NERC Lessons Learned

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Insulator Flashovers Due to Combination of Salt Spray Deposits Followed by Light Rainfall Initiating Loss of Load

Transmission Facilities

August 6, 2021

Problem Statement

- Parallel insulators in a bulk power substation exposed to salt spray during a tropical storm
- Flashed over two and a half days later when light rain began to fall
- Flash overs were attributable to dry band arcing
- Relay misoperations in the presence of the flashover faults resulted in loss of load

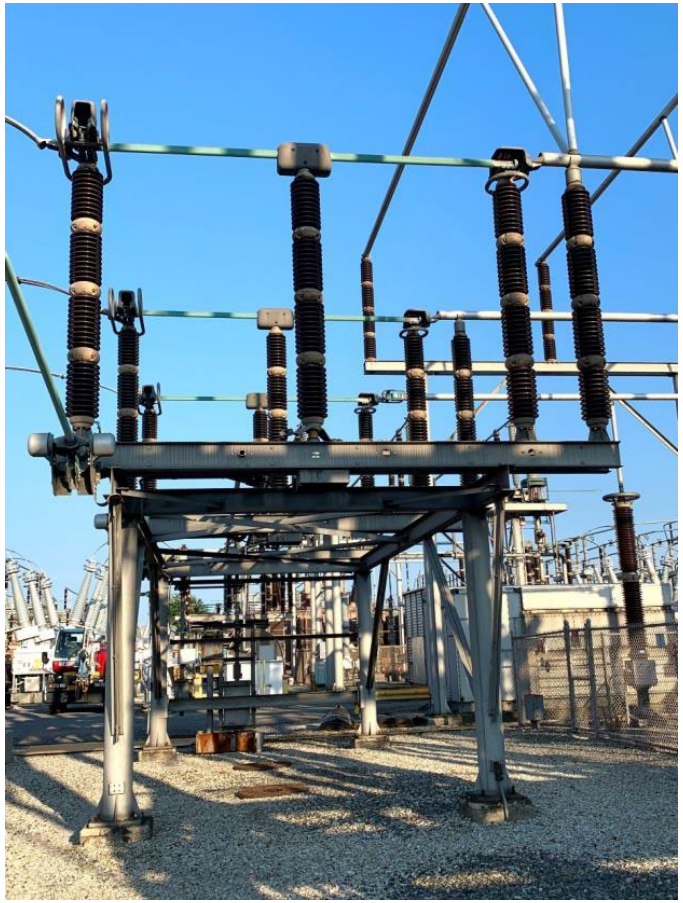

Figure 1: 345 kV Disconnect Switch w/Center-Pivot Horizontal Swing Arms [1]

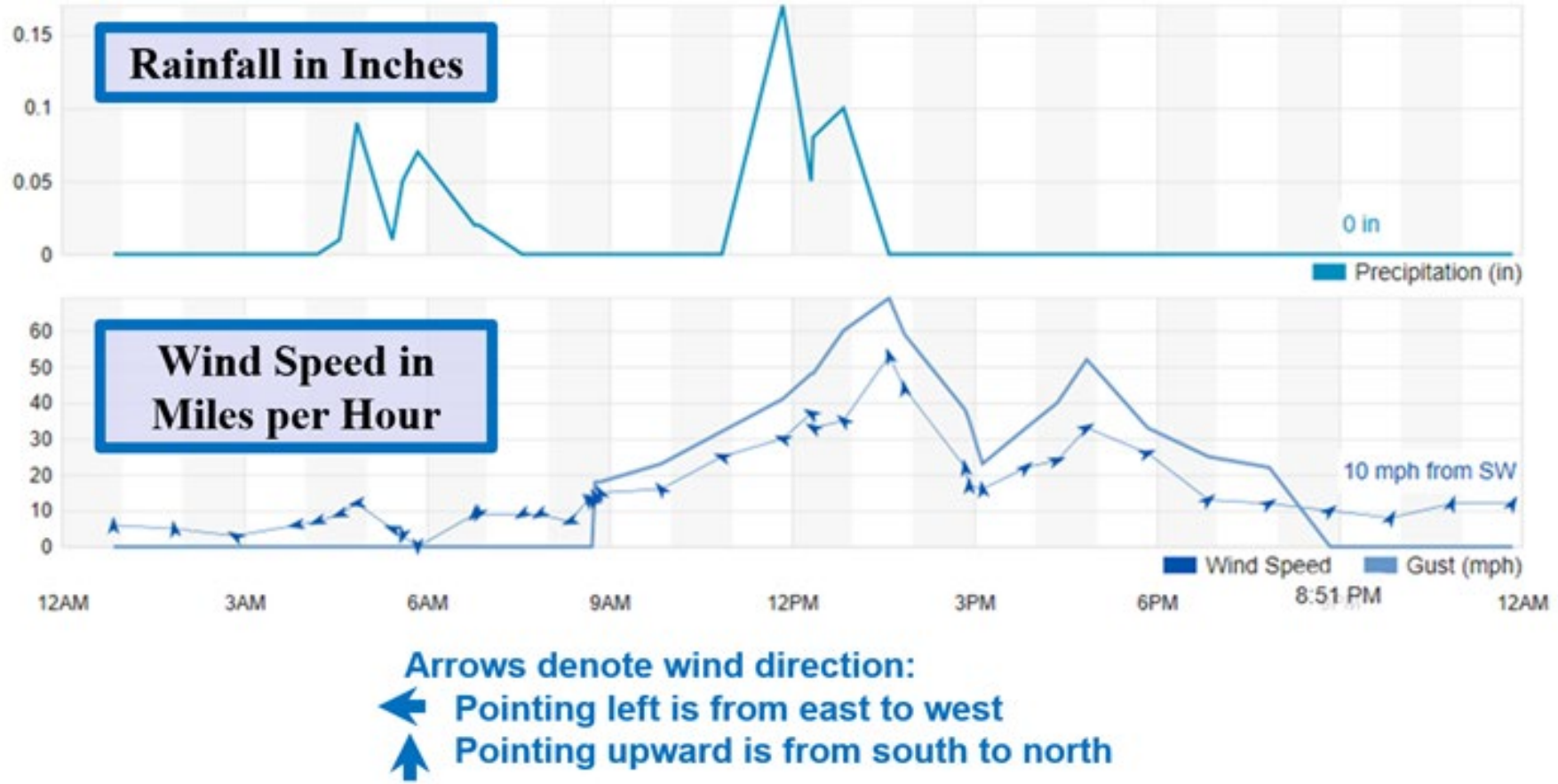

Figure 2: Rainfall, Windspeed, and Wind Direction During Tropical Storm [1]

Corrective Actions

- Substation has been in service for 56 years
- Never experienced simultaneous column insulator flashovers
- None of the other waterfront substations of similar design in the entity's service territory have experienced this type of problem
- Leakage current detectors are being installed on selected insulator columns so that the phenomenon can be tracked and trended over time

Lessons Learned

- During inclement weather, an unusual combination of strong winds, high tide, and absence of rain can cause airborne salt spray to deposit in surfaces, leaving a dry film
- Wetting of that film during subsequent rainfall, even days later, can wreak havoc with the overall dielectric withstand capability of insulator columns
- The probability of flashovers is significantly increased where parallel columns are used as arcing on one column can jump across and meet up with arcing on the adjacent column
- The event described in this Lesson Learned was driven by a more rapid contamination process than generally considered for scheduled insulator cleanings

Multiple Faults in Rapid Succession Contribute to Relay Misoperations Leading to Loss of Load

Relaying and Protection Systems

August 6, 2021

Problem Statement

- Four separate faults and relay misoperations occurred in rapid succession as a result of weather-induced salt contamination
  - A breaker failure relaying scheme incorrectly registered one breaker closed and tripped bus/line
  - A back-up relaying scheme used to protect a PAR did not have a proper polarizing source
  - Saturation of an auxiliary CT caused inaccurate input to a line differential relaying circuit, resulting in tripping of line
  - Overreaching of the Zone 1 ground distance elements occurred in the stepped distance relaying scheme
- Relay misoperations during faults resulted in load loss

Corrective Actions

- The breaker failure scheme comprised of current sensing to determine if the breaker has opened and a separate timer will no longer be used going forward
- The PAR protection has been corrected by installing the proper polarizing source
- The faulty aux CT that saturated has been disconnected. The approach has been modified to eliminate the need for the aux CT
- The zone one elements of the stepped distance back-up relaying on the underground pipe-type cables have been put on standby to be armed only when the communications used by the line current differential relaying are unavailable

Lessons Learned

- Interconnecting old and new protective relays can introduce unforeseen problems
- Current sensing elements used to determine if circuit breakers have opened when called upon to trip may be subjected to repeated pickup and dropout if loading levels fluctuate around the setpoint
- Multifunction microprocessor relays offer a variety of protective elements and schemes
- Aux CTs permit compensation of differential relaying to remove sources of imbalance

Loss of Monitoring or Control Capability due to a Software Version Mismatch

Communications

August 6, 2021

Problem Statement

- A couple of entities have experienced energy management system (EMS) outages due to a software version mismatch between the product development system (PDS), quality assurance system (QAS), and production system (production)

Details

- Case 1:
  - The entity performed front-end processor (FEP) database maintenance on the PDS and then applied that database to the QAS and then production. After an FEP database validation on production, the entity lost the ability to monitor and control its BES elements remotely
- Case 2:
  - A SCADA engineer made a minor change to an FEP database on production and executed an FEP database validation after which the FEP stopped scanning the remote terminal units

Corrective Actions

- Case 1:
  - The entity contacted the SCADA/EMS vendor and initiated a full FEP build on production
- Case 2:
  - The entity contacted the SCADA/EMS vendor and manually updated the version in the FEP database followed by a full FEP build on production. The entity updated all the production and backup SCADA servers at the primary and the backup control center with the new version that matched the one installed on the PDS

Lessons Learned

- Entities should work with SCADA/EMS vendors to review and build patching procedures and database maintenance processes
- Checking the software version across all the entity's systems (PDS, QAS, and production) is paramount during database maintenance
- Any database changes requiring FEP/SCADA validation should not be made on production directly

References

[1] Insulator Flashovers Due to Combination of Salt Spray Deposits Followed by Light Rainfall Initiating Loss of Load

https://www.nerc.com/pa/rrm/ea/Lessons%20Learned%20Document%20Library/LL20210801_Insulator_Flashovers_Initiating_Loss_of_Load.pdf

[2] Multiple Faults in Rapid Succession Contribute to Relay Misoperations Leading to Loss of Load

https://www.nerc.com/pa/rrm/ea/Lessons%20Learned%20Document%20Library/LL20210802_Multiple_Faults_Contribute_to_Relay_Misop_Load_Loss.pdf

[3] Loss of Monitoring or Control Capability due to a Software Version Mismatch

https://www.nerc.com/pa/rrm/ea/Lessons%20Learned%20Document%20Library/LL20210803_Loss_of_monitoring_or_control_software_version_mismatch.pdf

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