Protection System Reliability
(NERC Technical Paper)

FERC Order 754 Discussions – Washington DC

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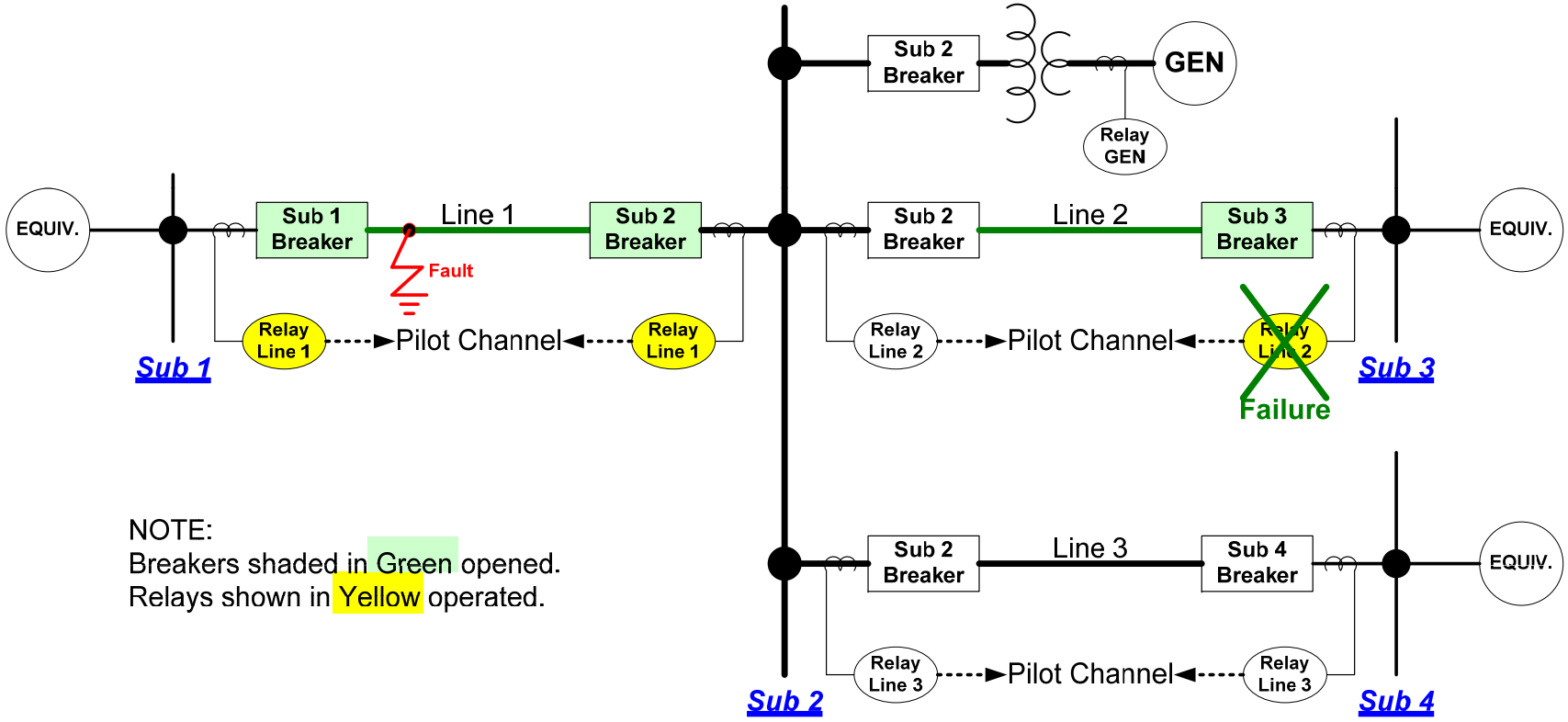
Jonathan Sykes
NERC System Protection and Control Subcommittee - Chairman

Background

- Provides a detailed method to design Protection Systems that operate and clear faults within the required clearance time to satisfy the proposed performance requirements
- Addressed in earlier Standards as C and D (Not B)
- Lack of Redundancy has been contributory cause of outages
  - 2004 – Westwing
  - 2007 – Broad River
  - 2008 – PacifiCorp East
- Bring the Planner and Protection Engineer together

Redundancy
Redundancy means that two or more functionally equivalent Protection Systems are used to protect each electric system element. Redundancy can be achieved in a variety of ways depending on the performance required and the infrastructure available.

Protection System Failure - Security

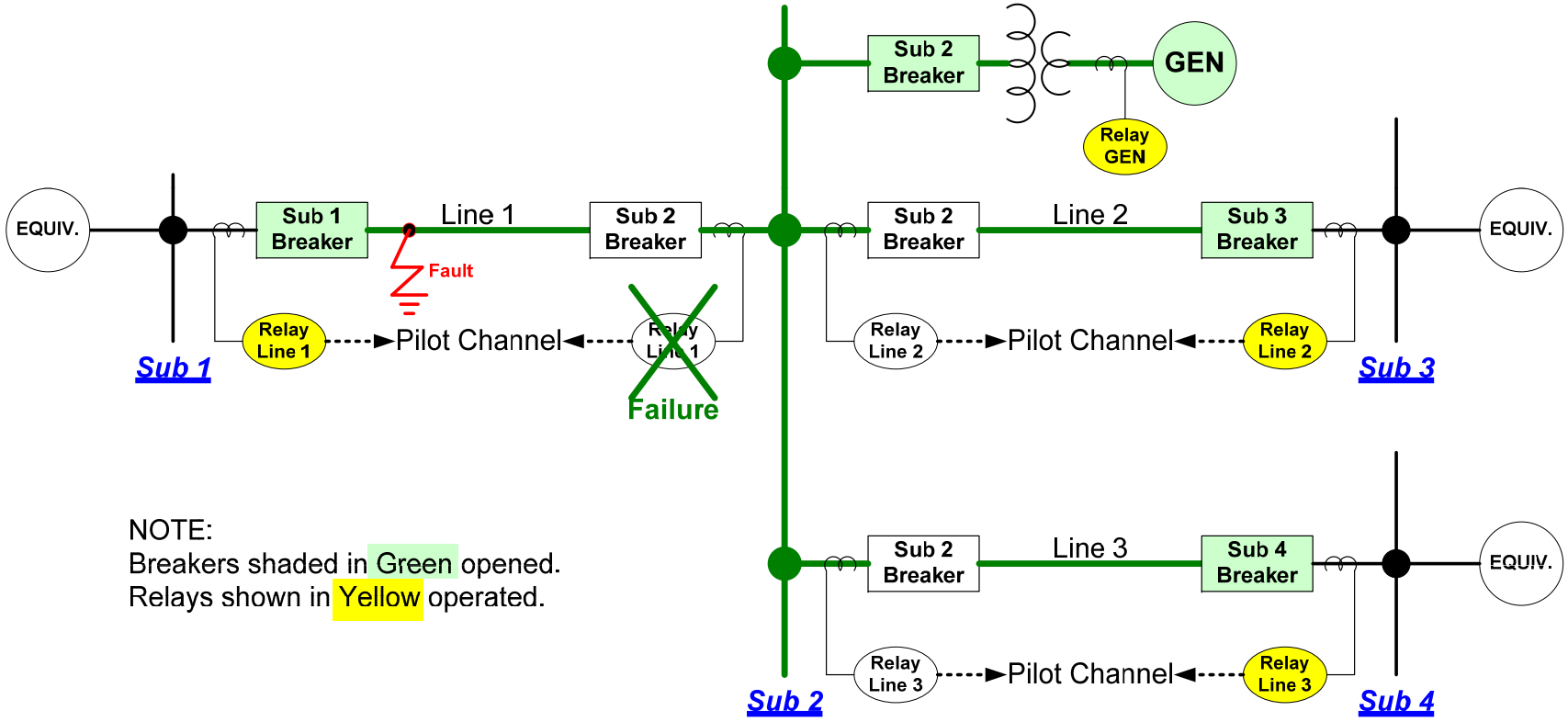


Security

Is the degree of certainty that Protection Systems will not operate incorrectly.

Security Type failures and misoperations generally do not have significant impact to the electric system.

Protection System Failure - Dependability



Dependability

Is the degree of certainty that Protection Systems will operate correctly.

Dependability Type failures and misoperations can have significant impact to the electric system.

PS Failure and Delayed Clearing

- Normal Clearing
  - Protection System Operates per design
  - Only the faulted element(s) is removed from service
- Breaker Failure or Stuck Breaker
  - Predictable Consequences and Times
- Delayed Clearing (Dependability)
  - Times can vary with type of Protection System failure (Not just Zone 2 time)
  - Remote Clearing can be more extensive than BF

Protection System Components

- 1997 Standards
- NERC Glossary of Terms (11/19/2010)
  - Protective relays which respond to electrical quantities
  - Communications systems necessary for correct operation of protective functions
  - Voltage and current sensing devices providing inputs to protective relays
  - Station dc supply associated with protective functions (including batteries, battery chargers, and non-battery-based dc supply), and
  - Control circuitry associated with protective functions through the trip coil(s) of the circuit breakers or other interrupting devices.

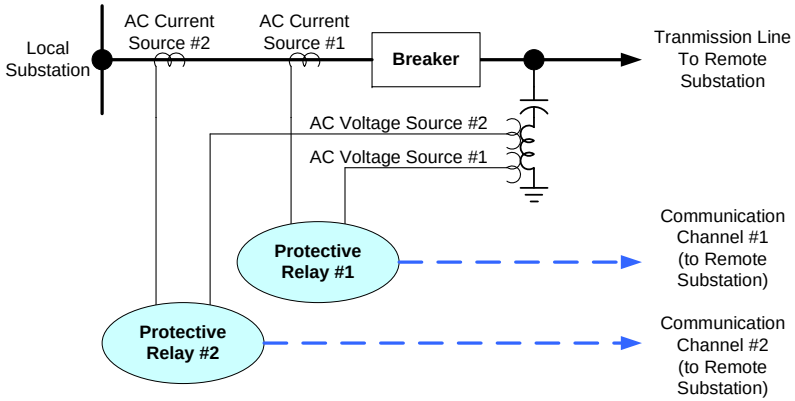
Methodology

- Determine Redundancy of the Protection Systems
- Ascertain the Performance of the Protection Systems
- Compare Protection Systems performance with electric system performance requirements in the TPL standards
- Mitigate all performance shortfalls

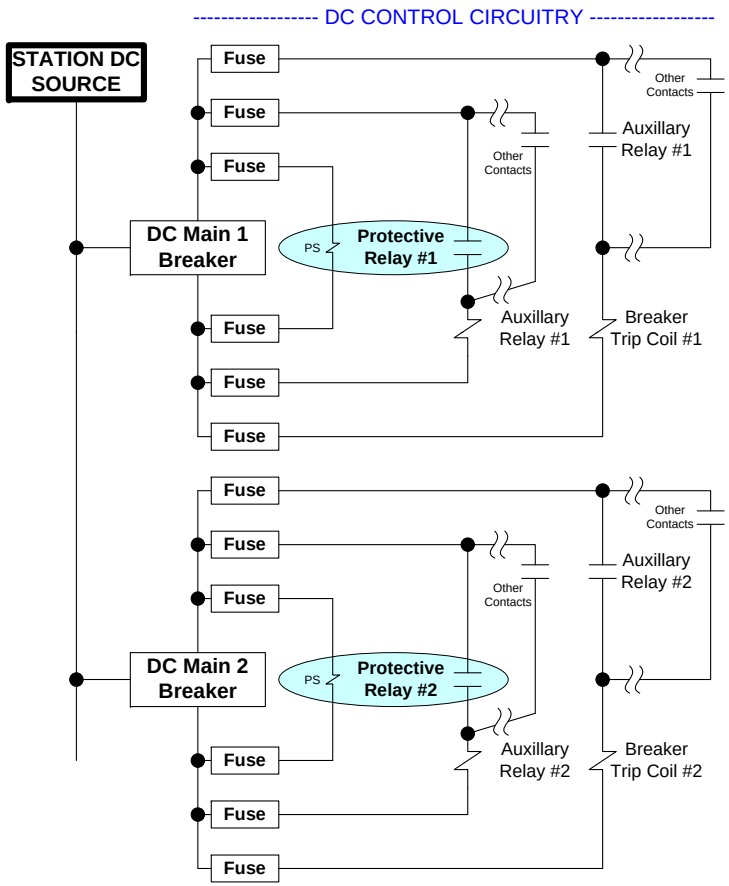
Determine Redundancy of the PS

Full Redundancy of PS Components

If all components of the Protection System are redundant then no action is needed.



SIMPLIFIED ONE LINE

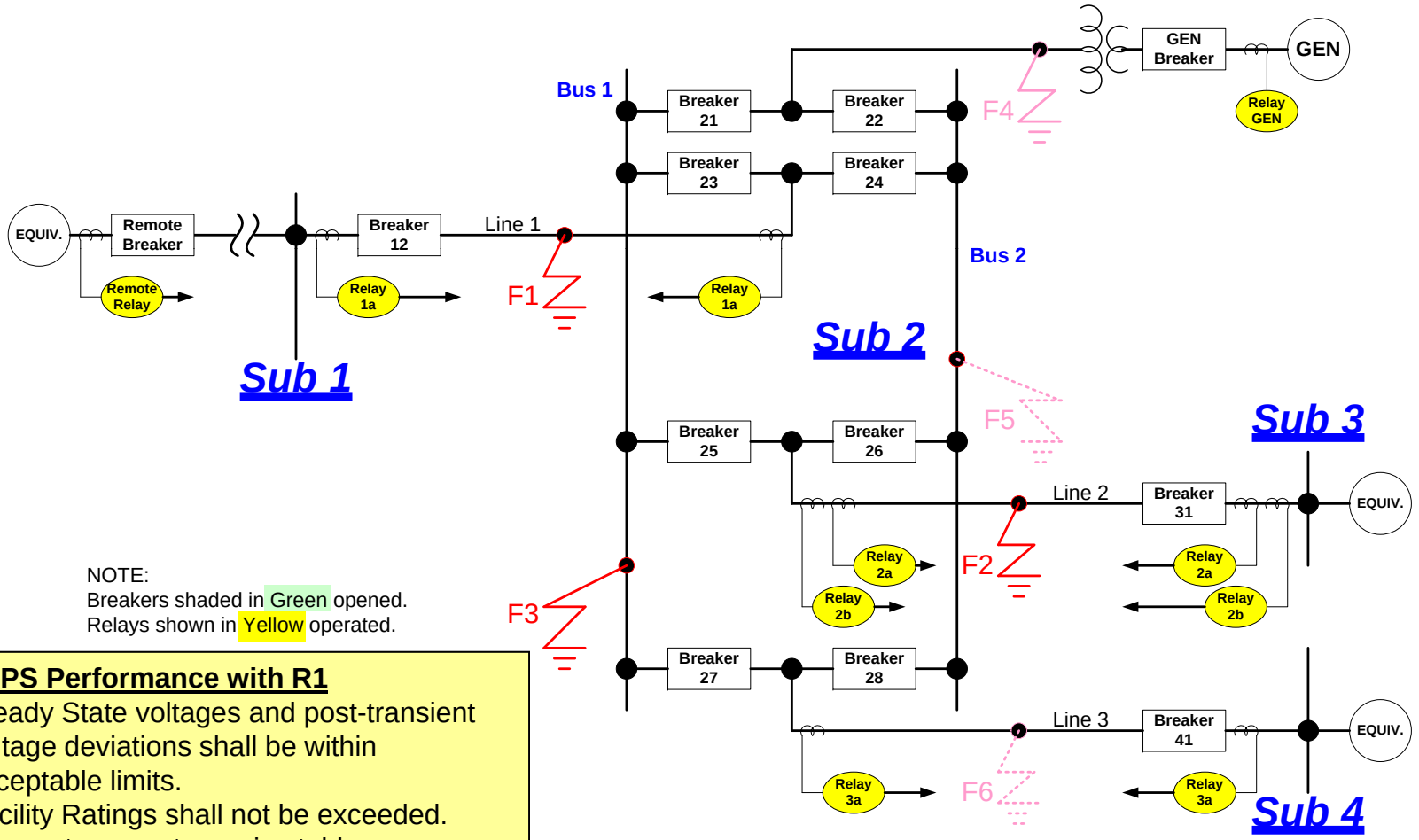


SIMPLIFIED DC SCHEMATIC FOR RELAY AND BREAKER

Components of a Protection System

AC Current Source, AC Voltage Source, Protective Relay, Communication Channel, DC Circuitry, Aux Trip Relay, Breaker Trip Coil, and Station DC Source.

Ascertain the Performance of the PS



NOTE:
Breakers shaded in Green opened.
Relays shown in Yellow operated.

Compare PS Performance with R1

1. Steady State voltages and post-transient voltage deviations shall be within acceptable limits.
2. Facility Ratings shall not be exceeded.
3. The system must remain stable.
4. The protection system must not trip system elements beyond those associated with the designed backup protection.

Summary

- Provides a detailed method that Planners and Protection Engineers can use to identify performance gaps and increase reliability.
- Transmission Planners model scenarios and measure system performance and Protection Engineers design protection systems to meet performance requirements.
  - If system performance falls below the appropriate TPL requirements, then Transmission Planners and Protection System engineers must work together to find and implement the most effective solution

Questions?