

Faults per Feeder Mile

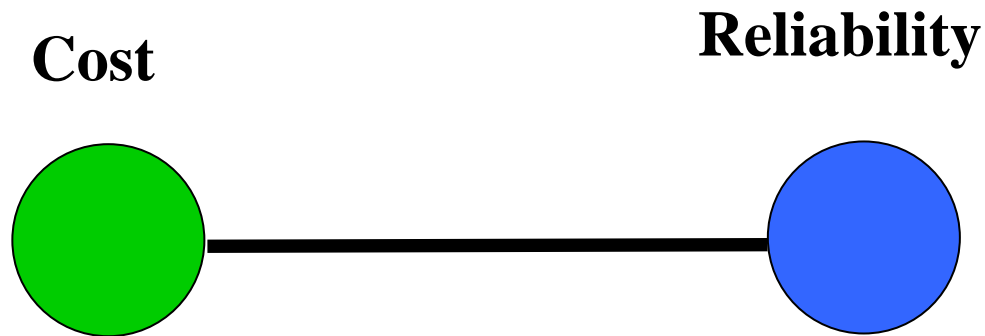
Presented by
Scott Peele PE



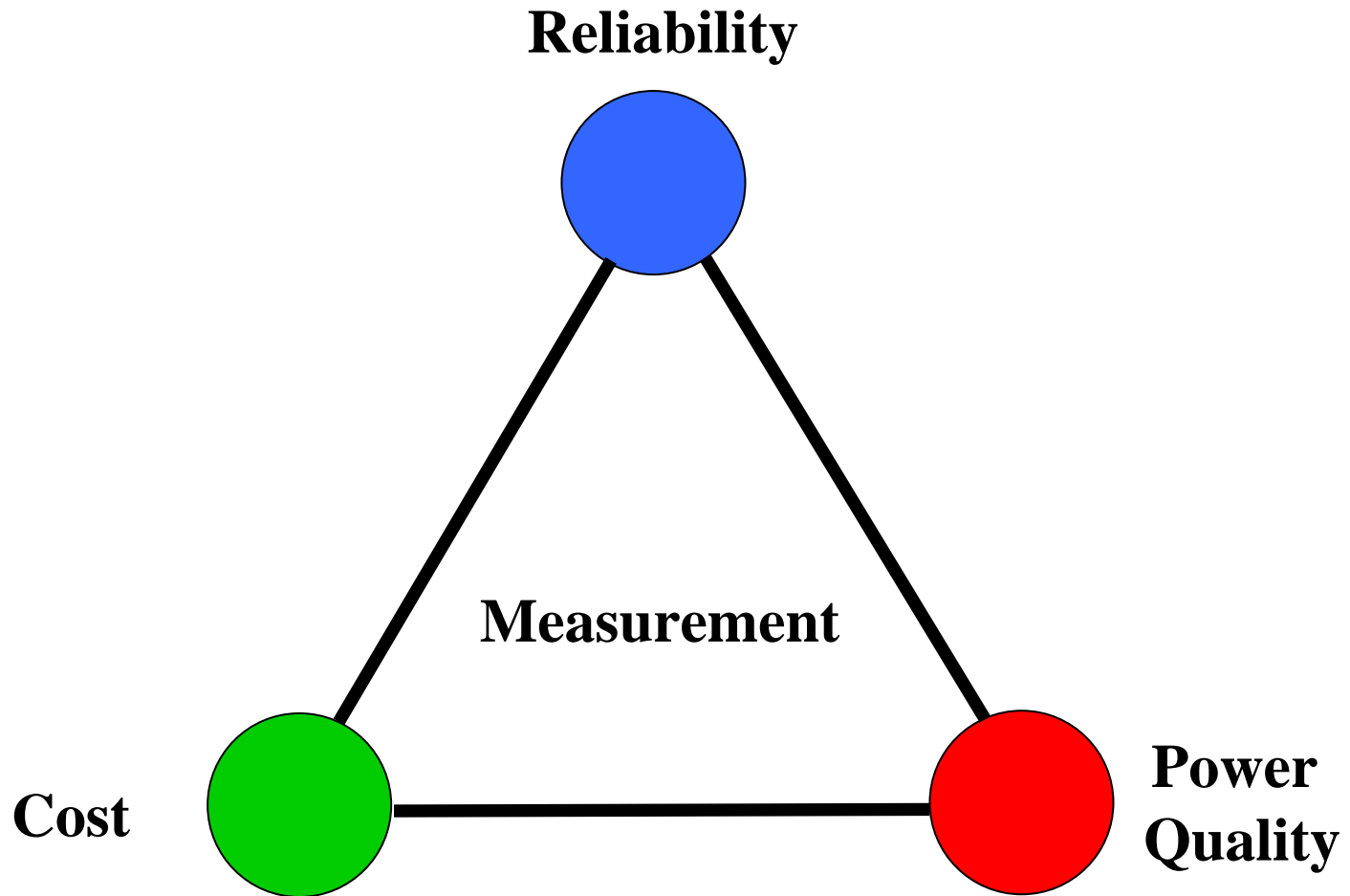
CP&L

A Progress Energy Company

In the Past All We Needed



A Utility System Today

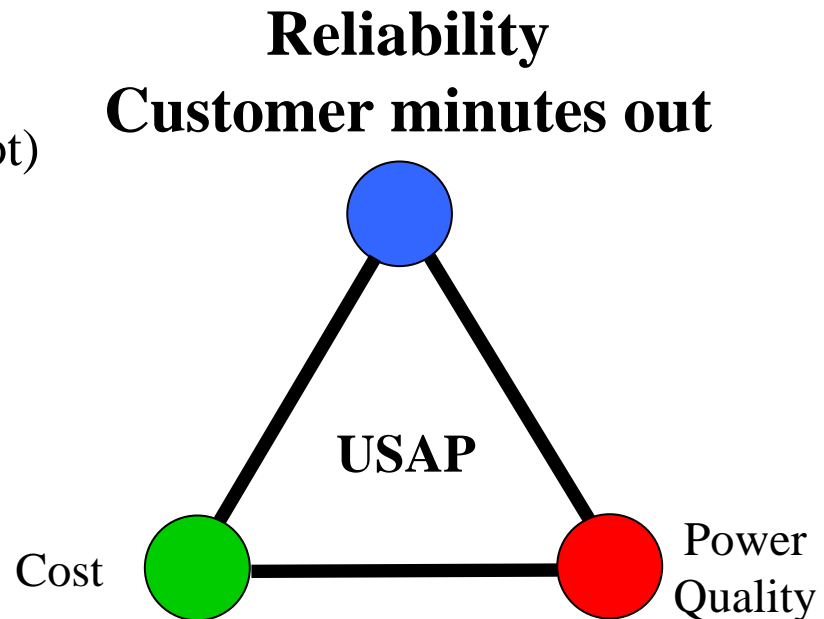


Power Quality vs. Reliability

- System Reliability Issues (Outages > 1 minute)
 - Human interface is required to restore the system
- System Power Quality
 - Events less than one minute
 - Voltage regulation
 - Harmonics
 - Most all of the reliability events will cause a power quality event
- Faults on system cause most of the Power Quality and Reliability issues

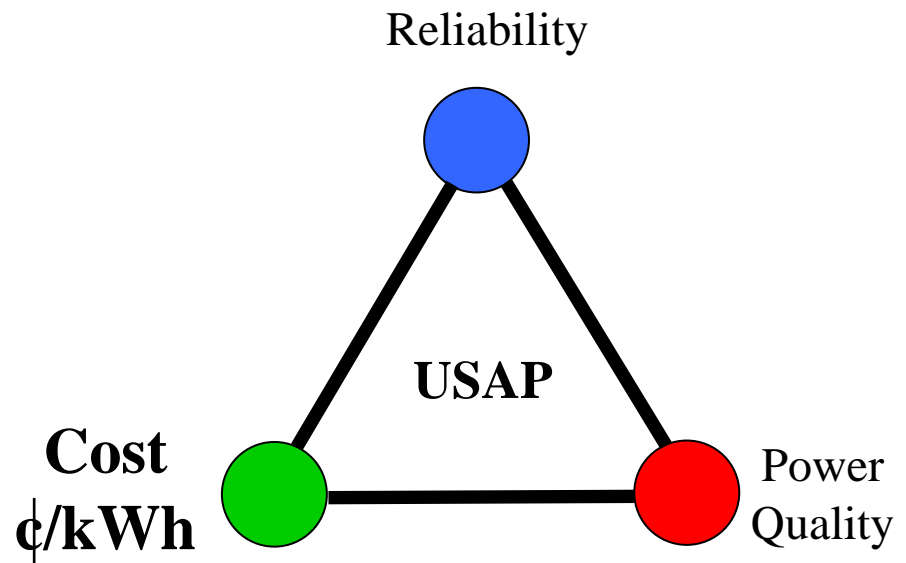
Reliability- Minutes Out

- Reliability
- Number of Customer
 - Customer Minutes Out
- Type (some sensitive some not)
 - Industrial
 - Commercial
 - Residential
- Location
 - Urban
 - Rural



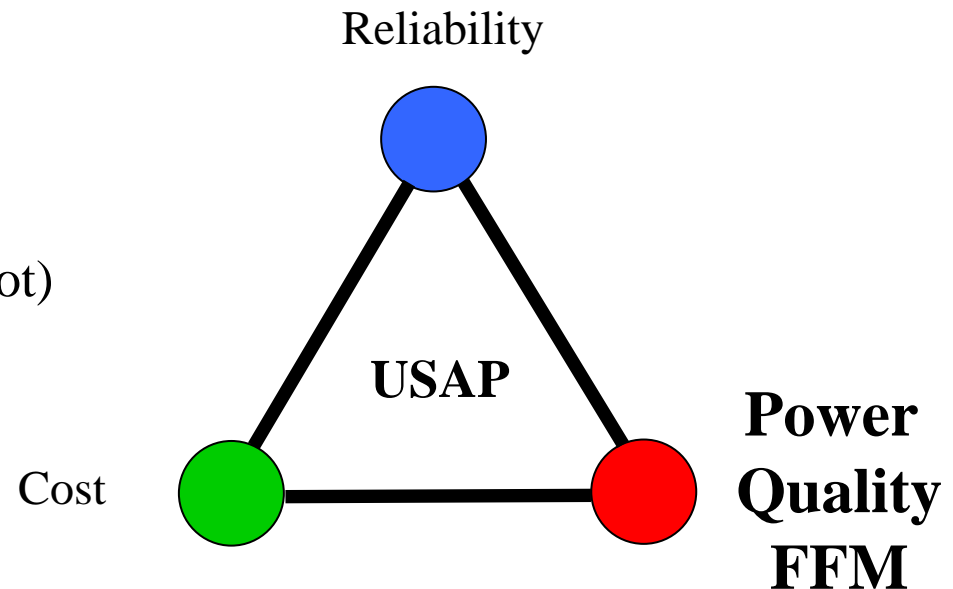
Cost - Cents per kWh

- Cost to Customer
- Revenue
- kW Demand
 - Large
 - Medium
 - Small
- Load Factor
- kWh
 - Total Energy Delivered

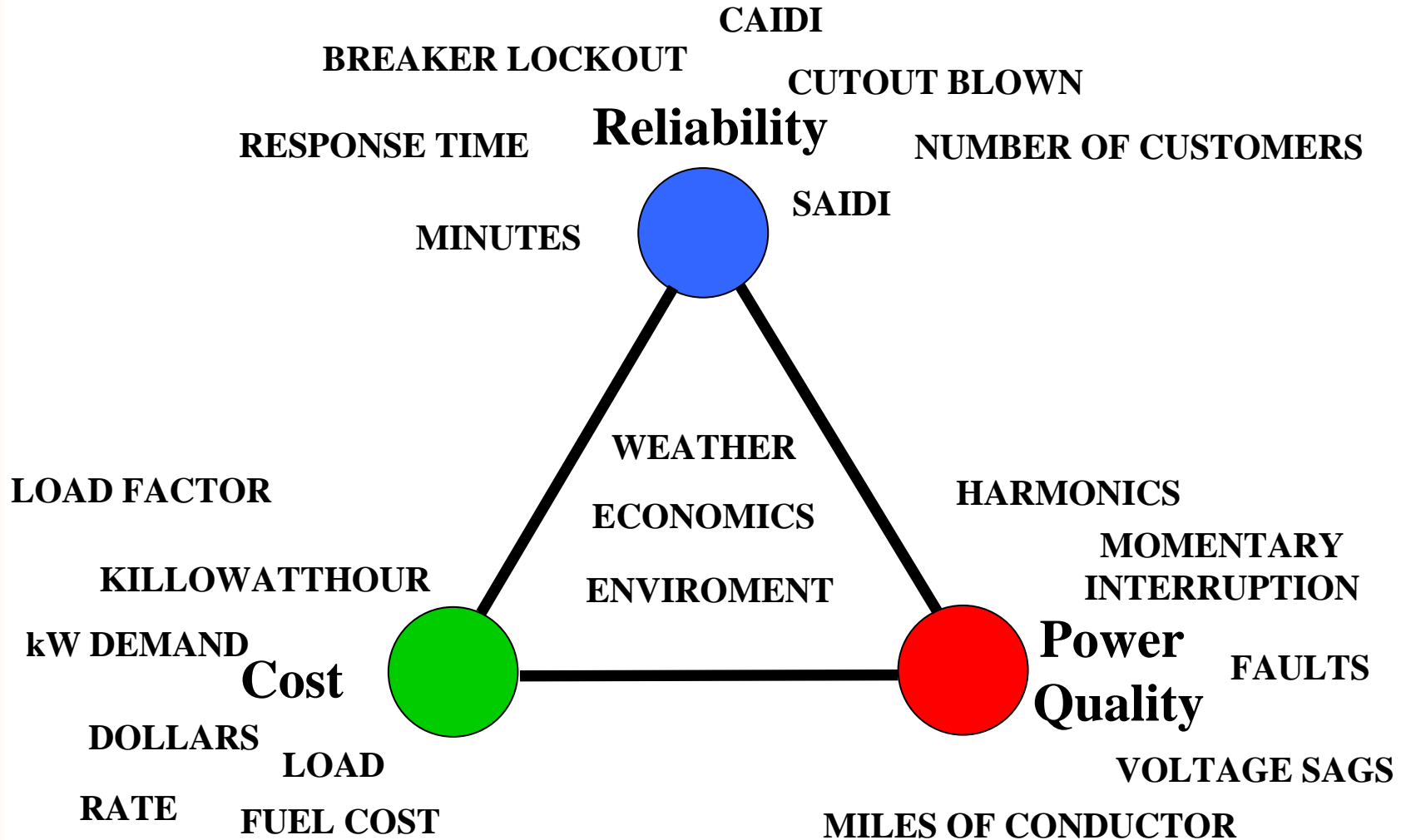


System - Faults/Feeder Mile

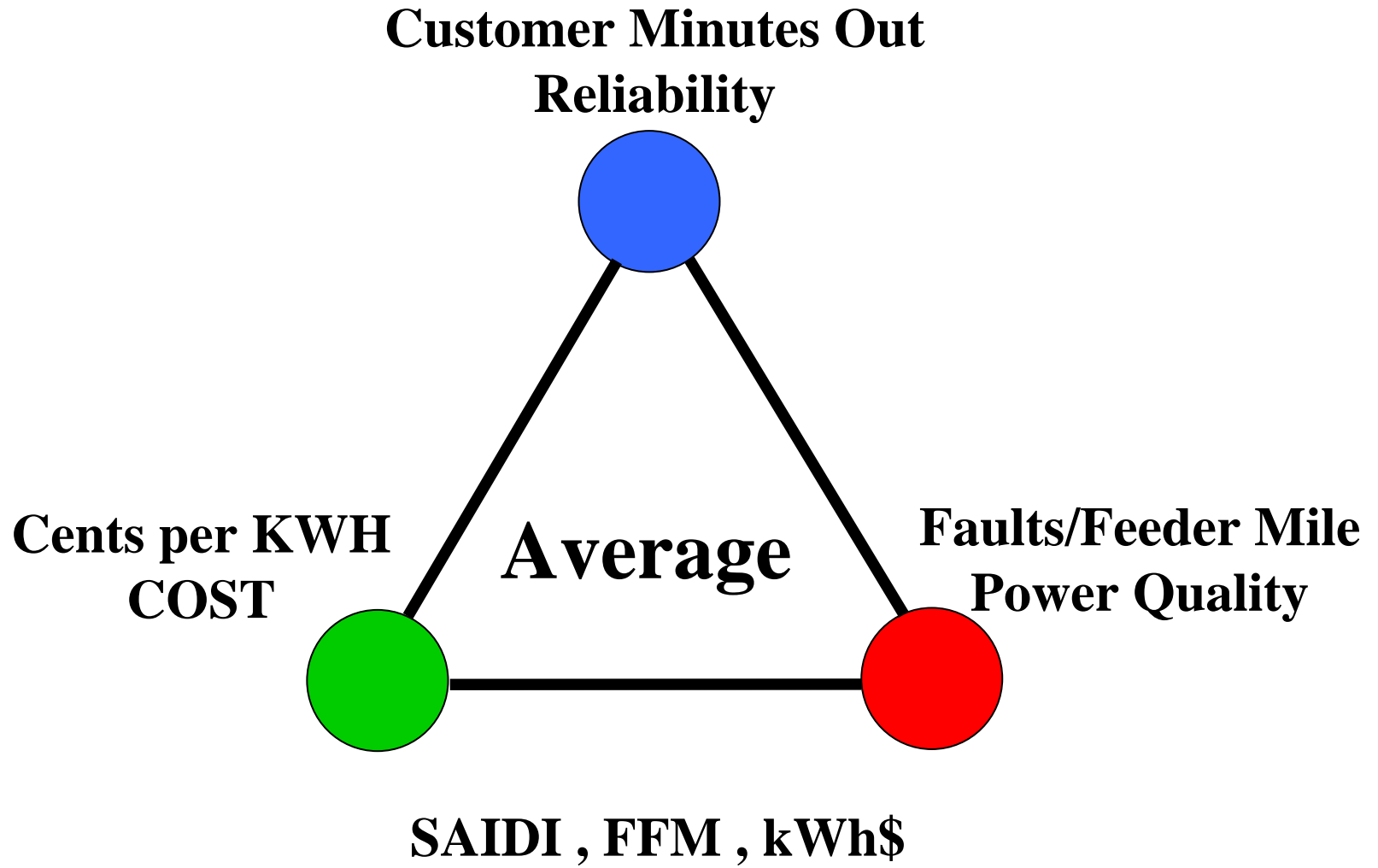
- Power Quality
- Events
 - Number of Faults
- Miles of Conductor
 - Transmission
 - Distribution
- Type (some sensitive some not)
 - Industrial
 - Commercial
 - Residential
- Location
 - Urban
 - Rural



Factors Today



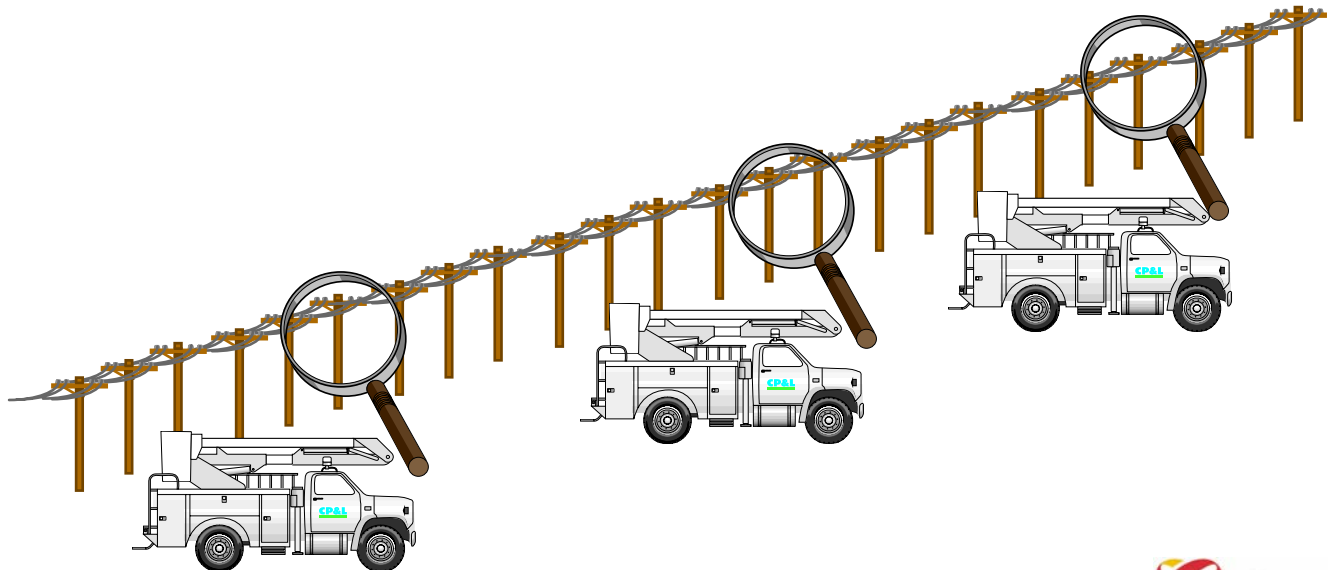
How We Measure Our System



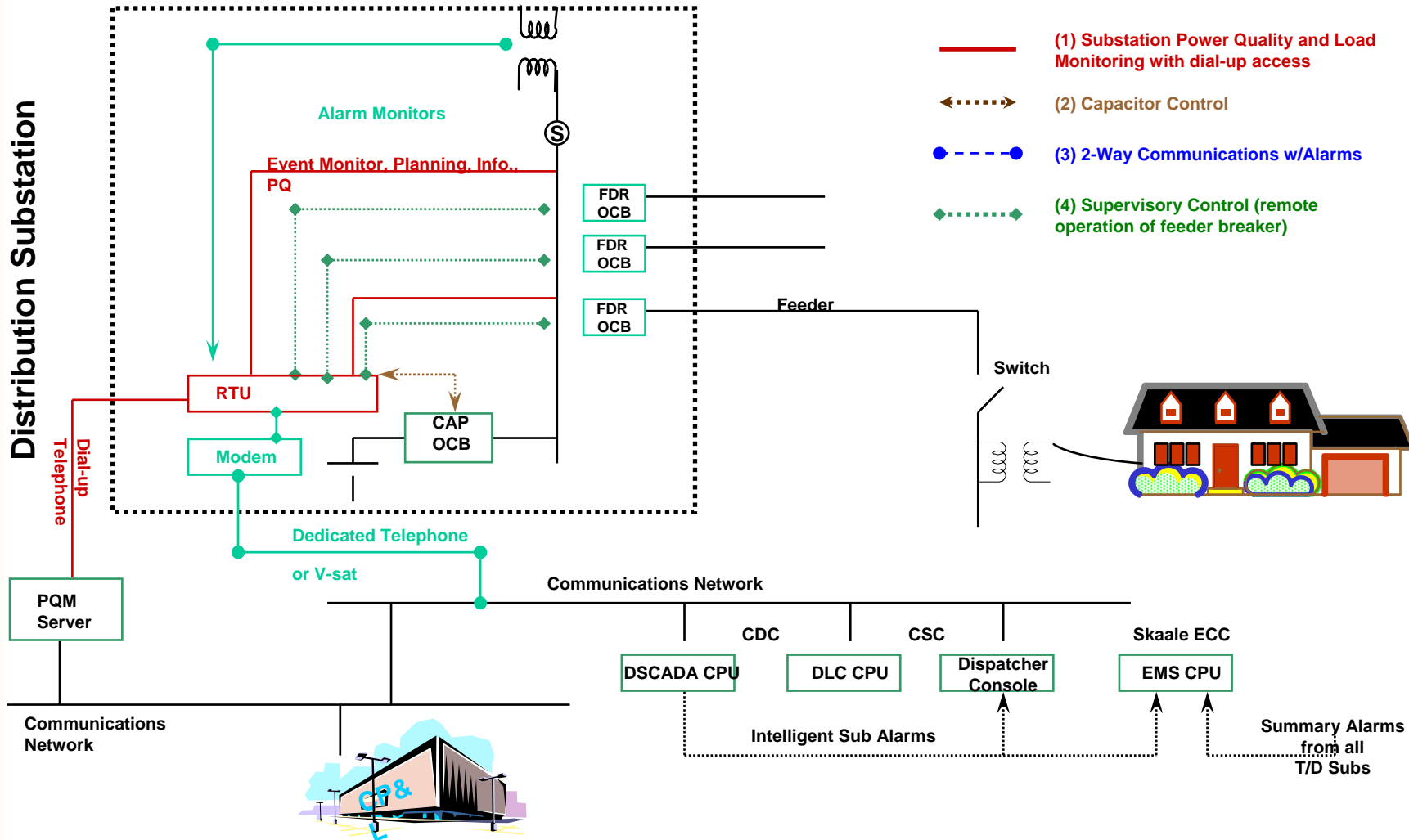
Monitoring Technology



Using new technologies engineers at CP&L are now able to put the distribution system under the magnifying glass to see how it is reacting to system disturbances.

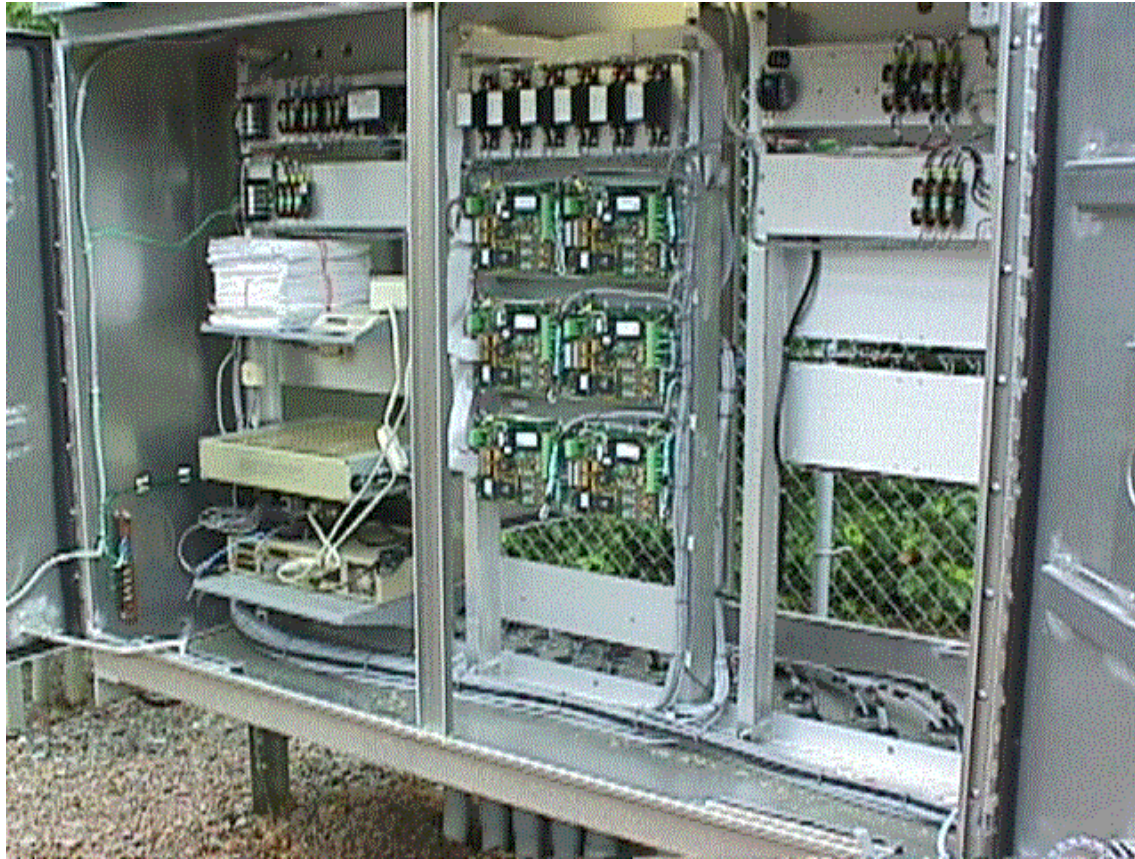


Distribution Automation Communications



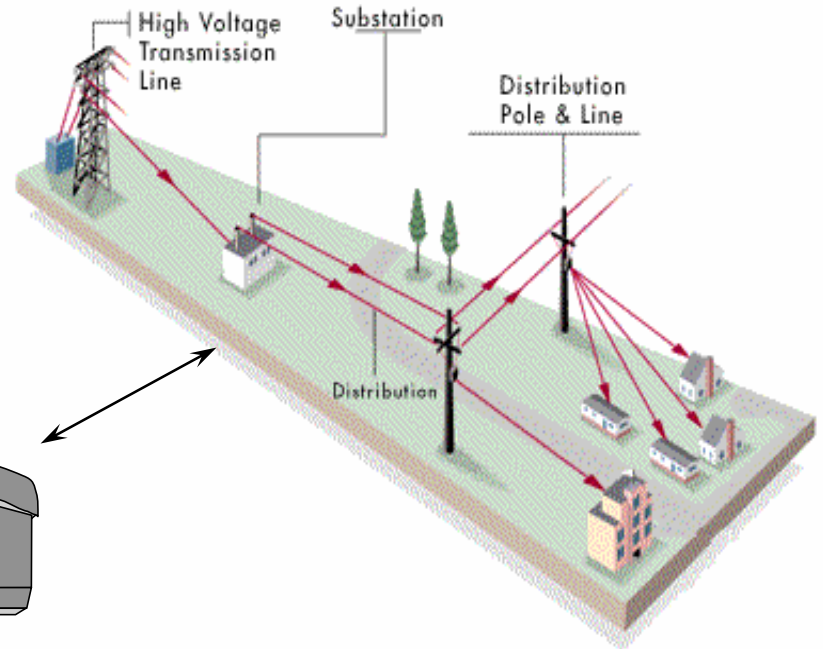
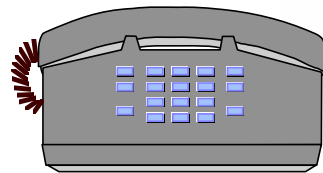
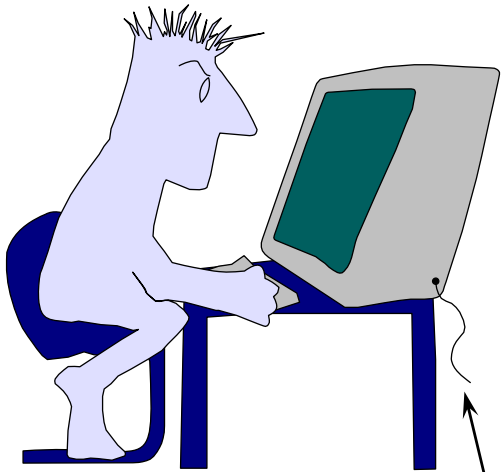
Monitoring Equipment

Substation RTU



Using the FMS

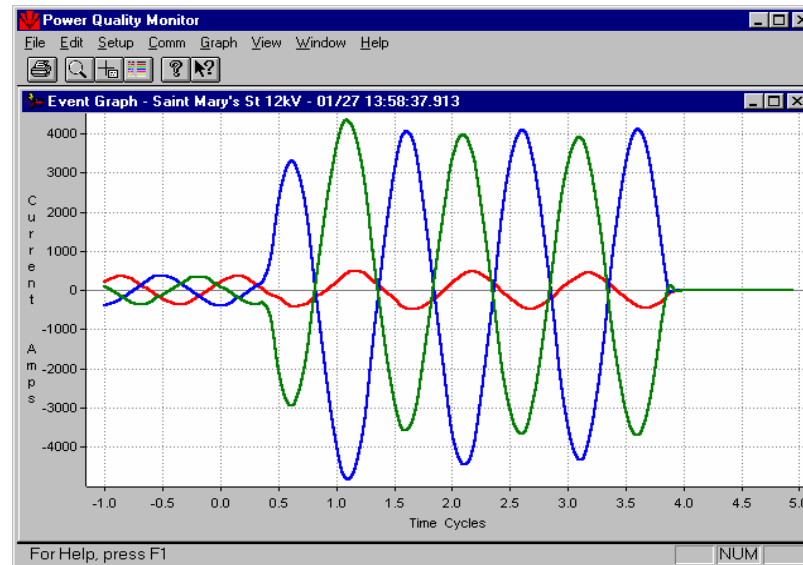
“Live” Connection



Events on the System

Power Quality Monitoring

Ability to monitor faults on every substation and feeder



FMS Screen

Feeder Monitor System - PQMS - [Event Summary]

File Edit Setup Comm OpEvent Graph Report View Window Help

Time	FMRTU	Feeder	Duration	Outage	Ca	Cb	Cc	Cn	UVa	UVb	UVc	OVa	OVb	OVc
05/22/01 07:14:44.717	Marion By-Pass 115kV	Blumenthal 23kV	10.0 cyc		X	X		X	X	X				
05/22/01 07:14:44.884	Marion By-Pass 115kV	Blumenthal 23kV	8.0 cyc	X										
05/22/01 07:14:45.034	Marion By-Pass 115kV	Blumenthal 23kV	12.0 cyc		X	X	X	X	X	X	X			
05/22/01 07:14:45.234	Marion By-Pass 115kV	Blumenthal 23kV	14.8 sec	X										
05/22/01 07:15:00.001	Marion By-Pass 115kV	Blumenthal 23kV	8.0 cyc		X	X	X	X		X	X			

Event Description and Graph Options

Event Description

FMRTU: Marion By-Pass 115kV Start: 05/22/2001 07:14:44.717

Feeder: Blumenthal 23kV Duration: 10.0 cycles

Event Type:	C	OV	UV	Voltage Severity	Fault Current
Phase A	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	0.685	3857
Phase B	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	0.489	3591
Phase C	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	1.105	
Neutral	<input checked="" type="checkbox"/>				3918

Outage Snapshot

Show Graph Previous

Close Next

Help

Delete

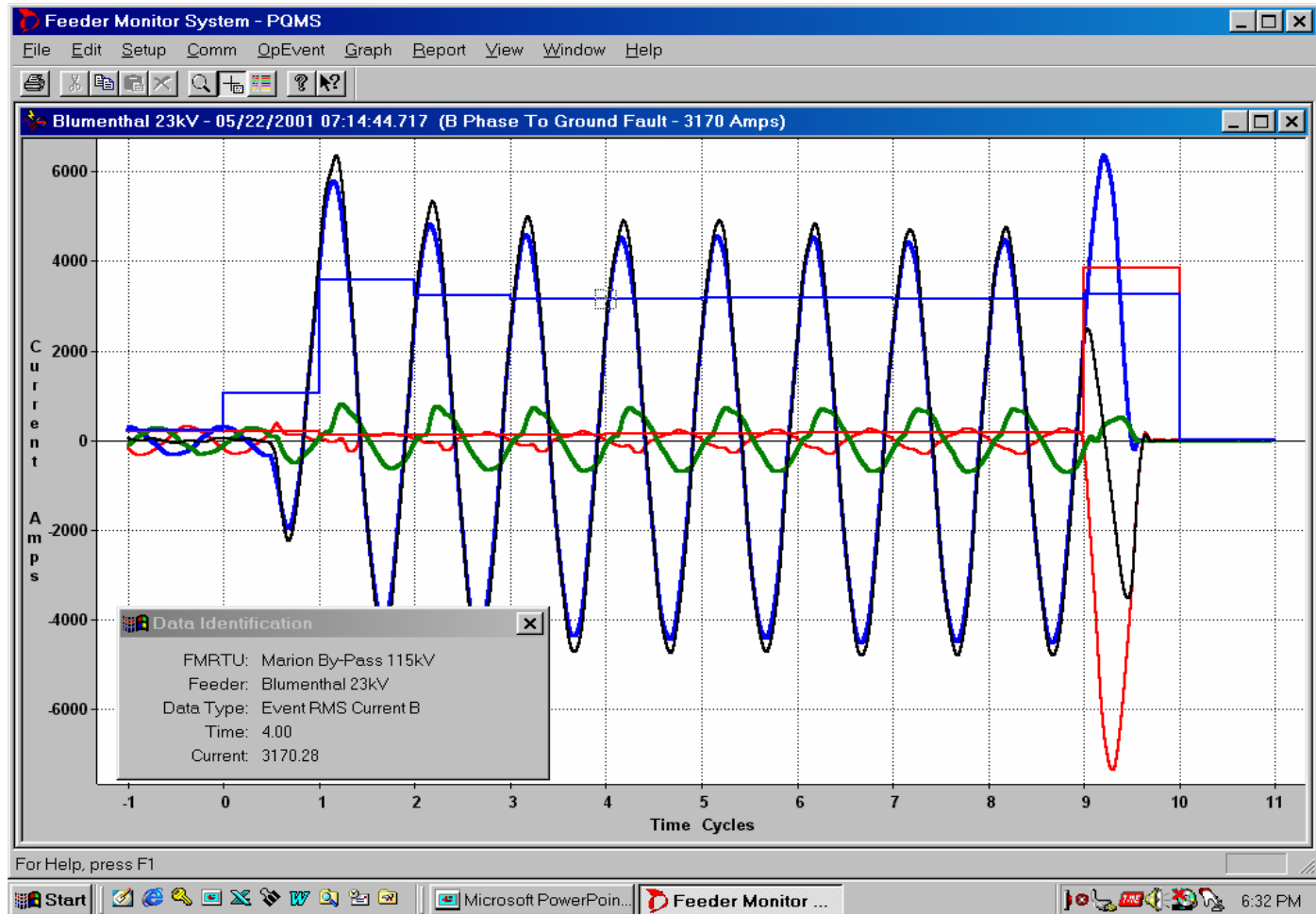
Detach

Show Options

For Help, press F1

Start Microsoft PowerPoin... Feeder Monitor ... 6:23 PM

Phase To Ground Fault Event



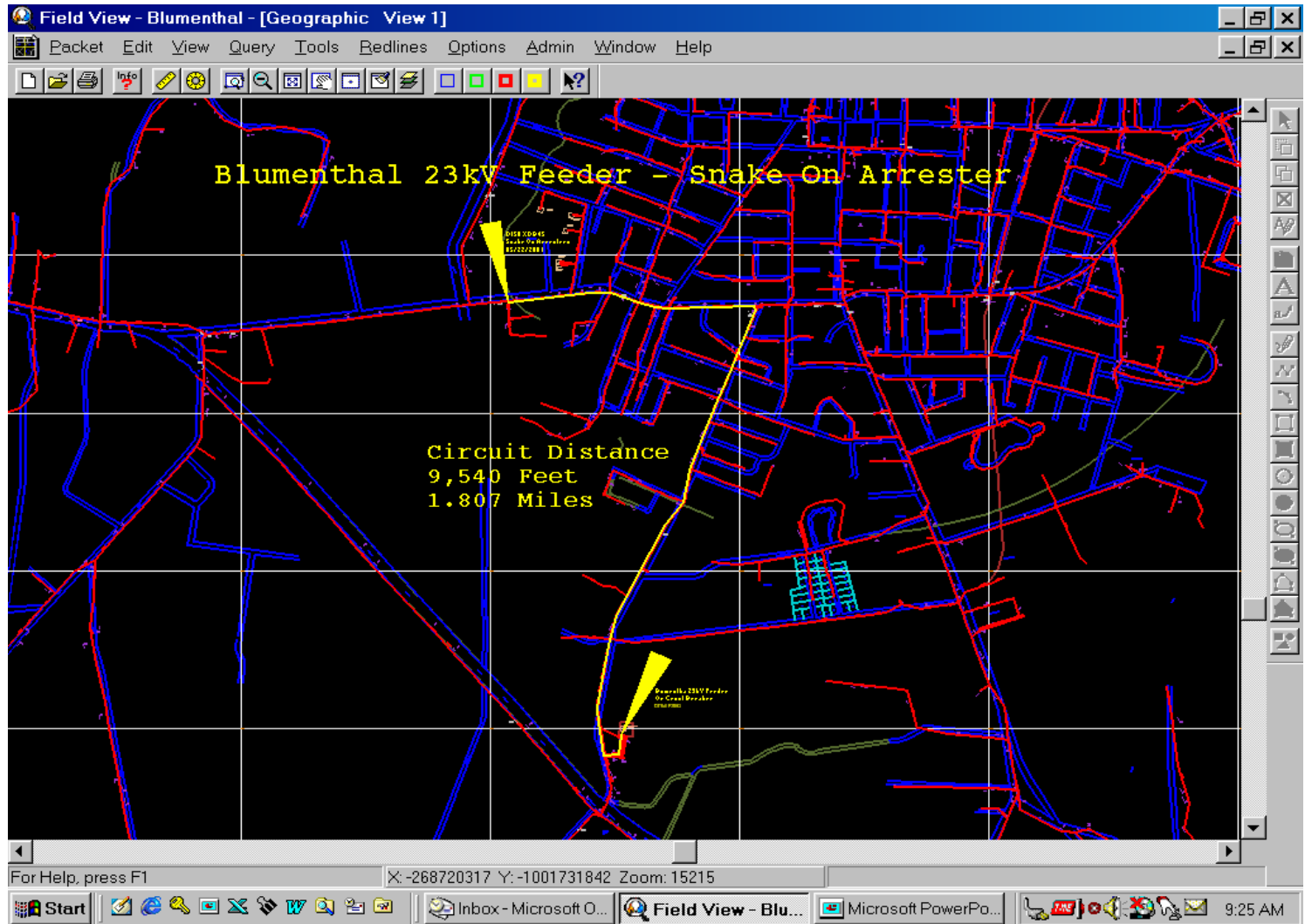
Estimating Fault Location Based On Fault Current

The screenshot displays the 'Microsoft Excel - Fault Current Program' interface. The window title is 'Microsoft Excel - Fault Current Program'. The menu bar includes File, Edit, View, Insert, Format, Tools, Data, Window, and Help. The toolbar shows various icons for file operations and formatting. The spreadsheet area is visible with columns A through L and rows 1 through 24. The interface is divided into several sections:

- REGION:** A dropdown menu set to 'Southern'.
- OP CENTER:** A dropdown menu set to 'Florence'.
- SUBSTATION:** A list box containing the following options: FLOR. MARS BLUFF, FLORENCE #1, FLORENCE #2, FLORENCE CASHUA, FLORENCE EBENEZER, FLORENCE MT. HOPE, FLORENCE SOUTH, FLORENCE WEST, MARION, MARION BYPASS (highlighted), and MULLINS.
- FAULT TYPE:** Radio buttons for 'One Phase' (selected), 'Two Phase', and 'Three Phase'.
- FAULT CURRENT:** A text input field containing '3170'.
- DISTANCE:** A text input field containing '1.795'.

A circular logo for 'DISTRIBUTION ENGINEERING & OPERATIONS' is positioned in the lower-left quadrant of the spreadsheet area. The logo features a lightning bolt, a hard hat, and a computer keyboard, with the slogan 'WE DELIVER' at the bottom. The status bar at the bottom of the window shows 'Ready' and 'NUM'. The taskbar at the bottom of the screen includes the Start button, several application icons, and the system clock showing '6:36 PM'.

FieldView Map - Fault Location



Snake On Arrester

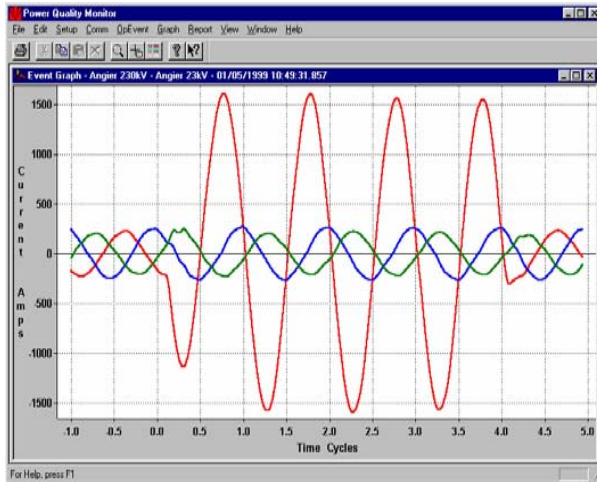


Snake On Arrester

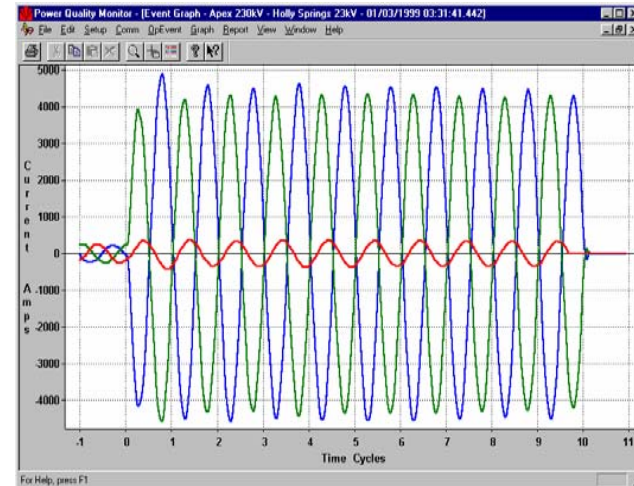


Types of Faults

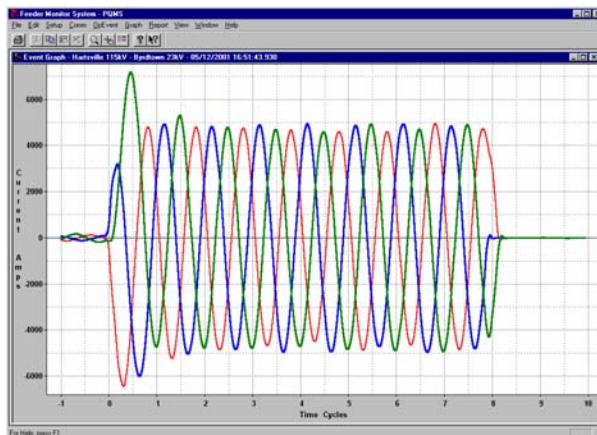
Phase To Ground Fault



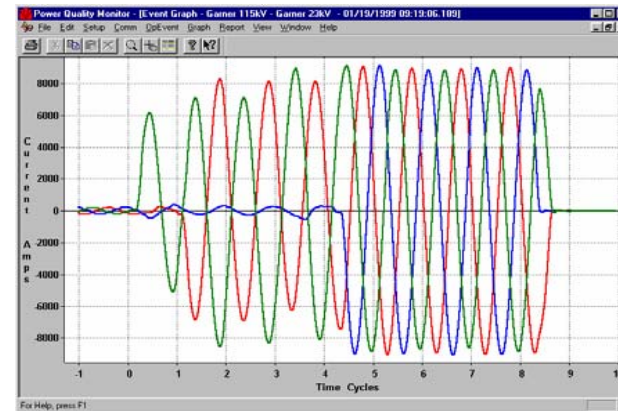
Phase To Phase Fault



Three Phase Fault

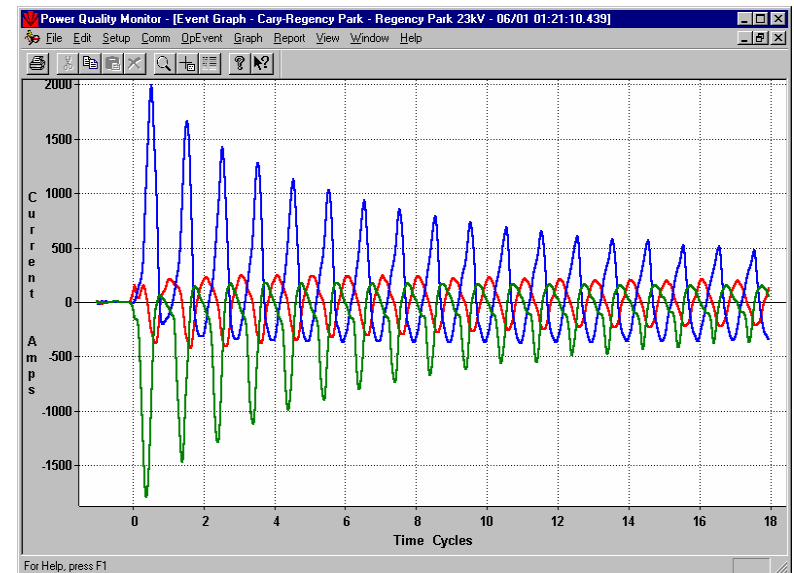
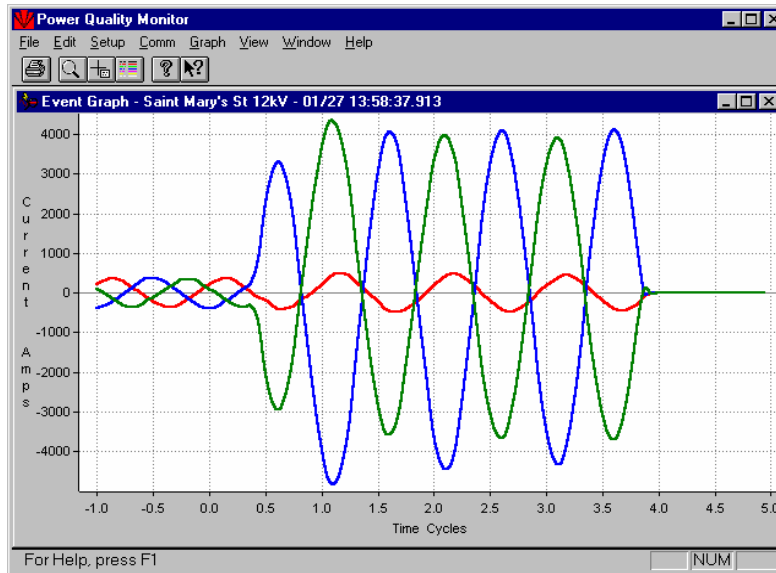


Multiple Fault



Other Variable in Faults

Fault vs Magnetizing Current



Time Aggregation of One Minute

Faults per Feeder Mile (FFM)

Apr-01					
Region	UG Miles	OH Miles	Faults	Average	Totals
Northern	5,244	11,175	544	0.5822	0.0331
Eastern	1,790	8,092	368	0.5689	0.0372
Southern	1,390	10,427	568	0.7629	0.0481
Western	549	2,617	196	0.6467	0.0619
System	8,972	32,312	1,676	0.6402	0.0406

YTD 2001 totals FFM					
Region	UG Miles	OH Miles	Faults	Average	Totals
Northern	5,244	11,175	1,957	0.5547	0.1192
Eastern	1,790	8,092	1,258	0.4857	0.1273
Southern	1,390	10,427	1,602	0.5136	0.1356
Western	444	2,170	1,104	1.0380	0.4223
System	8,868	31,864	5,921	0.6480	0.1454

Conclusion

Faults per Feeder Mile

- Most all power quality events on the utility systems are caused by a fault
- Exposure is a big factor for utilities
 - Rural vs Urban on line length
- Easy for linemen and others in the utility industry to understand
- Easy to count less variables
- Good comparison to other utility systems for power quality events