

Voltage, Congestion & Special Protection

Overview:

This course is intended to provide system operators with knowledge and operating principles to address voltage and congestion issues that occur when operating the Bulk Electric System. This course is delivered over a 2-day period and includes topics related to Voltage Control Equipment, Voltage Control Concepts, Power Transfers and Limits, Congestion Mitigation Techniques, and Special Relaying Schemes that include UFLS, UVLS, and SPS/RAS schemes. The course also reviews NERC Standards related to Voltage Control and Special Relay Protection.

Target Audience

The target audience includes:

- System personnel that have the responsibility for transmission/generation operations control and special relay operations
- Individuals who desire insight into the challenges of Control Room personnel related to transmission and generation control, in addition to special relay operations

NERC Continuing Education Hours

16.0 CEHs – Total
8.0 CEHs – Standards
16.0 CEHs – Ops Topics
10.0 CEHs – Sim

NERC Emergency Training Requirement

16.0 hours of Emergency Operations

Course Delivery:

The course delivery includes both lecture and simulation activities with a major portion involving interaction with a generic power system simulator.

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Course Content:

Objectives:

- Define voltage control and transmission operation standards
- Identify methods of voltage control
- Identify consequences of improper control
- Identify System Operator Actions to perform voltage control
- Monitor power flow in conjunction with power transfer limits
- Define the various types of limits: thermal, angle stability, and voltage limits
- Utilize system equipment in a system simulator to control congestion on a simulator transmission system
- Identify the various options and techniques for congestion management
- Define standards related to UVLS, UFLS, and Special Protection Schemes
- Define the operation of UVLS and UFLS relay schemes
- Identify results of special protection/remedial action schemes
- Demonstrate the recovery from a UVLS, UFLS, or SPS/RMS activation

Classroom Schedule:

Day 1: 8:00 AM to 5:00 PM (Lunch provided)

AM: NERC TOP/VAR Standards Review
Voltage Control Equipment
Voltage control concepts
Operations Review - Voltage
Voltage Control Exercise

PM: Congestion Mitigation Techniques and Equipment
Operations Review - Congestion
Congestion Management Exercise

Day 2: 8:00 AM to 5:00 PM (Lunch provided)

AM: NERC PRC Standards Review
Undervoltage Load Shed Schemes
UVLS Scenario
Underfrequency Load Shed Schemes
UFLS Scenario

PM: Special Protection Schemes/Remedial Action Schemes
SPS/RAS Scenarios

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Course Outline:

1. TOP and VAR NERC Standard Review
2. Voltage Control
 - a. Reactive Power
 - b. Role of reactive power
 - c. Sources of reactive power
 - d. Principles of operation of reactive resources
 - e. Voltage control equipment
3. Finist Tutorial
4. Voltage Control Equipment Simulation Exercises
 - a. Power Flow Illustration
 - b. High Voltage Exercise
 - c. Generator Impact
 - d. Transformer Taps Impact
 - e. Conductor Impact
 - f. Capacitor Impact
 - g. Reactor Impact
 - h. SVC Impact
 - i. Synchronous Condenser Impact
 - j. Load Impact
5. Congestion Management
 - a. Real Power Transfer
 - b. Role of real power
 - c. Principles of power flow
 - d. Factors that affect active power flow
 - e. Transfer Limitations
 - f. Types of limits
 - i. Thermal
 - ii. Angle stability
 - iii. Voltage limits
 - g. Distribution factors
 - h. Generation shift factors
 - i. Generation resources
 - j. Interchange adjustments
 - k. Non-cost solutions
 - l. Market solutions

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Course Outline (continued):

6. Congestion Management Action Exercises
 - a. Switching solution
 - b. Generation shifts
 - c. Phase Shifting Transformers
 - d. Interchange Schedule Adjustment
 - e. Reactive Adjustments
 - f. Pumped storage Pump/Off-line Generator Operation
 - g. Customer Load - Voltage Reduction
 - h. Customer Load – Load Shedding
7. Voltage control concepts
 - a. Causes of low voltage and high voltage conditions
 - b. Impacts on reliable operation
 - c. Voltage Stability
 - d. Voltage Collapse
 - i. Long term
 - ii. Classical
 - iii. Transient
 - e. Operations Review - Voltage
 - f. Voltage Control Exercise
8. Mitigation Techniques and Equipment
 - a. Techniques to control congestion
 - b. Operations Review - Congestion
 - c. Congestion Management Exercise
9. Relay Protection Schemes
 - a. NERC PRC Standards review
 - b. Undervoltage Load Shed Schemes
 - i. Scheme designs
 - ii. Results of operation
 - iii. Steps for System recovery
 - iv. UVLS Scenario
 - c. Underfrequency Load Shed Schemes
 - i. Scheme designs
 - ii. Results of operation
 - iii. Steps for System recovery
 - iv. UFLS Scenario
 - d. Special Protection Schemes/Remedial Action Schemes
 - i. Scheme designs
 - ii. Results of operation
 - iii. Steps for System recovery
 - iv. SPS/RAS Scenarios

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