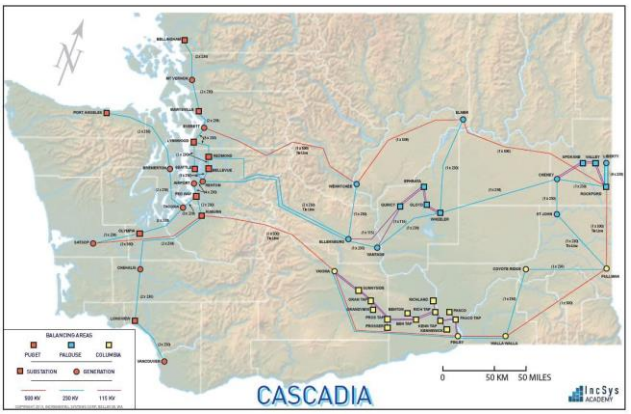
Pole & Beam Analogy



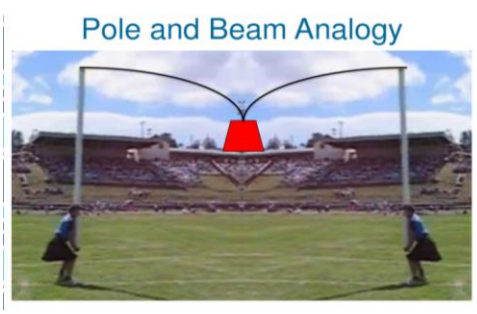
This is a computer-based training module which consists of a blend of a video lecture and simulations to instruct students on the Pole and Beam analogy to explain voltage control on networks. Students will view a video lecture explaining the fundamentals of MW and MVArs and what techniques are available to operators when controlling voltage on the system. Students apply what they have learned through two simulation exercises where they operate a hypothetical network. Students will view a video lecture on the fundamentals of voltage and MVArs in a power system and students are introduced to the pole and beam analogy that describes the interaction of line length, capacitors, reactors, and generators in a network to explain how voltage and MVARs behave. Students learn which transmission elements will cause the voltage profile to rise or sag. Using the analogy, students learn how to anticipate MVAR deficiencies and predict over and under voltages on a hypothetical network. Students perform an exercise using an online simulation of a hypothetical network while acting as a Transmission Operator, students perform operations according to NERC standards, and learn how to apply the standards from VAR-001, TOP-001 and IRO-009. During the exercise, students experience a bus outage on a radial part of the system causing low voltage. Students run the contingency analysis program to identify SOLs and IROLs, then identify corrective action to remove the violations. Students respond the contingency by bringing online more generation and returning equipment to service. Students calculate the correct amount of load shed and take that action. Students perform an exercise using an online simulation of a hypothetical network. Acting as a Transmission Operator, students perform operations according to NERC standards, and learn how to apply the standards from VAR-001 and TOP-001. During the exercise, students receive a circuit breaker SF6 low pressure alarm. Students respond by removing the breaker from service. A following wind storm event causes multiple faults on the system and students use displays and the alarm log to identify the effected lines and busses. Students run the contingency analysis program to identify SOLs and IROLs, then identify corrective action to remove the violations. Students record and monitor voltage as they remove capacitors and return transmission lines to service. Students review their actions and how the pole and beam analogy apply to the scenario.

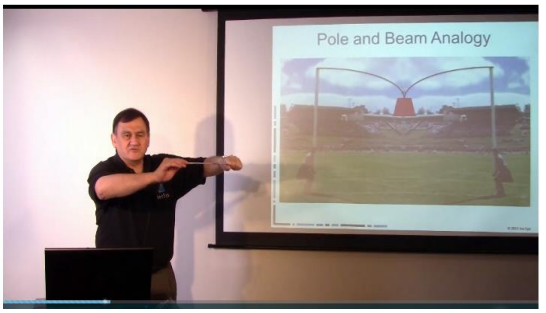
Cascadia 5040 Course Objectives

Pole & Beam Analog

COURSE CE HOURS		
OT	STD	SIM
2.5	2	2

- Use pole and beam analogy to predict the behavior of voltage and MVArs in networks
- Apply the analogy to anticipate MVAr reserves, identify weak busses, and bus voltages
- Identify how bus voltages will vary as capacitors, inductors, and MW loads are added and removed from the network
- Identify signs and causes of voltage collapse
- Define MVAR reserves and identify signs that reserves may be deficient
- State conditions that can cause severe over voltages in a network
- Respond to a severe wind storm event with multiple outages.
- Identify the equipment that has been removed from service.
- Recognize the conditions for potential voltage collapse in a radial power system without contingency analysis.
- Identify the contingencies that cause IROL violations due to voltage collapse.
- Manually shed sufficient load to remove all IROL violations.
- Manually shed load additional load to restore voltages to normal operating limits.
- Identify best options to restore outage equipment, so that manually shed load can be returned to service.
- Respond to a wind storm event with multiple outages.
- Identify the equipment that has been removed from service.
- Recognize the conditions for extreme over-voltages
- Take corrective actions in a radial power system to restore voltages to normal operating limits.
- Explain the over-voltages in the power system using a pole, beam, and helium balloon analogy.





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