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Course Information Letter ---- OP321

FUNDAMENTALS OF VOLTAGE & FREQUENCY CONTROLS OP321

This Course covers the importance of voltage and frequency in the bulk power system. In order to respond to rapid, unexpected system voltage deviations, we need to carry sufficient reactive reserves to better respond to unannounced voltage fluctuations. In addition to these changing voltages, power system frequency varies due to the constantly changing load. This course is designed to present the day-to-day, hour-to-hour, minute-to-minute changes in system load that result in voltage and frequency deviations from the “scheduled” voltage and frequency. Operations personnel, electrical supervisors and engineers should attend the Voltage and Frequency course.

A **topical outline** includes: Active / Reactive Power, Voltage Deviation & Schedules, Causes and Effect of High/Low Voltage, Voltage Control Equipment, Reactive Capability of Generators, Energy Balance, Governor Control Systems, and Automatic Generation Control.

OBJECTIVES: At the completion of this course the participant will be able to:

1. Define true power and Reactive Power and the relationship between Reactive and Power and Voltage Control.
2. Define voltage deviations.
3. Discuss the causes and effects of high and low voltages.
4. Discuss voltage control equipment available and the role of the power system operator in the control of voltage.
5. Discuss the reactive capability of synchronous generators.
6. Explain the need to match generation to load and describe how the load/frequency relationship and system inertia contribute to frequency control.
7. Explain the principle of governor action and the contribution of generating unit governors to generation control.
8. Explain how the automatic generation control (AGC) system regulates frequency and controls interchange.

COURSE DATES/LOCATION/FEE

For current dates / locations / prices, please see HPC's website, www.hpcnet.com.

Fundamentals of Voltage / Frequency Control OP321

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COURSE OUTLINE

- I. **Power:** True and Reactive Power, Reactive Power and Voltage, Reactive Power Flow
- II. **Voltage Deviations and Schedules**
- III. **Causes and Effects of High/Low Voltage:** Causes of low voltage, Low Voltage and Shunt Capacitor Banks, Excessive Power Flows Across The Power System, Unscheduled Power Flows, Overvoltage, Long Term Overvoltages, Causes of Short Term Overvoltages, Load Rejection, Harmonic Overvoltages, Causes of Transient Overvoltages, Switching Surges, Lightning Strikes, Effects of High and Low Voltage, Effect of High Voltage on Transformers, Effect of High Voltage on Customer Equipment, Effect of High Voltage on Load Magnitude, Effects of Low Voltages, Effect of Low Voltage on Power System Equipment, Effect of Low Voltage on System Load Magnitude
- IV. **Voltage Control Equipment:** Use of Static VAR Compensators, Capacitors and Reactors, Use of Transformers, Role of the Power System Operator, Indication of Voltage Deviations, Responding to Low Voltage, Responding to High Voltage, Voltage Control Summary
- V. **Reactive Capability of Generators:** Excitation Systems, Generator Reactive Capability Curve, Constraints on the Capability Curve, Dynamic Reactive Reserves
- VI. **Energy Balances:** Changing Load, Need For Generation Control, Definition of a Control System, Consequences of Over and Under Generation, The Load Frequency Relationship, Non-Motor Loads, Motor Loads, Power System Inertia
- VII. **Governor Control Systems:** Governor Control System Operation, Governor Characteristic Curve, Isochronous Governor Control, Governors with a Droop Characteristic, Governor Control in the Interconnected Power System, System Frequency Response Characteristic, Frequency Bias, Response to a Loss of Generation, Limitations to Governor Response, Droop Limitations, Responsive Spinning Reserve and Ramp Rate, Blocked Governors
- VIII. **Automatic Generation Control System:** The Automatic Generation Control, Function of an AGC System, Definition of a Control Area, Interchange, Net Interchange (Actual, Scheduled, Inadvertent), AGC System Operating Modes, The Ace Equation, Frequency Bias Constant, Example of Tie-Line Bias Control, External Generation Loss, Internal Generation Loss

FREQUENTLY ASKED QUESTIONS

- Will HPC Technical Services bring this course to our location for our personnel only? YES, call or email Stephen Parker, stparker@hpcnet.com for a price quotation.
- Will HPC Technical Services customize the presentation at our site to suit our particular needs? Yes.
- Is HPC Technical Services' textbook available for purchase as a reference document? Yes, \$95.
- What is the cost for HPC Technical Service to deliver this course at our location? Well, of course that can vary, but generally speaking, if you're planning on having 6+ attend, when considering your T&L, it is to your advantage to perform the course at your plant (office). You gain from the customization and price.
- Can HPC Technical Services provide "Technical Assistance" in conducting functional checkouts or troubleshooting problems? Yes we can. Call or contact Harold Parker, hparker@hpcnet.com for our rate sheets and any further information required.

WHAT YOU WILL RECEIVE:

1. 1 copy of HPC Technical Services' textbook, OP321 [Fundamentals of Voltage/Frequency Control](#).
2. A "Certificate of Completion" with 1.3 CEUs, authorized for issue by the International Associate of Continuing Education/Training.

POWER PLANT OPERATOR CERTIFICATION:

This course is one of the courses required for Power Plant Operator Certification.

Those who attend this course are automatically qualified to take HPC Technical Services' Certification Examination. This examination is offered at no additional expense to the participant. An 80% passing grade is required. The examination length will not exceed 2-hours. Those who complete this examination will receive a revised "certificate of completion" that recognizes this accomplishment along with two-copies of a "To Whom It May Concern" letter that states their accomplishment. (Two copies are provided, one for the participants' employer and one for the participants' personal file.) Consult HPC's website, www.hpcnet.com, for detail on this certification program.

RECENT SATISFIED CLIENTS:

Allegheny Power, Calpine Corporation, New York Power Authority, Omaha Public Power District, Power Industry Consultants, Rochelle (IL) City of, Simkins Industries, US Army Corps of Engineers, US Bureau of Reclamation

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INSTRUCTOR (S):

Leonard Fox. Mr. Fox has approximately 20 years experience working in the electrical field. In his earlier career he worked for several manufacturers of power transformers where he was involved in the installation, checkout and troubleshooting of said transformers. Later in his career he became involved in the inspection of property to ensure safety and code requirements have been met. Over the past few years, Mr. Fox has started to teach some of HPC's electrical operations & maintenance courses.



Harold Parker is the founder & President of H Parker & Company, Inc. Mr. Parker, along with Mr. Douglas Lemmo (see below) were significant contributors to the development of the Steam Turbine Generator Maintenance training program used by GE for the "advanced" training of their field engineering force. Mr. Parker has worked in the "Power Generation" industry for 36 years, 14-years with GE as a Field Engineer, Start-Up Engineer, Technical Training Specialist and Manager. In 1983 Mr. Parker resigned from GE and started a training company, Schenectady Learning Systems, in Schenectady NY, which evolved into H Parker & Company, Inc. today. During this post-GE period, Mr. Parker was briefly employed as Manager Turbine-Generator Services with General Physics (2-years) and as a Field Engineer with Mechanical Dynamics & Analysis (2-years). Mr. Parker is the primary contributor to the development of the text used in this course presentation. Mr. Parker holds a BSME ('69 from Lawrence Institute of Technology), a MBA ('81 from the State University of New York @ Albany) and is a member of ASME. Harold resides in Bradenton FL.



John Mitchell. John Mitchell is a multi-talented leader with over 33 years management, engineering, installation and maintenance experience in thermoelectric power plants. He is especially an expert in steam turbines, generators and their controls. Prior to June 2003 (when he accepted an early retirement package from GE), John was a Customer Training Specialist with the GE International Department. Other past responsibilities included being Manager, Engineering Services, Senior Application Engineer, Senior Service Engineer, Lead Training Specialist, Program Support Engineer, Instructor Technical Training, and Field Engineer. All of this on operation & maintenance of steam turbine generator hardware and controls. John resides in Schenectady NY.

Robert Johndrow. Bob Johndrow hired into GE as a field engineer on the same day as HPC's founder, Harold Parker. That was 36-years ago. Since that date, Bob Johndrow has been a GE Field Engineer specializing in many disciplines including Generator Maintenance and Testing. Bob completed GE's Generator Specialist Training Program early in his career. Since then he has been involved in the commissioning of several steam turbine generators where he was responsible for the turbine controls, auxiliaries, startup sequence and the generator. Bob earned a BS in Industrial Distribution from Clarkson University in Potsdam NY and also has GE Six Sigma Green Belt Certification. Bob accepted an early retirement package late 2003 and has worked as an independent as well as being associated with HPC Technical Services since then. He resides in Rhode Island.

HPC TECHNICAL SERVICES
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REGISTRATION FORM

Company: _____

Plant: _____

Address: _____

City/State/Zip: _____

Telephone: _____ FAX: _____

Course Number/Title: _____

Course Dates: ____/____/____ Thru ____/____/____

Course Location: _____ Course Fee: _____

Please enroll the following individual(s) listed below:

Student #1: _____

Student #2: _____

Taking advantage of HPC's 3-4-2 Policy: Send 3, Pay for 2 when paying in advance.

Student #3: _____

Enrolled by: _____ **Date:** _____

METHOD OF PAYMENT

- Check to Follow
- Check Enclosed #: _____
- MC/Visa/AMEX #: _____
Expiration Date: _____ CV Code: _____
- Purchase Order #: _____

HOW DID YOU LEARN OF THIS COURSE?

- Familiar with HPC courses.
- Fellow employee
- Received a fax
- Received an email
- Internet search
- Other: _____