



WECC System Operator Training Transmission Operations – Protective Relaying

Emphasis on this class is on the following aspects of Transmission Operations. **Transmission Operations** is a week-long class, (Monday 1:00 pm – Friday 12:00 pm) that offers each student a total of **30 NERC Continuing Education (CE) Hours**, including six (6) NERC CE hours of NERC Standards and ten (10) NERC CE hours of simulation. Each student will also receive six (6) Emergency Operation (EOP) hours.

Primary Topics include:

- Protective Relaying
 - Introduction to Protective Relaying
 - Purpose & Function of Protective Relays
 - Characteristics of Relay Devices
 - IEEE Numbering Convention for Relay Devices
 - Power System Faults\
 - Instrument Transformers
 - Relay Construction & Operation
 - Types of Relays
 - Transmission Line Protection Systems
 - Substation Equipment Protection Systems
 - Generator Protection Systems
 - Remedial Action Schemes (RAS)
 - WECC RAS #1 Scheme

- Sub-Synchronous Resonance (SSR)
 - SSR & Series Capacitors
 - Resonance Frequency
 - Forms of SSR
 - Example of SSR

- Ferroresonance
 - Definition of Ferroresonance
 - Ferroresonance in a Transmission Substation

- Solar Magnetic Disturbances (SMD's)
 - Sunspots
 - Factors that influence SMD's
 - Impact of SMD's on the Transmission System
 - Controlling the Impact of SMD's on the Transmission System
 - Example of SMD events
 - Role of the System Operator

- High Voltage DC
 - Types of HVDC Systems
 - Components of HVDC Systems
 - Operation of HVDC Systems

- NERC Standards addressing Transmission Operations & Protective Relaying

The following simulation modules, using the PALCO* system, are included in the class. Additional Modules may be added as they are developed to enhance understanding of the covered topics.

- Responding to major system contingencies
- Synchronizing Module

*PALCO is a fictional 29-station power system.

Students will also utilize XCEL guilt simulators exercises for demonstrating & understanding various types of relay protection schemes.

Students will also utilize a Flash Player Synchronizing simulator to demonstrate and practice synchronizing a generator to the system and synchronizing between islanded systems.