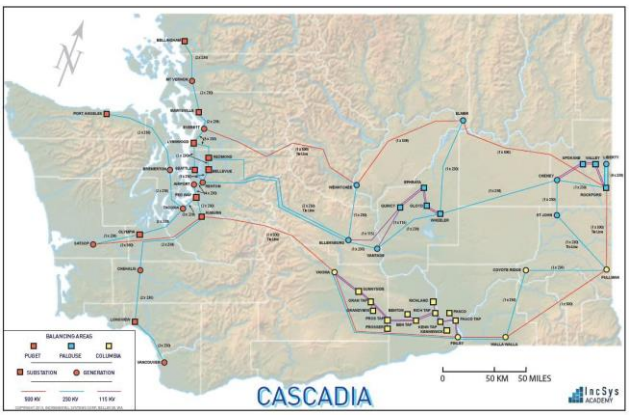
# Reactive Power & Voltage Operating Limits




This is a computer-based training module which consists of three video lectures and a simulation exercise. Students view a video lecture on the fundamentals of real and reactive power where the instructor discusses the role electric fields play in transmission system equipment and the production of reactive power, differentiating inductive reactive power and capacitive reactive power and the devices that provide those sources of MVars. To include explaining the components of power, power factor, and illustrating the real and reactive power triangles. The second video lecture explains the behavior of reactive power as applied to networks where the instructor discusses MVAR sources and MVAR loads within the power system, and describes how operators use those pieces of equipment to maintain voltage. Using diagrams, the instructor explains reactive power flow in relation to voltage, angle, and MW transferred and also discusses the condition of voltage collapse and provides examples of events that can cause low voltage. The final video lecture the instructor stresses the importance of voltage operating limits by illustrating the various causes, effects, and indicators of excessively high or low voltages and also provides real-world examples of voltage contingency limits, required actions and time limits. The simulation exercise engages the students to use various screens, tables, and controls to act as operators of a simulated power system. Working within a small islanded system, the student observes generator behavior as they add reactive load and then energize a line and hey also use transformer data to illustrate the real and reactive power triangle under multiple reactive load conditions.

## Cascadia 5010 Course Objectives

### Reactive Power & Voltage Operating Limits

| COURSE CE HOURS | | |
|---|---|---|
| OT | STD | SIM |
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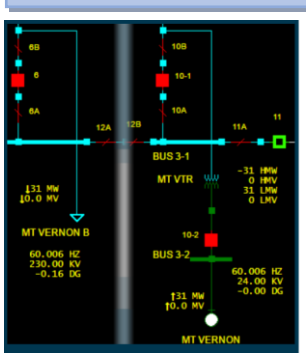
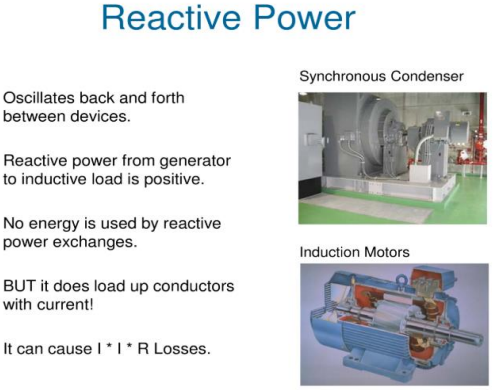
- Describe the need for reactive power
- Describe the difference between real and reactive power and how they vary over time with voltage
- Describe the real and reactive power triangle
- Define power factor
- List Reactive Sources and Reactive Loads
- Describe the MVAR characteristics of transmission lines and how flow changes with angle and voltage difference
- List causes of low voltage and the characteristics of voltage collapse in a radial system
- Describe the impact of high and low voltages on a system
- Describe how voltage limits are applied for a large reliability coordinator)
- On a simulated power system with just one station energized, observe the MW, MVAR and voltage conditions for the generator, transformer and load under three conditions
  - (a) a purely resistive load is served,
  - (b) a load with resistance and reactance is served and
  - (c) a purely resistive load is served and a transmission line is energized
- Log transformer MW, MVAR, and MVA values both before and after adding a capacitive and reactive load. Use the recorded values to draw Real/Reactive power triangles

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