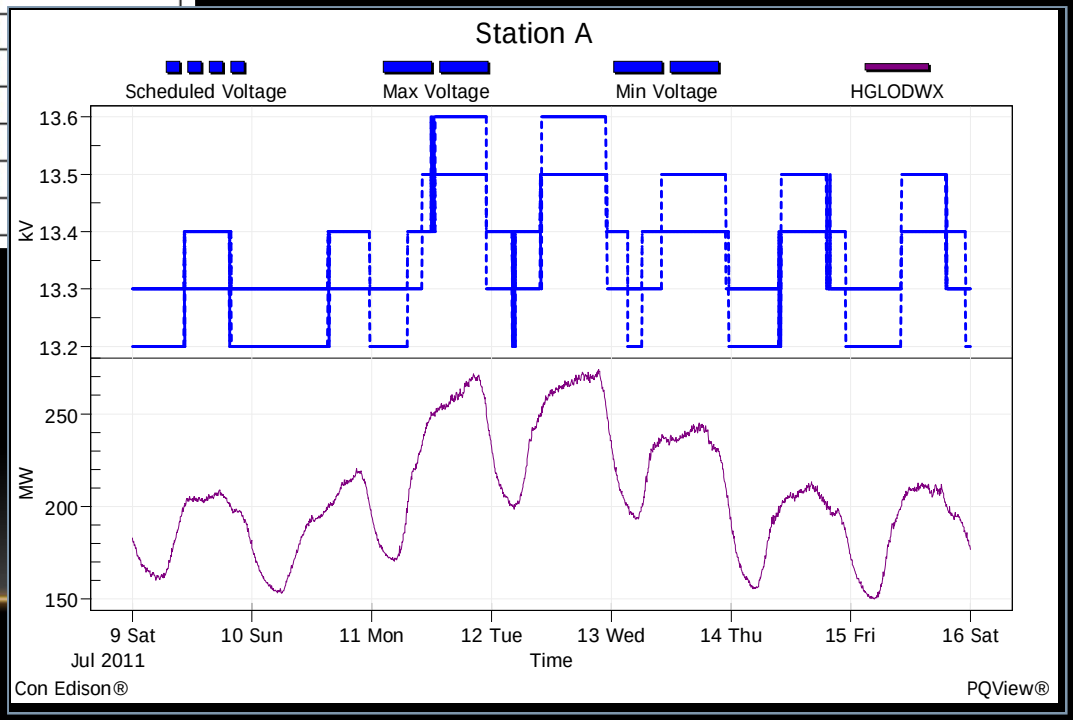
RESEARCH ON INCIPIENT FAULT LOCATION



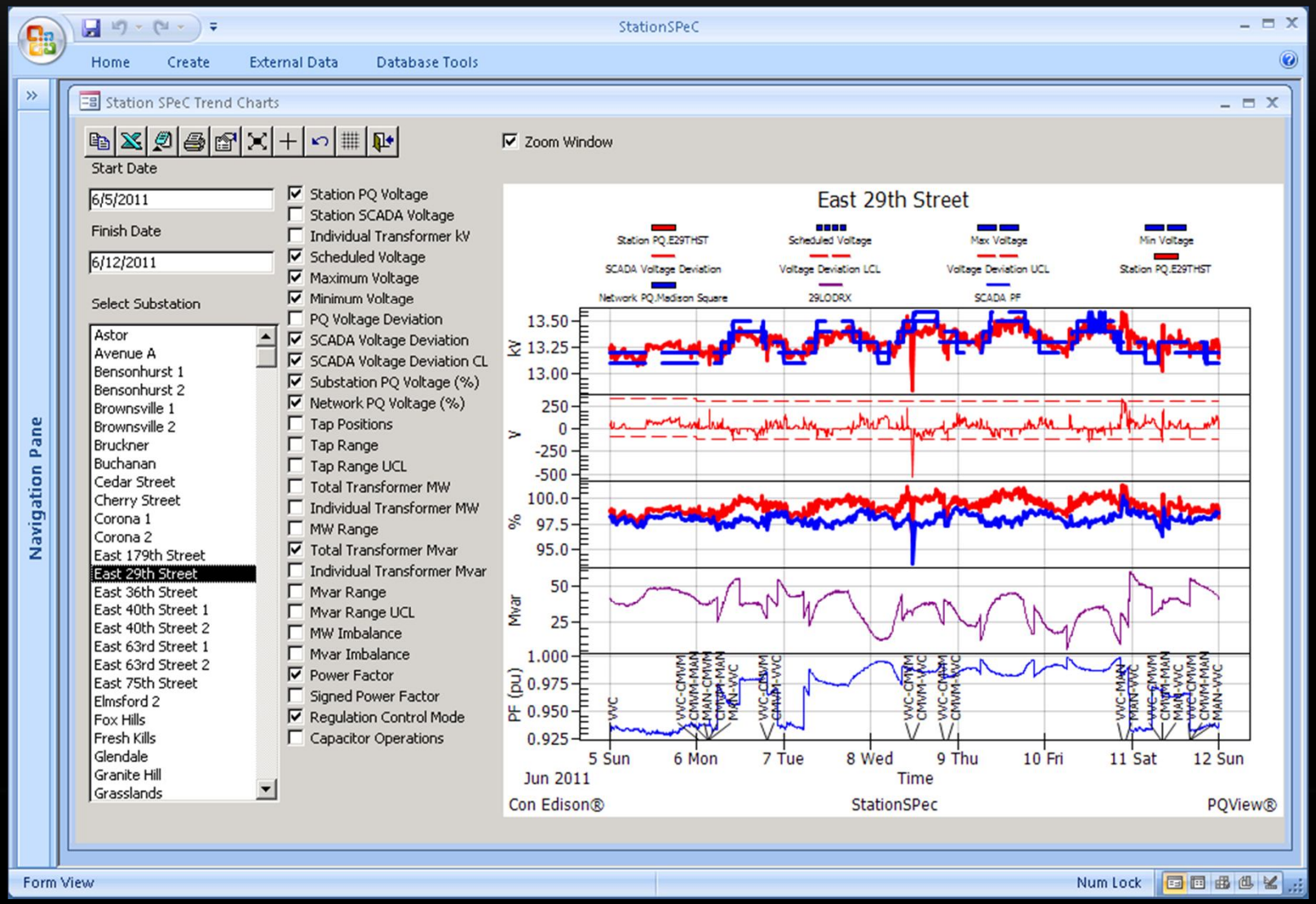
AREA SUBSTATION VOLTAGE CONTROL

Area Substation Load versus Voltage Schedule

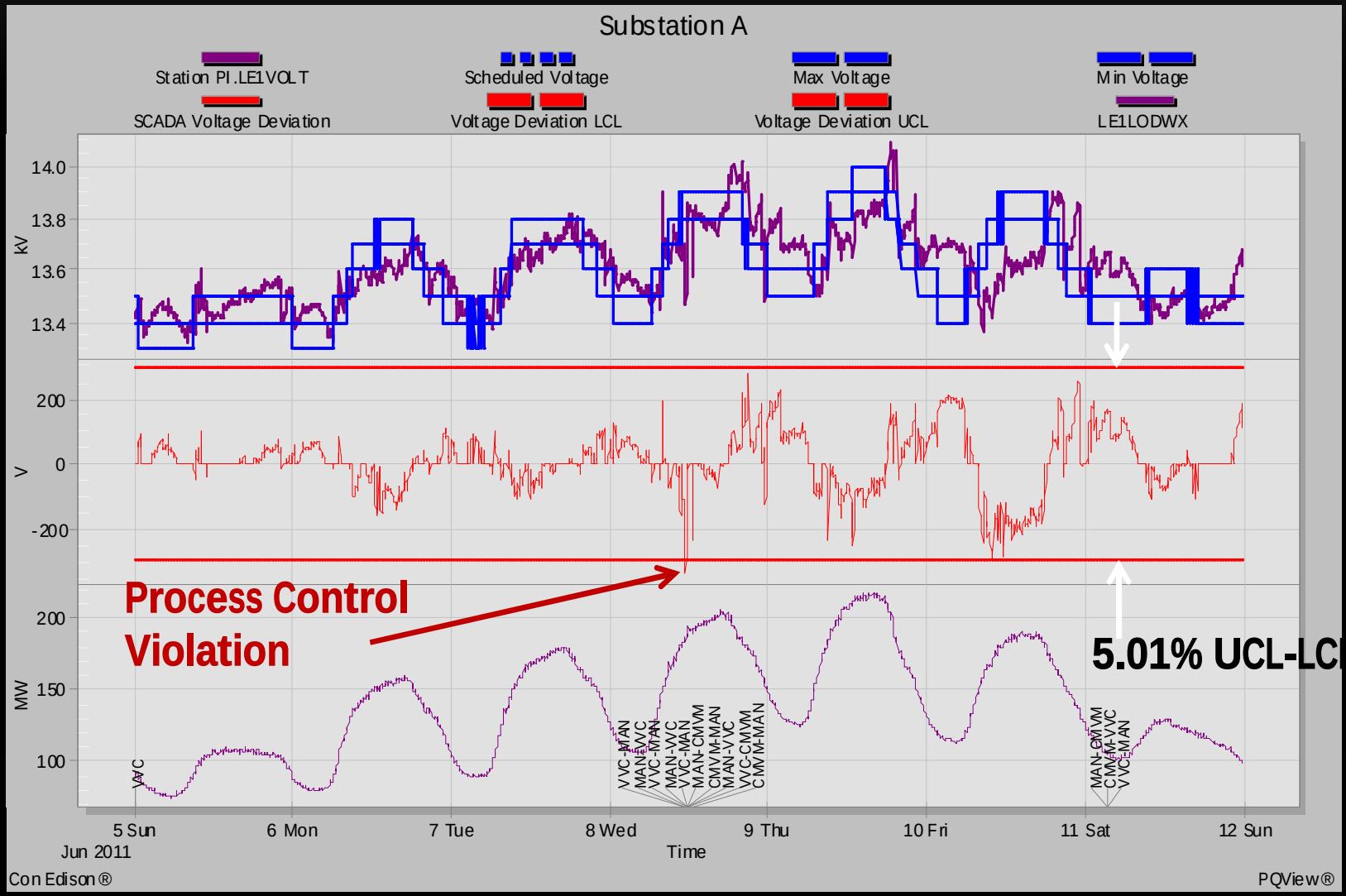
TOTAL 13KV BUS LOAD (Megawatts)	13KV Feeder Bus Volts
0 - 50	13,000
51 - 100	13,100
101 - 150	13,200
151 - 200	13,300
201 - 250	13,400
251 - 300	13,500
Above 300	13,600



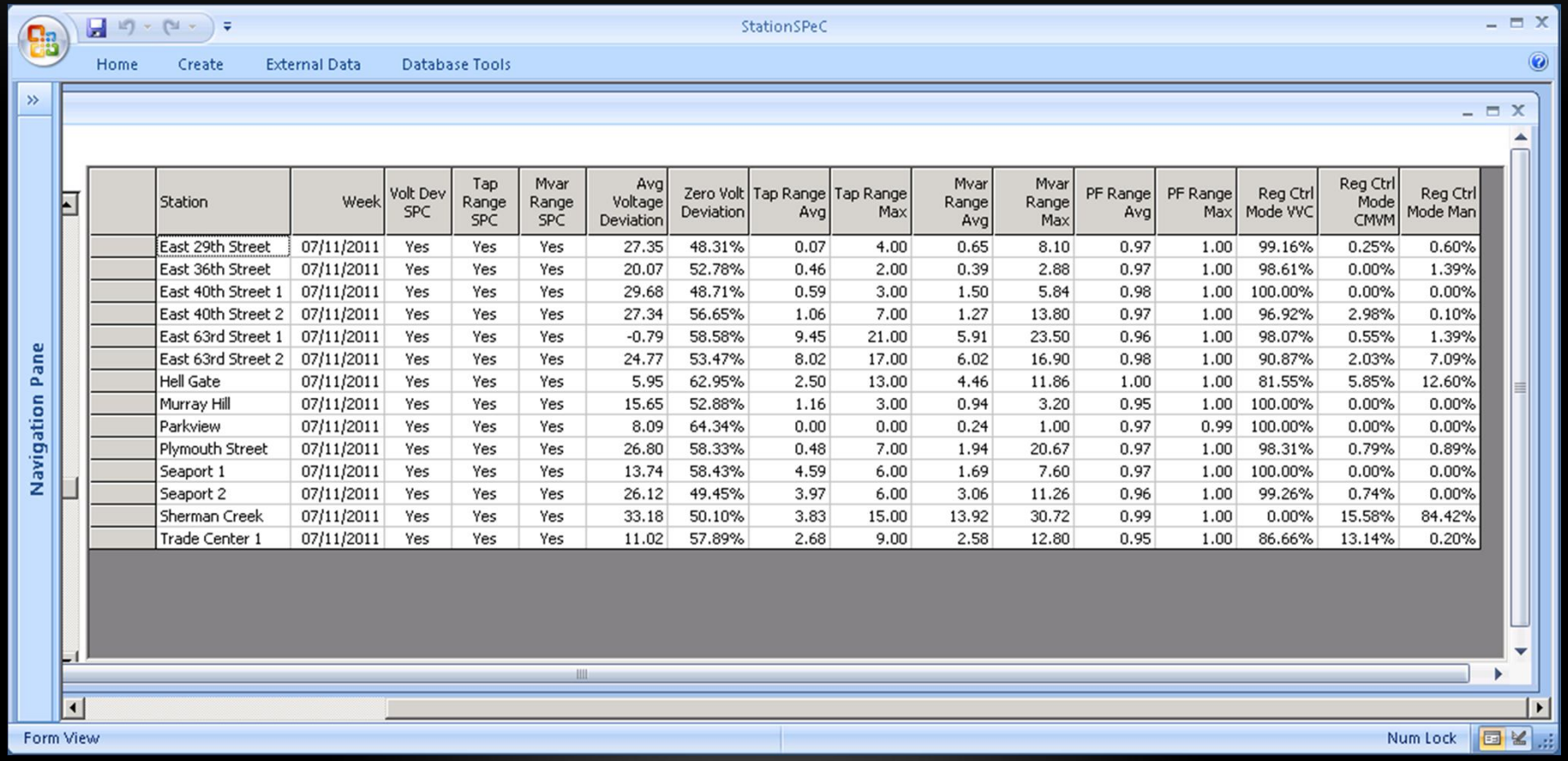
APPLICATION FOR ANALYZING SCADA ECC PI HISTORIAN AND PQVIEW DATA SIMULTANEOUSLY



VOLTAGE DEVIATION CONTROL CHART

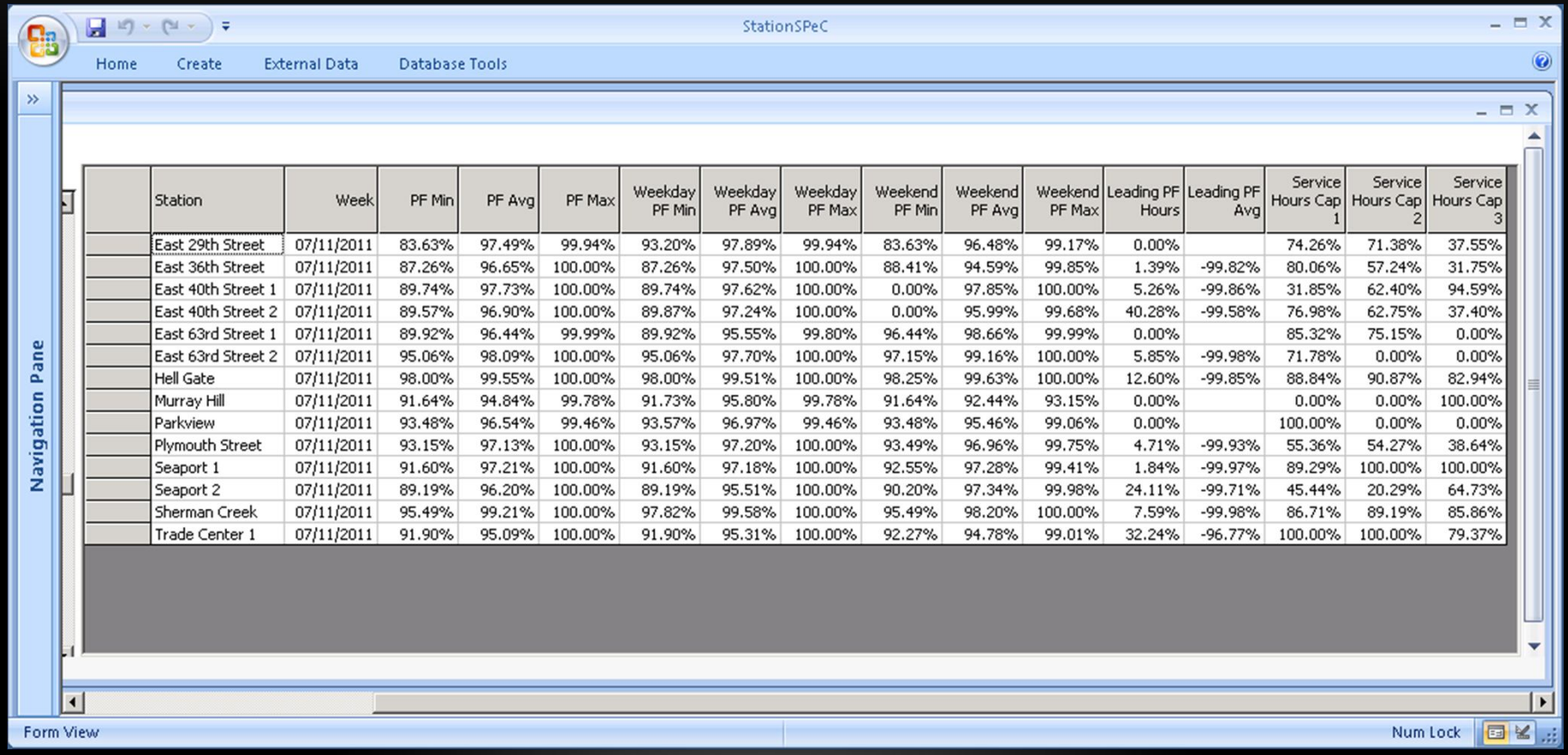


VOLTAGE REGULATION CONTROL WEEKLY REPORT



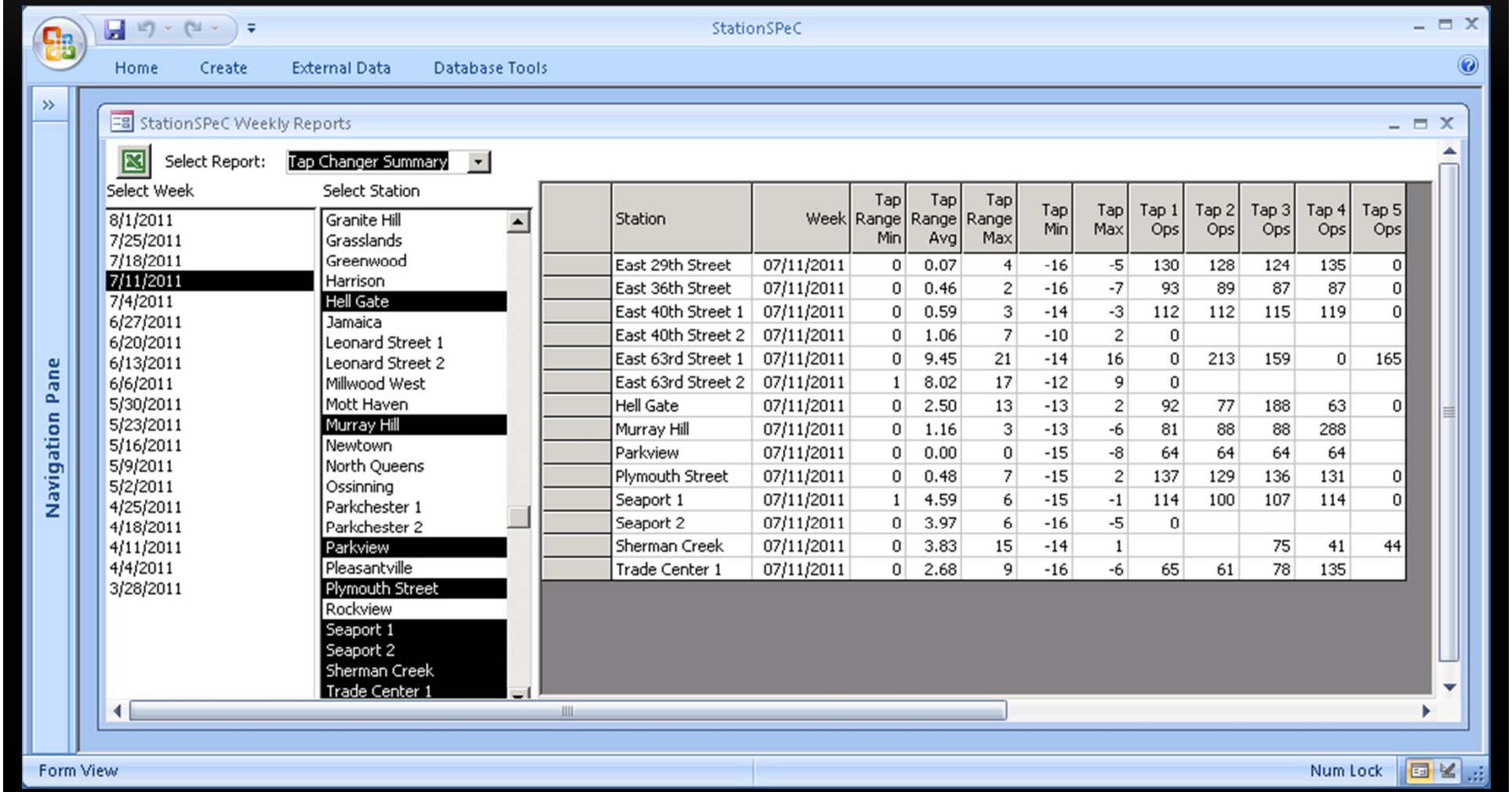
Station	Week	Volt Dev SPC	Tap Range SPC	Mvar Range SPC	Avg Voltage Deviation	Zero Volt Deviation	Tap Range Avg	Tap Range Max	Mvar Range Avg	Mvar Range Max	PF Range Avg	PF Range Max	Reg Ctrl Mode VVC	Reg Ctrl Mode CMVM	Reg Ctrl Mode Man
East 29th Street	07/11/2011	Yes	Yes	Yes	27.35	48.31%	0.07	4.00	0.65	8.10	0.97	1.00	99.16%	0.25%	0.60%
East 36th Street	07/11/2011	Yes	Yes	Yes	20.07	52.78%	0.46	2.00	0.39	2.88	0.97	1.00	98.61%	0.00%	1.39%
East 40th Street 1	07/11/2011	Yes	Yes	Yes	29.68	48.71%	0.59	3.00	1.50	5.84	0.98	1.00	100.00%	0.00%	0.00%
East 40th Street 2	07/11/2011	Yes	Yes	Yes	27.34	56.65%	1.06	7.00	1.27	13.80	0.97	1.00	96.92%	2.98%	0.10%
East 63rd Street 1	07/11/2011	Yes	Yes	Yes	-0.79	58.58%	9.45	21.00	5.91	23.50	0.96	1.00	98.07%	0.55%	1.39%
East 63rd Street 2	07/11/2011	Yes	Yes	Yes	24.77	53.47%	8.02	17.00	6.02	16.90	0.98	1.00	90.87%	2.03%	7.09%
Hell Gate	07/11/2011	Yes	Yes	Yes	5.95	62.95%	2.50	13.00	4.46	11.86	1.00	1.00	81.55%	5.85%	12.60%
Murray Hill	07/11/2011	Yes	Yes	Yes	15.65	52.88%	1.16	3.00	0.94	3.20	0.95	1.00	100.00%	0.00%	0.00%
Parkview	07/11/2011	Yes	Yes	Yes	8.09	64.34%	0.00	0.00	0.24	1.00	0.97	0.99	100.00%	0.00%	0.00%
Plymouth Street	07/11/2011	Yes	Yes	Yes	26.80	58.33%	0.48	7.00	1.94	20.67	0.97	1.00	98.31%	0.79%	0.89%
Seaport 1	07/11/2011	Yes	Yes	Yes	13.74	58.43%	4.59	6.00	1.69	7.60	0.97	1.00	100.00%	0.00%	0.00%
Seaport 2	07/11/2011	Yes	Yes	Yes	26.12	49.45%	3.97	6.00	3.06	11.26	0.96	1.00	99.26%	0.74%	0.00%
Sherman Creek	07/11/2011	Yes	Yes	Yes	33.18	50.10%	3.83	15.00	13.92	30.72	0.99	1.00	0.00%	15.58%	84.42%
Trade Center 1	07/11/2011	Yes	Yes	Yes	11.02	57.89%	2.68	9.00	2.58	12.80	0.95	1.00	86.66%	13.14%	0.20%

POWER FACTOR SUMMARY WEEKLY REPORT



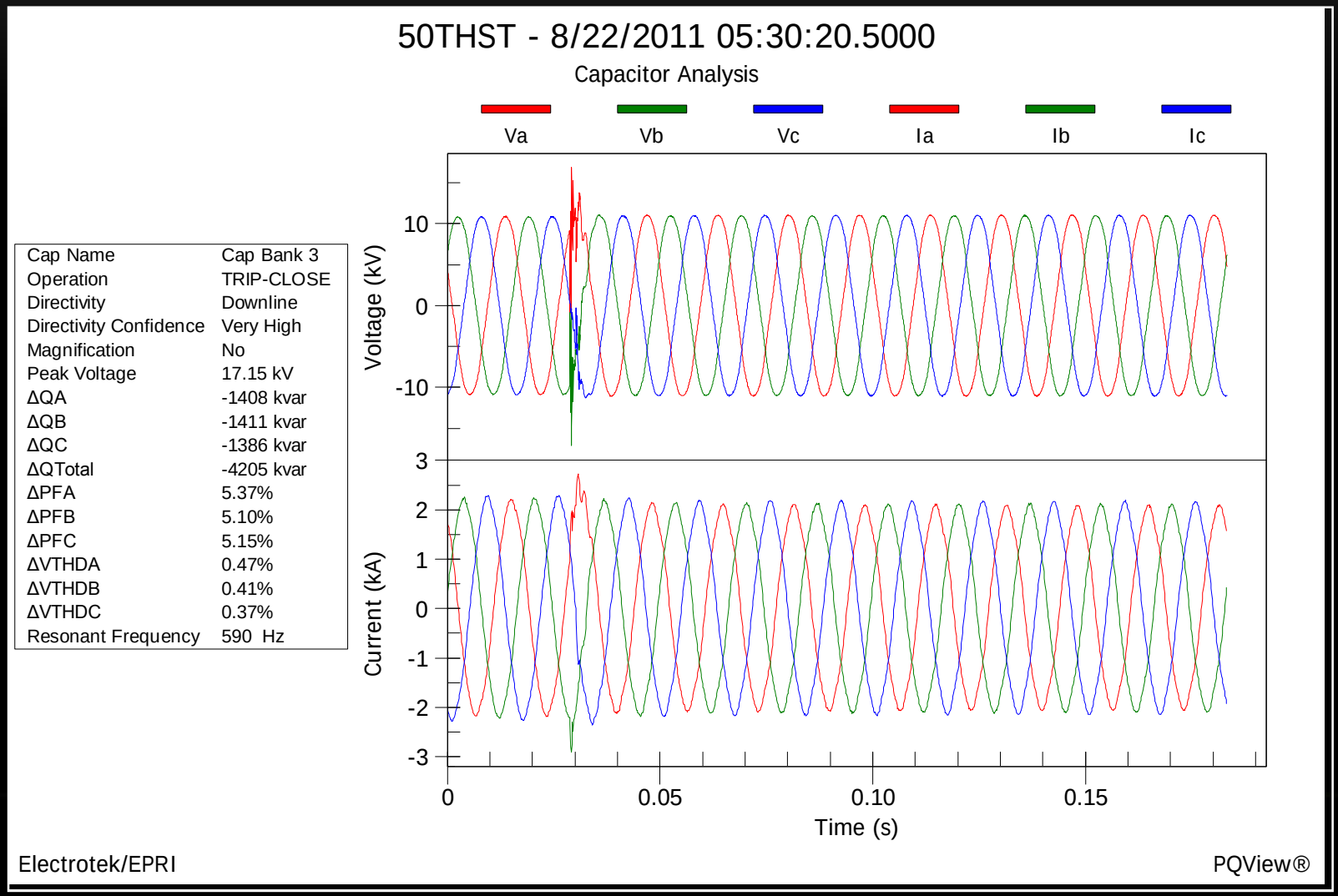
Station	Week	PF Min	PF Avg	PF Max	Weekday PF Min	Weekday PF Avg	Weekday PF Max	Weekend PF Min	Weekend PF Avg	Weekend PF Max	Leading PF Hours	Leading PF Avg	Service Hours Cap 1	Service Hours Cap 2	Service Hours Cap 3
East 29th Street	07/11/2011	83.63%	97.49%	99.94%	93.20%	97.89%	99.94%	83.63%	96.48%	99.17%	0.00%		74.26%	71.38%	37.55%
East 36th Street	07/11/2011	87.26%	96.65%	100.00%	87.26%	97.50%	100.00%	88.41%	94.59%	99.85%	1.39%	-99.82%	80.06%	57.24%	31.75%
East 40th Street 1	07/11/2011	89.74%	97.73%	100.00%	89.74%	97.62%	100.00%	0.00%	97.85%	100.00%	5.26%	-99.86%	31.85%	62.40%	94.59%
East 40th Street 2	07/11/2011	89.57%	96.90%	100.00%	89.87%	97.24%	100.00%	0.00%	95.99%	99.68%	40.28%	-99.58%	76.98%	62.75%	37.40%
East 63rd Street 1	07/11/2011	89.92%	96.44%	99.99%	89.92%	95.55%	99.80%	96.44%	98.66%	99.99%	0.00%		85.32%	75.15%	0.00%
East 63rd Street 2	07/11/2011	95.06%	98.09%	100.00%	95.06%	97.70%	100.00%	97.15%	99.16%	100.00%	5.85%	-99.98%	71.78%	0.00%	0.00%
Hell Gate	07/11/2011	98.00%	99.55%	100.00%	98.00%	99.51%	100.00%	98.25%	99.63%	100.00%	12.60%	-99.85%	88.84%	90.87%	82.94%
Murray Hill	07/11/2011	91.64%	94.84%	99.78%	91.73%	95.80%	99.78%	91.64%	92.44%	93.15%	0.00%		0.00%	0.00%	100.00%
Parkview	07/11/2011	93.48%	96.54%	99.46%	93.57%	96.97%	99.46%	93.48%	95.46%	99.06%	0.00%		100.00%	0.00%	0.00%
Plymouth Street	07/11/2011	93.15%	97.13%	100.00%	93.15%	97.20%	100.00%	93.49%	96.96%	99.75%	4.71%	-99.93%	55.36%	54.27%	38.64%
Seaport 1	07/11/2011	91.60%	97.21%	100.00%	91.60%	97.18%	100.00%	92.55%	97.28%	99.41%	1.84%	-99.97%	89.29%	100.00%	100.00%
Seaport 2	07/11/2011	89.19%	96.20%	100.00%	89.19%	95.51%	100.00%	90.20%	97.34%	99.98%	24.11%	-99.71%	45.44%	20.29%	64.73%
Sherman Creek	07/11/2011	95.49%	99.21%	100.00%	97.82%	99.58%	100.00%	95.49%	98.20%	100.00%	7.59%	-99.98%	86.71%	89.19%	85.86%
Trade Center 1	07/11/2011	91.90%	95.09%	100.00%	91.90%	95.31%	100.00%	92.27%	94.78%	99.01%	32.24%	-96.77%	100.00%	100.00%	79.37%

TAP CHANGER SUMMARY WEEKLY REPORT



Station	Week	Tap Range Min	Tap Range Avg	Tap Range Max	Tap Min	Tap Max	Tap 1 Ops	Tap 2 Ops	Tap 3 Ops	Tap 4 Ops	Tap 5 Ops
East 29th Street	07/11/2011	0	0.07	4	-16	-5	130	128	124	135	0
East 36th Street	07/11/2011	0	0.46	2	-16	-7	93	89	87	87	0
East 40th Street 1	07/11/2011	0	0.59	3	-14	-3	112	112	115	119	0
East 40th Street 2	07/11/2011	0	1.06	7	-10	2	0				
East 63rd Street 1	07/11/2011	0	9.45	21	-14	16	0	213	159	0	165
East 63rd Street 2	07/11/2011	1	8.02	17	-12	9	0				
Hell Gate	07/11/2011	0	2.50	13	-13	2	92	77	188	63	0
Murray Hill	07/11/2011	0	1.16	3	-13	-6	81	88	88	288	
Parkview	07/11/2011	0	0.00	0	-15	-8	64	64	64	64	
Plymouth Street	07/11/2011	0	0.48	7	-15	2	137	129	136	131	0
Seaport 1	07/11/2011	1	4.59	6	-15	-1	114	100	107	114	0
Seaport 2	07/11/2011	0	3.97	6	-16	-5	0				
Sherman Creek	07/11/2011	0	3.83	15	-14	1			75	41	44
Trade Center 1	07/11/2011	0	2.68	9	-16	-6	65	61	78	135	

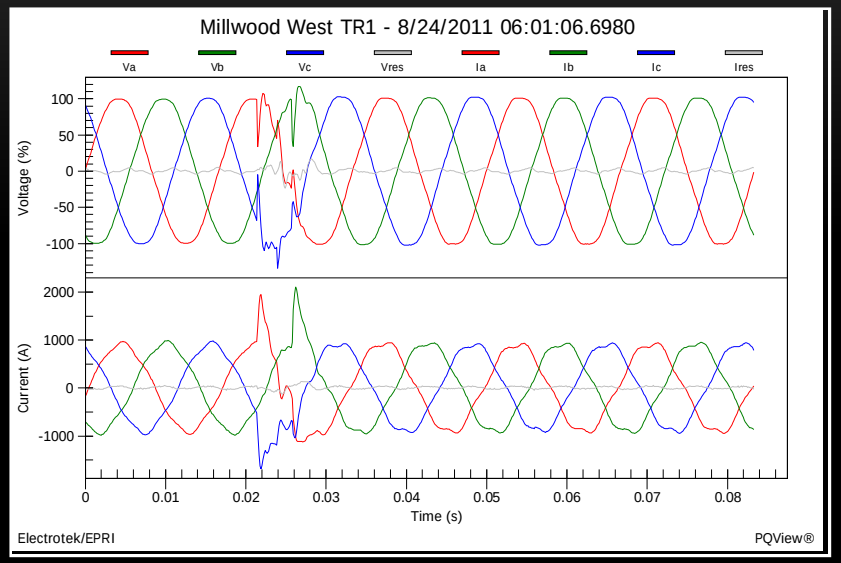
CAPACITOR ANALYSIS AT AREA SUBSTATIONS



Cap Name	Cap Bank 3
Operation	TRIP-CLOSE
Directivity	Downline
Directivity Confidence	Very High
Magnification	No
Peak Voltage	17.15 kV
ΔQA	-1408 kvar
ΔQB	-1411 kvar
ΔQC	-1386 kvar
ΔQTotal	-4205 kvar
ΔPFA	5.37%
ΔPFB	5.10%
ΔPFC	5.15%
ΔVTHDA	0.47%
ΔVTHDB	0.41%
ΔVTHDC	0.37%
Resonant Frequency	590 Hz

SYNCHRONOUS CLOSING ASSESSMENT METHODS

- New module in testing to analyze how measured closing time was to the ideal closing time



Manhattan Station	Joslyn Banks
Avenue A	C3
Parkview	C1
Astor	C1A, C2, C3
Murray Hill	C3
Seaport No. 1	C1, C2, C3
Trade Center No. 1	C1, C2, C3

Staten Island Station	Joslyn Banks
Woodrow	C1

Bronx/Westchester Station	Joslyn Banks
Cedar Street	C1
East 179th Street	C1
Millwood	C1
Ossining	C1
Pleasantville	C1
White Plains	C1, C2, C3