



TECHNICAL ENGINEERING COURSES

Voltage Stability

Distribution System Reliability

System Restoration

Long Term Dynamics

Reactive Power Compensation and Voltage Stability

Introduction

Economic and environmental pressures require electric utilities to use available generation and transmission more intensively. Reactive power compensation and reactive power control are cost-effective, short lead time methods to increase transmission capacity. All power system engineers should understand the basics of reactive power compensation.

Related to reactive power compensation is the relatively new field of voltage stability. As power systems mature, voltage instability often limits power transfers and threatens reliability.

High voltage power electronics devices offer new options in power system planning and operation. For example, thyristor-controlled series compensation eliminates SSR problems, allows higher compensation levels, improves system dynamic performance, improves parallel flow control and optimizes loading for loss minimization.

Course Language:

English

Duration:

3 days

Instructor:

Carson W. Taylor

CYME Technical Engineering Courses Program Director:

Dr. Atef S. Morched

Further Information:

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What you will learn

Participants will develop a working knowledge of reactive power compensation, voltage stability, and power system steady-state and dynamic operation.

They will be exposed to methods of improving transmission utilization and reliability. Participants will learn the most important aspects of transmission line compensation and reactive power control. Series and shunt compensation methods will be compared as well as static VAR compensators and mechanically switched shunt capacitors and shunt reactors.

With this background, participants will be introduced to voltage stability analysis and collapse phenomena in planning and operating heavily stressed power systems. Emphasis will be on practical methods to analyze and solve complex and difficult power transfer problems using both conventional and advanced software programs are explained.

Audience

- System planning engineers and system operating engineers who must find ways to remove limits on power transmission.
- Engineers interested in broadening their knowledge of voltage stability and other important power system concepts.
- Decision makers of power system expansion, rehabilitation and enforcement.
- Participation by engineers from several disciplines (generation, planning, operations, distribution, protection) fosters synergies in problem solving.

Course Outline

Day 1

- **Introduction, basic power transmission concepts**
 - Goals of seminar
 - Active power transmission using elementary models
 - Reactive power transmission using elementary models
 - Reactive compensation of loads
 - Introduction to voltage stability—definitions
 - Time frames for voltage instability, scenarios
 - Class problems
- **AC transmission lines**
 - Transmission line parameters
 - Transmission line theory (simplified—lossless case)
 - Transmission line compensation
 - Class problems

Day 2

- **Reactive power compensation and control**
 - Series compensation
 - Shunt compensation
 - Static var systems
 - Thyristor controlled series compensation
 - STATCOM and other voltage sourced converter devices
 - Class problems
- **Power system modeling related to voltage stability**
 - Component loads as function of voltage and time
 - Aggregated loads and distribution feeders
 - Generators and excitation systems
 - Prime movers, prime mover controls, and automatic generation control
 - Class Problems
- **Voltage stability analysis**
 - P - V and V - Q curves
 - Power flow methods and extensions
 - Voltage stability indices, on-line voltage security assessment
 - Optimal power flow
 - Dynamic analysis
 - DC links
 - Class problems

Day 3

- **Voltage instability/collapse incidents worldwide**
 - List of incidents
 - Description of selected incidents, lessons learned
- **Case studies of voltage instability and collapse**
 - Ontario Hydro
 - BC Hydro
 - SVC versus mechanically switched shunt capacitor banks
 - Equivalent system with LTCs and induction motors
 - Concepts of undervoltage load shedding
 - Other case studies
- **Voltage stability reliability criteria and countermeasures**
 - Planning/operating criteria, margins
 - Methods to remove transmission limitations and improve security

Each participant will receive a set of course notes as well as a copy of the book *Power System Voltage Stability*, by Carson Taylor, McGraw Hill, 1994.

Instructor



Carson W. Taylor

Mr. Taylor joined Bonneville Power Administration in 1969 after earning degrees from the University of Wisconsin and Rensselaer Polytechnic Institute. His interests include power system control and protection, system dynamic performance, ac/dc interactions, and power system operations and planning. He is Principal Engineer in Transmission Operations and Planning, where he is currently developing wide-area voltage and stability controls.

Mr. Taylor is a member of the U.S. National Academy of Engineering. He is a Fellow of the IEEE and past chairman of the IEEE Power System Stability Controls Subcommittee. He is a Distinguished Member of CIGRÉ and convenor of three CIGRÉ task forces on power system voltage and angle stability.

He is the author of the McGraw-Hill textbook *Power System Voltage Stability*. The book is translated into Chinese. Mr. Taylor has authored or co-authored many IEEE and CIGRÉ papers.



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