PacifiCorp Outage Investigation

2017 General Meeting
Distribution Reliability Working Group
Chicago, Illinois
Investigation Processes

1. **FIRE: Frequent Interrupters Requiring Evaluation** (kind of like a DEMI metric)
   1. Web-based application that allows us to establish thresholds for notification or
   2. If certain triggers are reached, an investigation is required, which has an expected delivery date.
      1. Loss of supply investigation
      2. Lockout investigation
      3. CAIDI investigation
Investigation Processes

2. **Reliability Forum**
   
   1. If an outage gains management attention or raises concern of key participants, it can be nominated for investigation.
   
   2. Typically is the result of departments perceiving the events that took place differently.
   
   3. Summary of findings is developed into structured document with “opportunities” specifically identified as well as what the possible reliability improvements were.
Investigation into device performance can be performed by any FIRE user
### FIRE: Investigation Page

#### Thresholds Exceeded:

<table>
<thead>
<tr>
<th>Threshold Description</th>
<th>Outage Count</th>
<th>Max Customers Out</th>
<th>Total Customers Interrupted</th>
<th>Total Momentsy</th>
<th>Total Duration</th>
<th>Time to Repair</th>
<th>Time to Power</th>
<th>Assign to Arrive</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 momentary outages in a month</td>
<td>5</td>
<td>1,939</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Tasks/Tags/Comments:

<table>
<thead>
<tr>
<th>Select</th>
<th>Report Date</th>
<th>Comments/Task/Tag</th>
<th>Task</th>
<th>Date</th>
<th>Closed</th>
<th>Assign to</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6/19/2012</td>
<td>Interrogated relay to determine approximate location of faults, peak fault amps</td>
<td></td>
<td>6/29/2012</td>
<td></td>
<td>Wittkop, Wade</td>
</tr>
<tr>
<td></td>
<td></td>
<td>between 2664 A and 3763 A, recommend line patrol.</td>
<td></td>
<td></td>
<td></td>
<td>Hansen, Greg</td>
</tr>
<tr>
<td>Select</td>
<td>6/19/2012</td>
<td>Patrol line from substation to facility p. 214060. (Map provided)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Select</td>
<td>6/19/2012</td>
<td>Line was patrolled and no cause was found. Relay interrogation showed: 6/10/2012</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1257 hrs IA: 3541A IB: 203A IC: 3763A IN: 123A 5/17/2012 1757 hrs IA: 3489A IB:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6/5/2012 0646 hrs IA: 2664A IB: 2755A IC: 248A IN: 33A</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Select</td>
<td>6/19/2012</td>
<td>Appears to be within approximately one line mile of substation bus. &quot;One&quot; mile</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>from substation bus: 3ph-3491 amps, 1ph-2991, 2ph&amp;grd-3293, 2ph-3023</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

FIRE investigator documents conclusions, designates actions and requests deadlines for actions; conclusions are included in Area Improvement Team meetings.
FIRE: Links to Google Earth for virtual inspection

Local conditions of interrupting devices can also be looked at in map form to consider terrain, exposure.
FIRE: Shows device descending impact view

For regional performance and operating area assessment, individual devices can be investigated to determine which are impacting the most customers and incurring the longest customer interruptions.
EXECUTIVE SUMMARY
On April 12, 2016 a tree contacted two phases on 44kV of Grant Street substation, located in the
corners of operating area. The breaker tripped and locked out, opening the high side fuse on transformer T-
3266, leaving 10,046 customers without power. Since the adjacent transformer was out for maintenance
work, immediate restoration of transformer T-3266 was undertaken to restore power to customers. At its
conclusion, the outage resulted in 4,414,702 customer minutes interrupted with the average restoration
(CAIN) of 225 minutes. While the event exceeded the Willamette Reliability Reporting Region major event
threshold (1,950 min), the event is notable for the lessons learned to improve subsequent system performance.

EVENT BACKGROUND
Facilities Discussion
Transformer T-3266 was taken out of service on April 4th for scheduled maintenance procedures the paper
carried lighting arresters. During this work all loads were on T-3788. This is a 15/25/35 MVA
approximately 16 MVA of load on the transformer at the substation was transferred to the main transformer prior to the
loading. Loading was not a concern.

Timeline of event:
1. 7:21 tree falls through feeder and breaker trips
2. 5:42 Dispatch calls sub ops manager (Joe Kuehn) and a wireman
3. 7:21 Wireman arrives on site, reports blown high side
4. 6:22 1 sup ops wireman leaves shop with test equipment
5. 6:50 Sub station wireman arrive at substation and called crew
6. 7:05 Called dispatch to explain situation and had them set up and collect data sample.
7. 7:30 Received switching from dispatch
8. 7:42 Checked bus dead and grounded
9. 7:46 Replaced all high side fuses with spares in control
10. 8:30 Remove grounds
11. 8:45 Called dispatch and removed clearance
12. 9:30 Re-energize 44kV (222 customers)
13. 9:25 Re-energize 44kV (222 customers)
14. 9:34 Re-energize 44kV (222 customers)
15. 9:40 Re-energize 44kV (222 customers)

T&D Operations Opportunities:
1. The Albany sub ops team worked with engineering (Paul Harris) to test the other 2 fuses for fatigue. If
tells of weaknesses is found it would be prudent to replace all 3 high side fuses with brand new fuses.
Anytime we have a through fault and blow a high side fuse (COMPLETE)
2. Although the annual breaker inspection and operations are helpful in exercising the breakers that do
not get operated often, maintenance and lubrication still needs to be done to ensure proper operation.
Maintenance schedule should be implemented for distribution breaker.

Estimated impacts to outage metrics:
Two opportunities for alternate results exist. First, had T-3265 not been out for maintenance prompt
restoration could have been affected. So, while maintenance is important to complete, to the extent
possible it should be recognized that during an out of normal configuration there are potential risks to the
network and prompt restoration to normal configuration is critical. Had all circuits except 44kV been
able to be shifted to the adjacent transformer, approximately 8.15 million customer minutes interrupted
would have been saved, per the chart below.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Customers Outaged</th>
</tr>
</thead>
<tbody>
<tr>
<td>With Stage Restoration</td>
<td>10,240</td>
</tr>
<tr>
<td>Without Stage Restoration</td>
<td>2,418,702</td>
</tr>
</tbody>
</table>

Note: Stage restoration can save outage minutes, proceed!
Reliability Forum

- Data sources include recordings, logs, outage records, drawings and any relevant maps
- Are generally assigned to an operations manager, but recent assignments have been made to dispatch managers
- To date, approximately 30 forum investigations have been done
- Have broken through some organizational barriers
- Have begun to build better fact finding skills across organization
Findings from certain analysis...Vehicle Interference

• Several large impact outages involved vehicle (and train) accidents
• Resulted in deeper mining for persistence of that specific outage trigger
• Findings were eye-opening
• Have resulted in pilot activities, including collaboration with transportation officials
Vehicle Interference: Impacts Experienced

Pacific Power - 2016

- Car Hit Pole
- Cause Category
- Cumulative Cause Category
Vehicle Interference: The History

Pacific Power Car Hit Pole - Annual Poles Replaced and SAIDI

365-Day Rolling Car Hit Pole Outages
Vehicle Interference: Time of Day/Day of Week/Day or Night/Operating Area...what matters?
Involved working with City Transportation officials, State DOT, etc.
6 months later, pilot device placed (ice storms caused their own impacts to transporting device)
Vehicle Interference: How it stacks up geographically
Outage Investigation: The Moral of the Story

- Each person plays specific roles in outage investigations...leadership is one of the most important
- Figure out what their role can & should be & you’ll be golden
- Create mechanisms to make the investigation more streamlined
- When people investigate & come up with reasonable solutions, support that advancement
- Then the good ideas will start to snowball!