Almost Real-Time Reliability Improvements

Taking reliability analysis to the next level!

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A MIDAMERICAN ENERGY HOLDINGS COMPANY

Pacific Power | Rocky Mountain Power

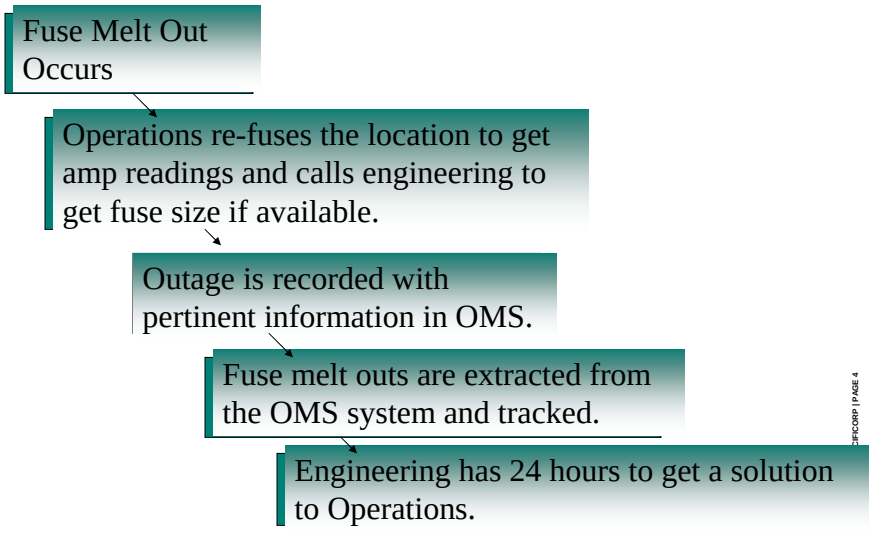
The Challenge…

- With the advent of outage management systems and reporting systems, how can solutions be delivered in a more proactive way?
  - With that in mind, how can we get ahead of customer's concerns when their reliability is slipping?
- Pacific Power and Rocky Mountain Power have used process and technology to balance the answers for these two questions.

Real-Time Improvement vs. Program Improvement

- Program Improvement
  - System metrics are used to measure the effectiveness of the system *as a whole*.
    - Long range budgeting!
    - Historical analysis and trending.
  - Changes to the system *should not* be reactive.
  - Generally requires a longer time to deliver reliability benefits.
- Real-Time Improvement
  - Mainly customer oriented programs
    - Fuse melt outs
    - Reliability work plans
    - Breaker operations
    - Response metrics
  - Managed well, the programs will result in very quick impact to system reliability metrics.

Fuse Melt Out Process



Fuse Melt Out Form Example

Fuse Melt-out Report Form - Return to the operations manager by the next business day.

CADOPS Number: _____ Responder Name: _____ Date: _____
Time: _____ Weather/Temperature: _____ Circuit: _____

Fuse melt out
Circle the phase(s) that had the fuse melt-out
N C S or E C W or T C B ____ Amps ____ Amps ____ Amps FPN: _____

Fuse size that melted: _____ Replacement fuse size: _____Wait 5 minutes after replacing fuse for the load to settle and then check and record amps per phase. If the amp reading on fuse is greater than the fuse size please contact the engineer on call.

Field engineer _____ ☐ agrees ☐ disagrees with fuse melt out solution. Date: _____ Notify Operations of required changes.
Required Changes: _____

General Instructions:
The Fuse Melt-out Report Form should be used whenever a fuse appears to have melted out on the primary system. Complete one form per event. All completed forms should be return to the local operations manager by the next business day.

Enter CADOPS outage number, your name, date, time, weather conditions, and circuit name.

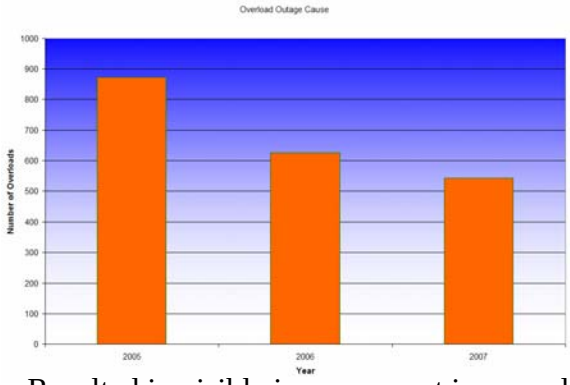
Fuse Melt Out - The fuse melt out section should be completed when a fuse appears melted..

Circle the phases that had the fuse melt out. On multi-phase taps use:
North Center South when the line is running east - west
East Center West when the line is running north – south
Top Center Bottom for vertical construction.
On single phase taps use N or S or E or W for flat construction and T for vertical construction.

Once a fuse is re-installed measure and record the amps on each phase of the impacted tap. Ensure the fuse label matches the fuse size on the pole.

Fuse Melt Out Results

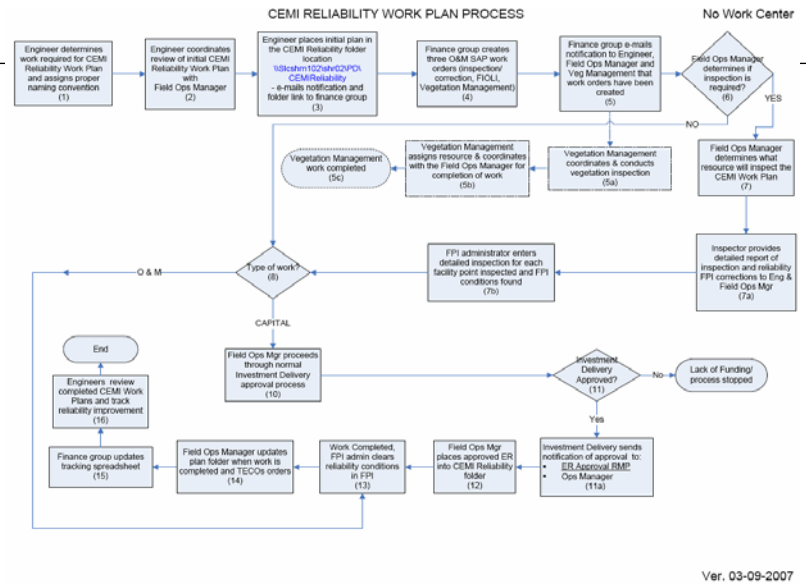
– 38% reduction from 2005 in overload related outages!



–Resulted in visible improvement in annual SAIDI/SAIFI metrics

Reliability Work Plans

- Reliability Work Plans are oriented around what the customer experiences.
  - The customer does not care what is interrupting their power they just want it to STOP!
- Areas and circuits have different characteristics in which they operate
- New technology has allowed us to view and identify characteristics isolated to a distinct location on a circuit.
- Build a plan targeted to meeting that location's needs.
- Do the work.
- Review the improvements and make changes if needed.

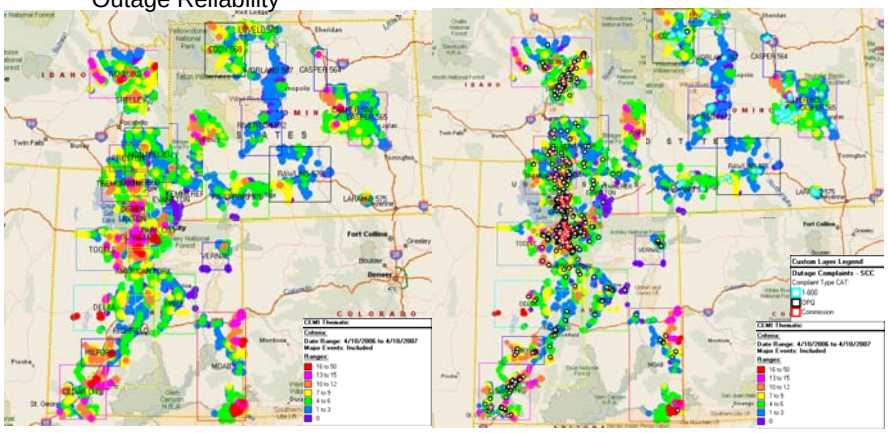


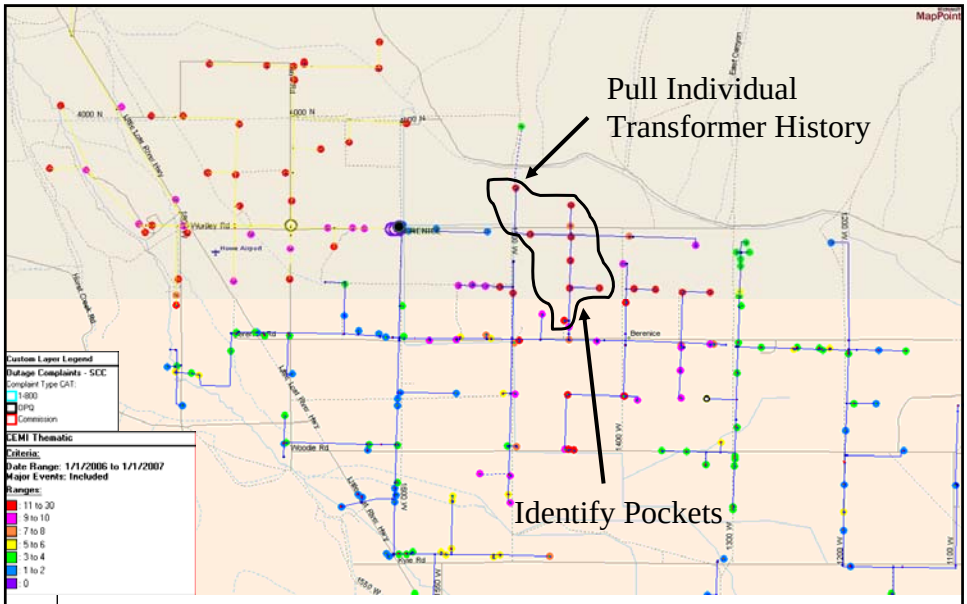
GREAT

(Geographical Reliability Enhancement Analysis Tool)

Outage Reliability

Outage Reliability and Customer Inquiries/Complaints





Individual Transformer Incident History

Incident History

JOB_NO	INCIDENT_DATE_TIME	DIRECT_CAUSE_CATEGORY	DIRECT_CAUSE	AUTO_SCDL_POINT_ID	AUTO_SCDL_POINT_X	AUTO_SCDL_POINT_Y	DESCRIPTION	PHASE	COMPONENT	MAJOR_EVENT_NUMBER	CUSTOMERS_OUT_SUSTAINED	CUSTOMERS_OUT_MOMENTARY	DURATION_HOURS
CSLC660497	7/12/2006 11:00	Equipment Failure	Deterioration or Rotting	LINECUT-25563	1114473	15927349	replaced burned off jumper and junction fuse	ABC	Jumper Wire/Stirrup OH	0	33	0	1.58
CSLC668125	7/25/2006 16:23	Weather	Lightning	OH_211000_495450381	1109845	15927374	patrolled and replaced blown junction fuse	A		0	35	0	2.582
CSLC622240	3/27/2006 1:14	Loss of Supply	Loss of Transmission Line	BRN_CB21	1109095	15932963	Lost the CB 77 at Scoville Sub tried it and it held	ABC		0	172	0	0.128
CSLC662632	1/5/2006 2:04	Weather	Snow, Sleet and Blizzard	OH_211000_495450381	1109845	15927374	junction fuses open	ABC		0	47	0	2.287
CSLC658190	7/5/2006 11:42	Other	Unknown	LINECUT-25439	1109188	15927367	patrolle line and replaced junction fuse	ABC	Fuse (No Cause Found) OH	0	50	0	1.526
CSLC683623	9/8/2006 21:36	Loss of Supply	Loss of Transmission Line	LINECUT-26641	1109194	15932042	CB 77 at Scoville locked open closed by scada holding	ABC		0	0	175	0.076
CSLC689968	10/7/2006 17:11	Other	Unknown	OH_211000_495450381	1109845	15927374	patrolled the line and refused the junction fuse ok	ABC	Fuse (No Cause Found) OH	0	48	0	1.567
CSLC690691	10/11/2006 11:52	Planned	Emergency Damage Repair	OH_225002_495450378	1117063	15927602	to replace bad cutout	ABC	Cut-Out B/O OH	0	12	0	0.35
CSLC692597	10/19/2006 9:04	Other	Unknown	OH_211000_495450381	1109845	15927374	blown line fuse	B	Fuse (No Cause Found) OH	0	40	0	1.97
CSLC698656	11/23/2006 8:17	Weather	Snow, Sleet and Blizzard	OH_211000_495450381	1109845	15927374	assign to 698650	B	No Distribution Damage	0	40	0	0.78
CSLC701791	12/15/2006 9:39	Weather	Wind	OH_211000_495450381	1109845	15927374	high winds jct fuse blown troubleman replaced fuse	A	No Distribution Damage	0	35	0	0.666

- Viewing what impacts a customer is experiencing both tabular and geographical.
- Identify the problems and recurring causes.
- Build a plan to meet the individual needs of that section of circuit or customer.

Reliability Work Plan (Page 1)

ROCKY MOUNTAIN POWER
A DIVISION OF PACIFICORP

Create Name

Reliability Work Plan

CEMI_07_03_26_Rexburg_Jefferson_to_Mud_Lake		Charge Numbers	Prioritization Criteria	
			Number of Incidents:	8
Operations Manager: Tony Nielsen	District: Rexburg	O&M Charge Number: 15447760	Plan Effects:	7
			36 Month Transformer CHI:	6.46
Prepared By: Joshua Jones	Substation: Jefferson	FIOLI Charge Number: 15447761	Average Incident Duration:	0.81
			Customer Count:	870
Date Created: 3/26/2007	Feeder/Transmission Line: Jefferson_to_Mud_Lake	Tree Trimming Number: 15447762	OPQ's/1-800/Commission:	6
			Overhead/Underground:	Overhead
Estimated By	Capital Cost	Capital Charge Number	Estimate Type	
Date Work Completed	Vegetation Inspection Requested: No			

Summary:
This year two transmission lines were picked for Incremental Improvments as part of the 2006 Underperforming Circuit.

Incremental Improvments Justification:
The transmission line was picked by Joshua Jones, Tony Perkins, Vance Witbeck, and Heide Caswell. The transmission line has had poor performance in the last three years with a TCPI of 503 and is ranked the 24th worst performing transmission line in Rocky Mountain Power's 2005 selection. The transmission line has a large number of reliability conditions conditions, poor ground clearance, rotten poles(200+), and a problem with raptor guarding. The geographical location of the line also causes for long restoration time due to a three hour travel time.

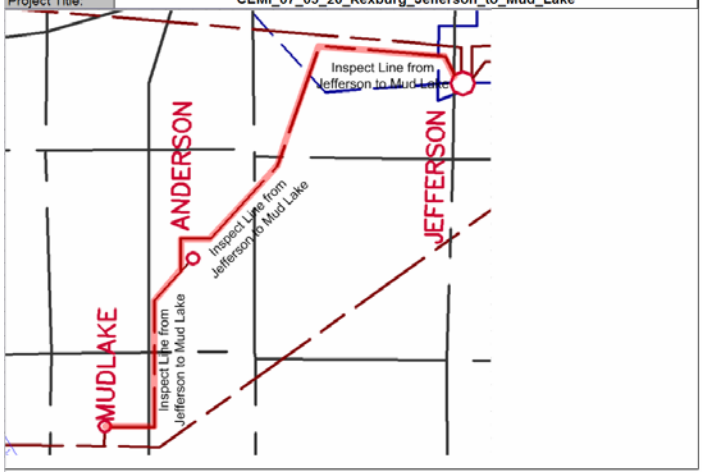
Initial Recommendations
Detailed inspection from Jefferson to Mud Lake on each structure and wire section.

Reliability Work Plan (Page 2)

ROCKY MOUNTAIN POWER

Reliability Work Plan Diagram

Project Title:	CEMI_07_03_26_Rexburg_Jefferson_to_Mud_Lake

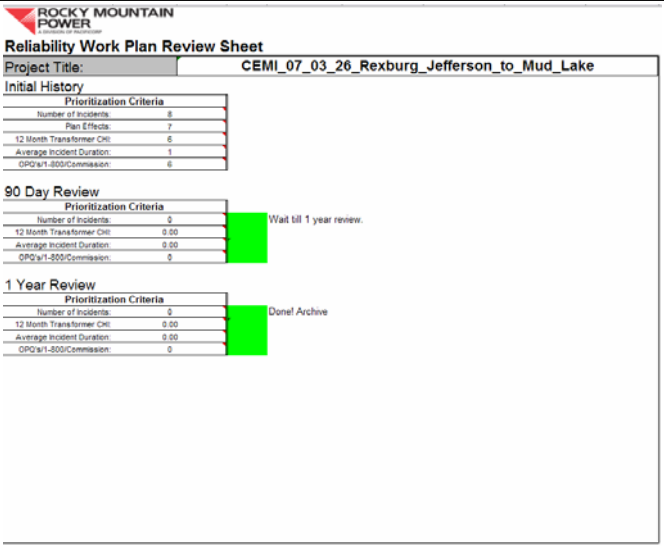


Reliability Work Plan (Page 3)

Incident History

JOB_NO	INCIDENT_DATE_TIME	DIRECT_CAUSE_CATEGORY	DIRECT_CAUSE	AUTO_ISOL_POINT_ID	AUTO_ISOL_POINT_X	AUTO_ISOL_POINT_Y	DESCRIPTION	PHASE	COMPONENT	MAJOR_EVENT_NUMBER	CUSTOMERS_OUT_SUSTAINED	CUSTOMERS_OUT_MOMENTARY	DURATION_HOUR
CSLC478653	7/26/2004 1:37	Loss of Supply	Loss of Transmission Line	LINECUT-13666	1251468	15928242	L66 CB at Amps opened up opened CB 66 closed CB 69 by SCADA	ABC		0	186	0	0.646
CSLC507966	11/14/2004 14:58	Loss of Supply	Loss of Transmission Line	LINECUT-15357	1251467	15928320	amps sub opened up closed in at mud lake cb 69	ABC		0	186	0	0.236
CSLC600159	12/23/2005 3:10	Loss of Supply	Loss of Transmission Line	LINECUT-21437	1251428	15928242	Amps 230 line tripped out. Going to have to close in at Anderson	ABC		0	205	0	0.663
CSLC612589	3/2/2006 12:40	Loss of Supply	Loss of Transmission Line	MDL_CB11	1251437	15928320	lost cb at amps closed in at mud lake	ABC		0	204	0	0.143
CSLC602639	1/3/2006 5:03	Loss of Supply	Loss of Transmission Line	LINECUT-21569	1251467	15928320	Lost transmission line feed from Jefferson closed at Mudlake	ABC		0	205	0	0.211
CSLC511011	12/8/2004 10:14	Loss of Supply	Loss of Transmission Line	LINECUT-15586	1251372	15928242	lost transmission line previous call noted into outage	ABC		0	186	0	2.298
CSLC517847	1/12/2005 12:47	Loss of Supply	Loss of Transmission Line	LINECUT-16060	1251458	15928320	Los of transmission line feeding the area. Troubleman on the way.	ABC		0	186	0	2.071
CSLC601279	12/29/2005 1:22	Loss of Supply	Loss of Transmission Line	MDL_CB11	1251437	15928320	Amps CS221I opened by scada close in Mudlake CB 68	ABC		0	205	0	0.193

Reliability Work Plan (Page 4)



ROCKY MOUNTAIN POWER

Reliability Work Plan Review Sheet

Project Title:	CEMI_07_03_26_Rexburg_Jefferson_to_Mud_Lake

Initial History

Prioritization Criteria	
Number of Incidents:	8
Plan Effects:	7
12 Month Transformer CHI:	6
Average Incident Duration:	1
OPQ's/1-800/Commission:	6

90 Day Review

Prioritization Criteria	
Number of Incidents:	0
12 Month Transformer CHI:	0.00
Average Incident Duration:	0.00
OPQ's/1-800/Commission:	0

Wait till 1 year review.

1 Year Review

Prioritization Criteria	
Number of Incidents:	0
12 Month Transformer CHI:	0.00
Average Incident Duration:	0.00
OPQ's/1-800/Commission:	0

Done! Archive

Reliability Work Plan Results

- The Reliability Work Plans have addressed a lot of low hanging fruit by putting outage visualization tools and processes in the hands of local engineering staff.
- Rocky Mountain Power has moderated the impact of summer related heat and weather during the summer months.
- Customers with specific needs can be explained or monitored with respect to the rest of the customers to find a balance between customer expectations and reliability concerns.

Breaker Operations

- Many companies have different philosophies.
  - Save the Fuse (Fuse Saving Scheme)
  - Operate the Fuse (Sensitive Customer Scheme)
- Regardless of the philosophy breaker operations should be tracked. (This is what the customers see)
  - High breaker activity should be reviewed and addressed regardless of type (momentary count or sustained count).
  - Sensitive customer circuits should be monitored closely to evaluate effective target ranges.
    - System serving industrial customers or high tech customers.

Historical Practices and Recent Feedback has helped Tailor the Approach Taken:

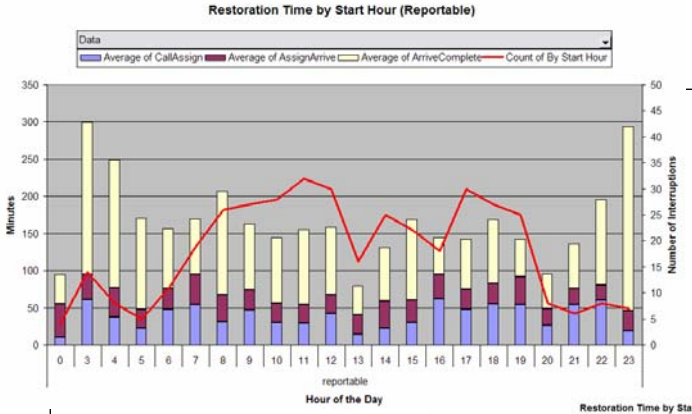
- Pacific Power has been more concerned by long duration interruptions caused by breaker lock outs.
  - Breaker Lock Outs are recorded.
  - Engineering reviews the lock outs daily, reviews relay settings and issues relay changes if necessary within 2 days.
- Rocky Mountain Power has been more concerned about number of interruptions.
  - Breaker lock outs and momentary operations are combined for a total operation count.
  - The list is dynamic and re-prioritizes with each operation.
  - Breakers on the top of the list require a review of the relay settings and cause of outages. If the outage cause can not be determined the engineer issues relay setting orders to disable the low set instantaneous trip, allowing the fuse to operate.
  - Operations is made aware of the relay change and investigates activity on the circuit.

Breaker Operation Benefits

- Pacific Power has made substantial inroads with certain circuits' performance, by catching improperly set equipment as well as by more promptly patrolling for root causes of repeated devices.
- Rocky Mountain Power customers have been very pleased with the change.
  - The company has received positive feedback from customers.
  - The down side can be the change in turning a momentary outage into a sustained outage, which can only be mitigated by finding where the problem is and fixing it.

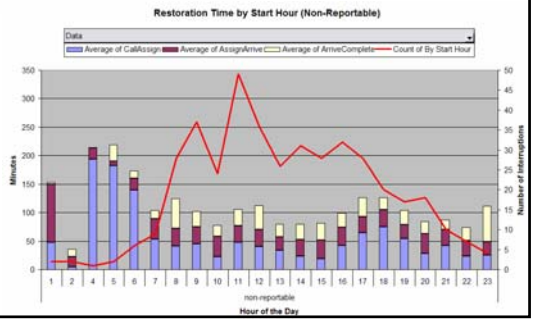
Response Metrics

- Outage Activity is a key real-time outage management opportunity.
- Outage management system technologies have delivered some improvements.
- Key areas for Pacific Power & Rocky Mountain Power are managing:
  - Resource hours,
  - Type of calls responded to,
  - Cause trends, and
  - Heavy-hitters that dominate day-to-day comparisons.



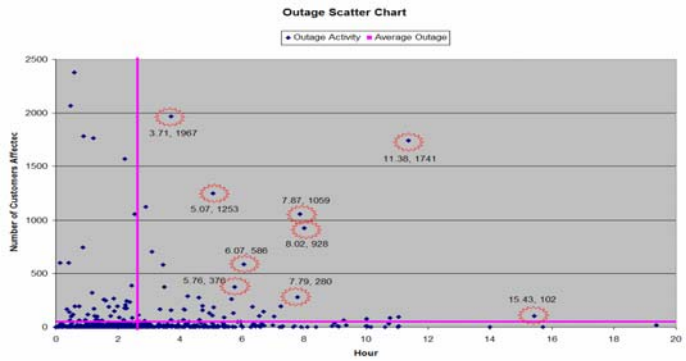
Reportable interruption events affect CAIDI and SAIDI.

Non-Reportable (trouble calls) affect response and troubleshooting resources.



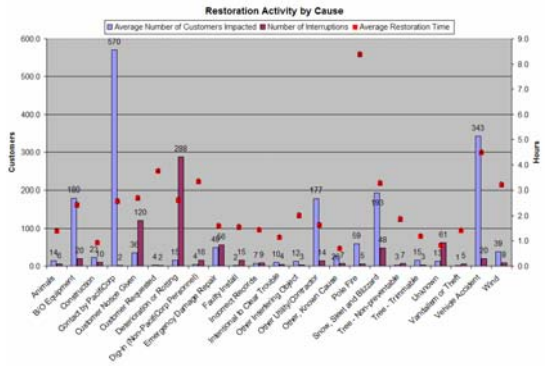
CAIDI Outliers

- All outages are plotted to identify outliers!
- Root cause analysis is done on the outliers and modifications are made to restoration methods.



Restoration Activity by Cause

- Review restoration activity by cause for abnormalities.
- Evaluate if abnormalities are a one time occurrence or a trend.



Restoration Metric Benefits

- This level of analysis has allowed the company to evaluate “time of day” inefficiencies and modify resource availability.
- System level CAIDI can be affected by outage cause!
  - Trending allows the engineer to determine:
    - Reduction strategies.
    - CAIDI deviation due to the elimination of low hanging fruit.

Summary

- Plans can be developed that put you in the driver's seat by acting more rapidly on reliability information.
- Several questions need to be considered:
  - What top issues are you facing?
  - What data do you take action on?
  - How do you use the data?
  - Who uses the data?
  - Do they know what differences in the data drive differing actions?
- If you've attacked the problem in this sort of way you too can be developing almost real-time solutions for managing reliability.

Questions