WECC

Webinar Series: Reduction of Unknown Outages and Misoperations

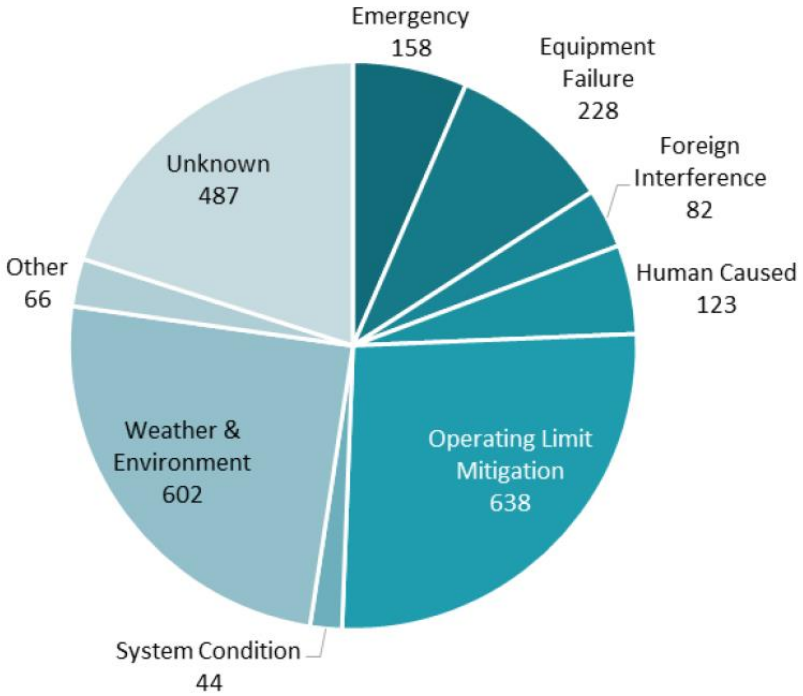
Session 2: Outage Analytics

Issue Identified

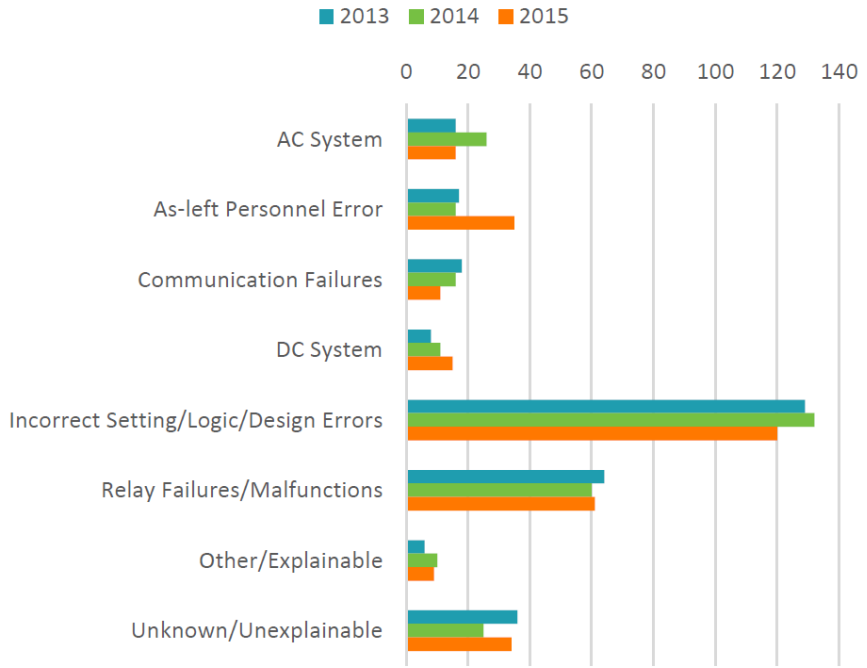
WECC identified issue with unknown transmission outages and protection system misoperations.

Western Interconnection

Transmission Outages

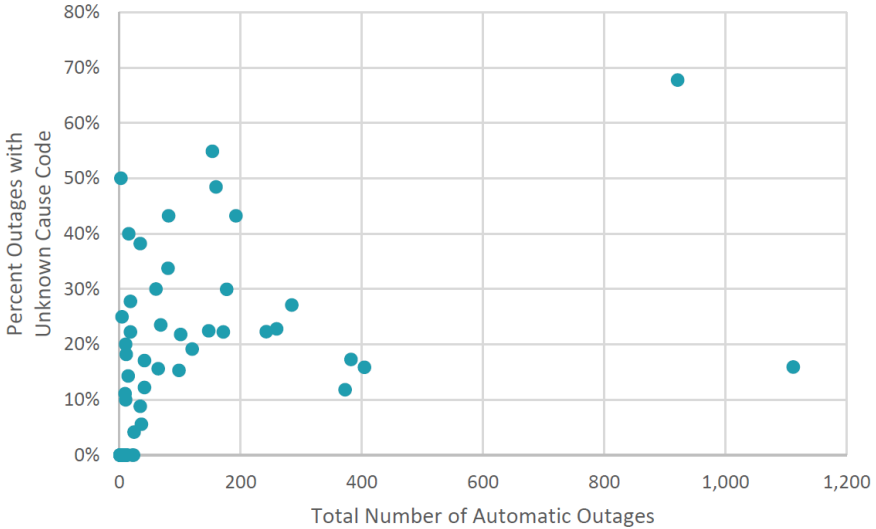


Protection System Misoperations

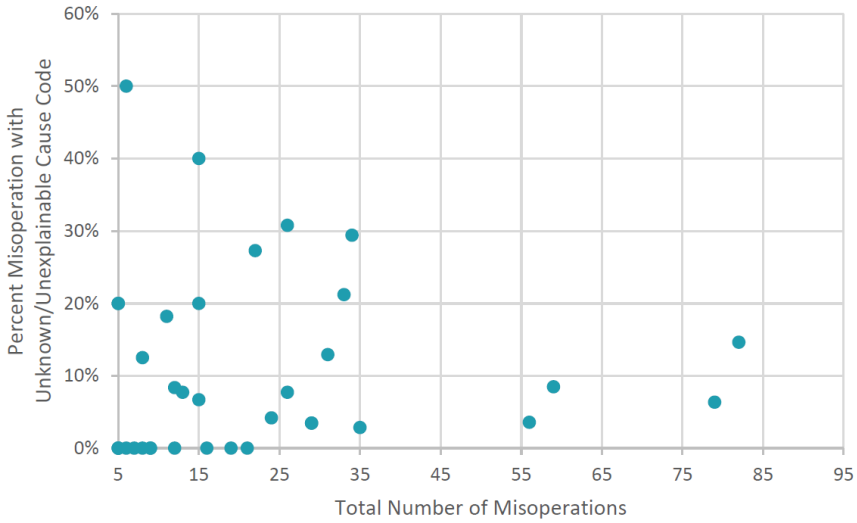


Distribution of Entities

Transmission Outages

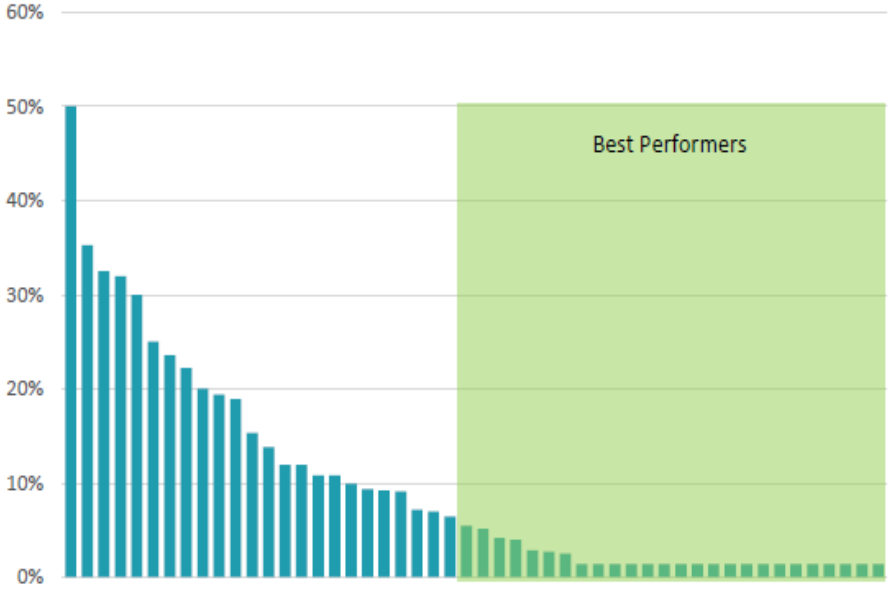


Protection System Misoperations



Best Performers

- AltaLink
- Arizona Electric Power Cooperative
- Bonneville Power Administration
- Comisión Federal de Electricidad
- Imperial Irrigation District
- Pacific Gas and Electric Company
- Platte River Power Authority
- Portland General Electric Company
- Public Utility District No. 2 of Grant County, Washington
- Salt River Project
- Seattle City Light
- Tri-State Generation and Transmission Association
- Tucson Electric Power



Summary of Entities Practices

Organizational Culture
- Attitude that unknown outages are not acceptable
- Focus on using mistakes for training and improvement not punishment
- Pursuit of continuous improvement
- Ownership at all levels within the organization

Process
- Documented, well-defined
- Consistency across all outage types
- Assignment of roles and responsibilities
- Clear communication plans
- Status updates
- Central location for information

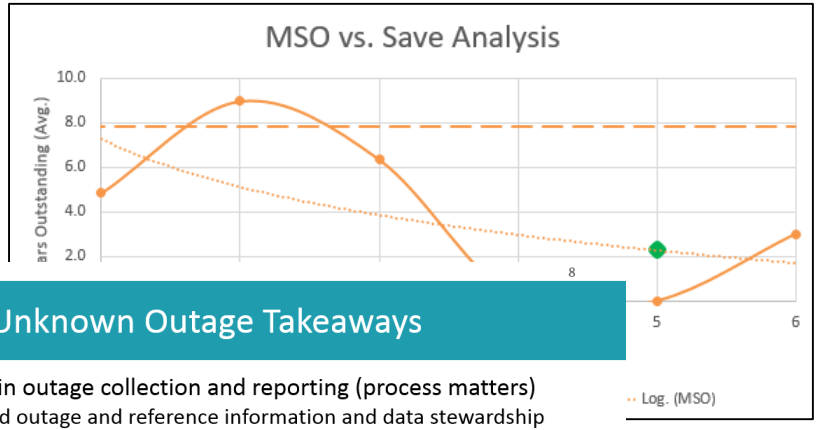
Analytics
- Identify patterns and trends in settings and equipment
- Use data to spot potential system vulnerabilities
- Create and share lessons learned
- Incorporate analysis into company performance metrics and strategic goals

Management Involvement
- Management involved in process
- Accountability for process spread across multiple departments
- Incentive programs to encourage employees to provide quality contributions
- Commitment of resources

18 practices across 4 themes

Webinar Series

- Session 1: Process and Documentation
  - Bonneville Power Administration
  - AltaLink



Unknown Outage Takeaways

- Consistency in outage collection and reporting (process matters)
  - Centralized outage and reference information and data stewardship
  - Common outage guidelines
  - IEEE standard outage metrics (SAIFI,SAIDI)
- Shared Accountability (everyone has a responsibility in the outage process)
  - Centralized database allows for trouble report completion rates by organization and by organizational headquarter (competition/shame)
- Unknown outages need not be scrutinized to have below average unknown outage rates

WESTERN ELECTRICITY COORDINATING COUNCIL

Webinar Series

- Session 2: Outage Analytics
  - Portland General Electric
  - Tucson Electric Power

WECC

Portland General Electric Presentation

David Beach, Protection Operations and Planning Engineer

Operations are Explainable - PGE

- Operations are Explainable
  - A mindset change from the “well, it reclosed” era.
  - A core belief that we now have sufficient data from the field and a sufficiently accurate system model to understand why every relay did what it did.

Operations are Explainable - PGE

- Data
  - Relay events; all relays trigger for their own trips and ‘B’ relays have voltage triggers – dispersed DFR.
  - System “fault” model is a protection model.
    - Extensive revisions to Z0 and mutual coupling
    - All transmission relays modeled
    - Loads imported from PI
    - Line susceptances included to model charging current

Operations are Explainable - PGE

- To a large extent this is a generational “passing of the baton” type change.
  - On June 5, 2011 PGE’s Faraday-Molalla 57kV line trip zone 3 (forward) at both end and successfully reclosed at both ends; in-line sectionalizing station failed to close.
  - The “well, it reclosed” crowd within the group dully noted the trips and the zones; and then on to the next event.

Operations are Explainable - PGE

- The “everything is explainable” group dug deeper and realized that it was the fifth of five lines that connected a generation area to the rest of the system. The line was significantly overloaded, but there was no fault.
- Situational awareness helps.

Operations are Explainable - PGE

- The actually story behind the trip turned out to be far more interesting than the simple recitation of operations.
- Enough relay events available to show significant over frequency followed by decay to 45Hz prior to final unit trip.

Operations are Explainable - PGE

- The faults them selves may never be explainable
  - On August 8, 2016 PGE had a fault on our North Marion-Sullivan 57kV line.
  - Relay fault location and customer calls of “flash seen” gave a good location, but ground and aerial patrols found nothing.
  - A bus lockout also tripped, a clear misoperation.

Operations are Explainable - PGE

- The fault became a given, it happened and had characteristics as recorded by the relays.
- That the fault cause remains unknown does not prevent a thorough analysis of the associated misoperation.
- It is not necessary to know why the fault currents/voltages exist, just how the relays respond to those currents/voltage.

Operations are Explainable - PGE

- The attitude that all is explainable is the result of not knowing better.
  - Prior generations had to live with what might now be considered to be an incomprehensible lack of information. Electromechanical relays tended not to reveal much.
  - New generation came of age as the available information began to greatly expand, making it possible to dig out answers for most operations and the rest became a challenge to be overcome.

Operations are Explainable - PGE

- Company culture
  - This was a changing of the guard type transition. For a few years there were often two parallel investigations, often with different levels of detail and resolution.
  - Current management began the transition, so management acceptance is total.

Operations are Explainable - PGE

- The Model Wins:
  - On 12/7/2015 a 115kV fault in the McMinnville, Oregon, area on an adjacent system was not properly interrupted, one breaker was slow to clear.
  - Fault conditions simulated in the model – breaker at non-SCADA station on 57kV predicted to have tripped and reclosed.
  - Trip counts confirmed breaker operation.

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Outage Cause Investigation Process
Tucson Electric Power

Thomas Mills

Manager, Transmission and Distribution Operations

History

- TEP investigates all 138kV and above outages.
  - Process started in 1986
  - All relay actions are investigated
  - Operations are analyzed for proper operation
  - Corrective measures are identified if required
  - Report generated and sent to all shareholders

Notification Process

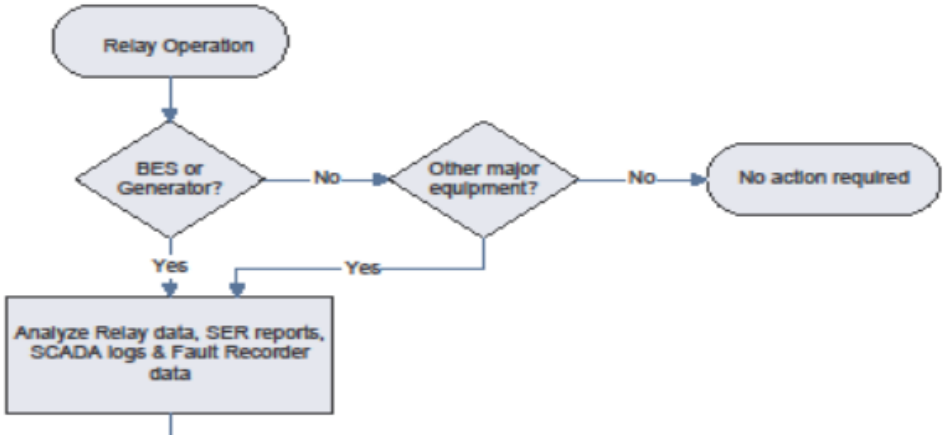
Transmission System Operator puts outage in “Daily Notes” report.

Relay Engineering follows their process to investigate all relay actions.

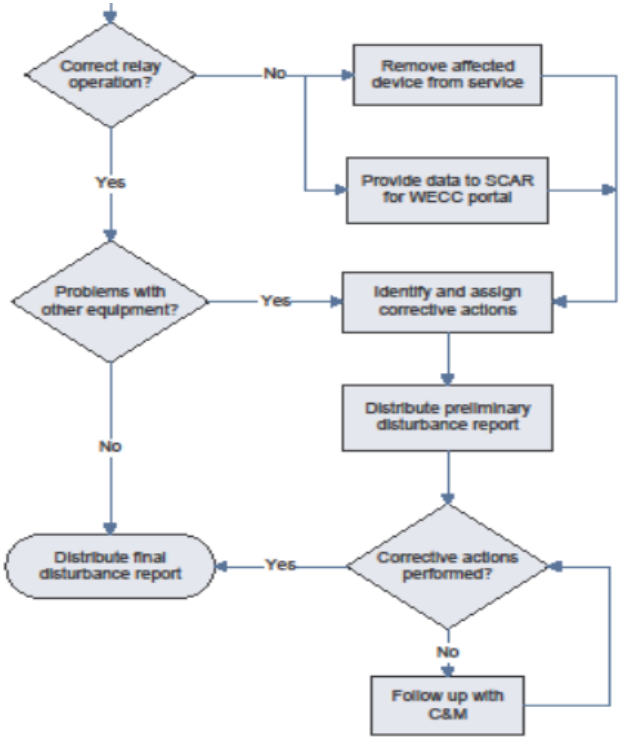
Investigation Process

Ref: PRC-004-1 R1

PCAM Disturbance Report Flow Chart



Investigation Process Continued



Tools

- Relay Data
- Sequential Event Recorder
- SCADA Logs
- Fault Recorder
- Lighting Detection Network
- Eyewitness Accounts
- Database of past outages

Database

- TEP has an extensive Access database of outages dating back to the late 1980's
- Database lists location, weather, fault type , cause
- Database can be referenced to determine trends and to help find root causes.

Report

February 9, 2017
Engineer: K. Peck
Report No. D1353 Final

ELECTRICAL ENGINEERING
PCM DISTURBANCE REPORT

I. Brief Disturbance Description

Springerville – Vail 345 kV trip disturbance at 1423 on August 3, 2016

A.

Stations Involved	Lines	Circuit Breakers
Springerville	SP-VL	SP360, SP362

B.

Operations Line	Fault Type	Equipment/Protective Relay Operations Correct	Incorrect
SP-VL	None		Springerville: Power Line Carrier (PLC)

C. Approximate Weather Conditions: Storm and lightning activity near Springerville

II. Brief Analysis of Events

An intense lightning storm near Springerville caused the PLC unit at Springerville to sense a false ½-cycle duration direct transfer trip (DTT) signal from Vail. The PLC unit operated resulting in a single-ended trip at Springerville. Systems restored the line at 1425.

Report continued

III. Corrective Measures

- The PLC manufacturer, RFL, analyzed the PLC event data and recommended that the pre-trip timer setting should be extended. This correction has been implemented. RFL stated that this type of misoperation is rare and extending the timer setting should prevent a repeat occurrence.
- The PLC unit at Vail was also found to have bad in-line tuner capacitors. These capacitors failed previously and were replaced with temporary locally-obtained parts. Capacitors were ultimately obtained from the tuner manufacturer and these were used to replace the failed temporary units. The PLC was returned to service and has been operating properly since.

IV. Fault Duty

Breaker(s)	Fault Level (Amps)
SP360, SP362	518 A (Load)

Distribution:

Transmission; Transmission Planning; Engineering Metering & Protection; Stubbs, Cary; Grisby, Makeba; Thumm, Randy; Ojeda, Ernesto; Taylor, Jim; Mills, Thomas; Dickerson, Scott; Falkenstine, Mark; Coronado, Hector; Bailey, Shelly; Varner, Keith; Vos, Richard; Belval, Ron; Peru (Hernandez) Amanda; Malone, Ronald; Wildman, Greg; Wagner, David; Robinson, Larry; Quintero, Daniel; Bustamante, Ana; Bryner, Clark; Orona, Christopher; Kaplan, Stephen

Follow up

- If a root cause cannot be identified a line patrol will be scheduled.
- All equipment that has mis-operated will be removed from service.
- Follow up on corrective actions.

Questions

Session 3: Management Involvement

Tuesday, February 28, 2017 10-11 a.m. MT

Recordings:

Session 1
https://wecc.webex.com/wecc/ldr.php?RCID=3f0fd83beeb75df7a3352fcc92ee9b4e

Session 2 – Pending

Registration questions: Marshelle Butler (801) 819-7693 mbutler@wecc.biz

Webinar content questions: Maggie Peacock (801) 819-7621 mpeacock@wecc.biz