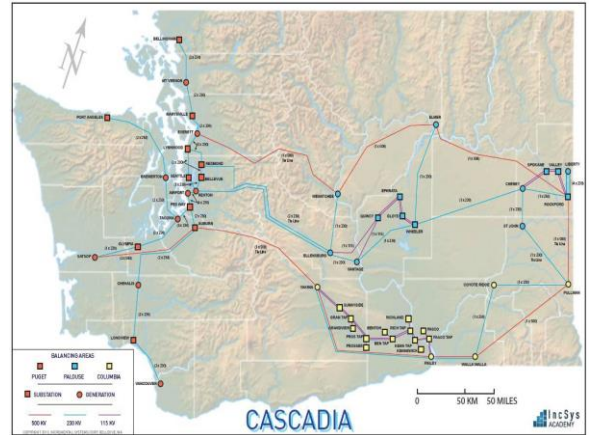


# Managing a Bus Outage

This is a computer-based training module which consists of a video lecture and two simulation exercises. Students watch a video lecture explaining bus configurations and bus outages. The instructor discusses the causes and conditions of both planned and forced bus outages. Using one-line station diagrams, the instructor provides explanations of Double Breaker, Main and Transfer, Breaker and Half, and Ring Bus schemes and the advantages of each scheme and how a bus outage in each could affect load and transmission elements. Students perform a simulated exercise where they respond to two types of outages at a main and transfer substation while reviewing the applicable NERC TOP-001 requirements, and operating limits, and definitions for System Operating Limit (SOL) or Interconnection Reliability Operating Limit (IROL). Students will set up the proper displays for running the system as a transmission operator and identify equipment transmission equipment and substations configurations on the simulator station one-line displays. They will also respond to the contingencies by making the correct reports to the Reliability Coordinator placing the system into a secure state. Students will use contingency analysis to help determine the severity of the fault and any SOL or IROL violations and whether their actions have resolved any SOL and IROL violations while developing switching plans to return equipment back into service. In the second exercise the students will experience contingencies that affect a breaker and half scheme and they will apply a fault to a transmission line and then apply a fault to a bus, observing the results and comparing the effects of each. While one bus in a breaker and half scheme is out of service, students apply faults on other transmission elements to observe the effect.



## Cascadia 4060 Course Objectives

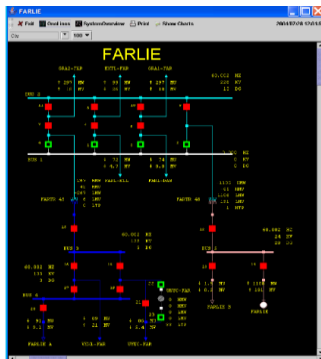
### Managing a Bus Outage

COURSE CE HOURS		
OT	STD	SIM
2.5	1.5	2

- Identify typical bus schemes, including breaker and half, double breaker, single bus, main and transfer, and ring bus configurations on system reliability.
- Identify how bus outages can affect system reliability & Identify the unique characteristics of each bus configuration.
- Identify elements of a Main & Transfer Bus Scheme.
- Simulate the impact of a Bus Fault on a Main & Transfer Scheme with Bus Tie Breaker configuration.
- Assess the system conditions and identify SOL violations following the outage of a Main Bus in a Main and Transfer Scheme.
- Run Contingency Analysis to determine if there are any IROL violations and identify the next most harmful contingencies.
- Develop and implement a Corrective Action Plan for alleviating the SOL violations with a system reconfiguration that avoids the need for generation redispatch.
- Apply a Corrective Action Scheme for the SOL violations associated with a Bus Fault on a Main & Transfer Scheme with Bus Tie Breaker configuration.
- Reconfigure a main and transfer station so line loading is lowered to within the emergency rating limits within 5 minutes following a bus outage.
- Observe and confirm how single line faults with a cleared bus in a breaker and half configuration can cause secondary outages of equipment in the same bay
- Apply a line fault to a fully functioning breaker and a half scheme.
- Observe the lack of substantial system disturbance resulting from the fault & Apply a line fault to a compromised breaker and a half scheme.
- Observe and record the secondary disturbance resulting from the fault.
- Repeat contingency analysis for a range of line faults & Predict the effects of faults on breaker and half schemes under different conditions.

### Breaker and Half Scheme

- Devices normally connected to Bus 1 do not cause added outages:
  - Farlie 230:138 kV Transformer
  - Farlie-Ells Line
  - Farlie-Dawson Lin
- Isolated by opening center breakers.
- Devices connected to Bus 2 cause secondary outages:
  - GRA1-FAR > FARTR45
  - EXTL-FAR > FARL-ELL
  - GRA1-FAR > FARL-DAW



### Double Breaker Configuration



**NERC**  
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

IncSys & NERC ID: INCSYS\_001 is recognized by the North American Electric Reliability Corporation as a continuing education provider who adheres to NERC Continuing Education Program Criteria