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Course Information Letter ---- G401

UTILITY GENERATORS:

THEORY, CONTROLS, OPERATIONS, MAINTENANCE & TESTING

G401

In most plants, the AC generator is the least understood, most "mysterious", and most reliable component in the power plant. Given all this, it should be understood that "**There are NO SMALL PROBLEMS when it comes to your GENERATOR!"** Now is the time to close this knowledge gap. In this course you will learn: Design, Construction, Operations, Safety, Testing, Inspection/Repair as well as disassembly/reassembly. Don't be surprised. Be prepared. Register for this course today. This course is designed for plant engineers who have a specific need to better understand generator equipment. The course is intended for "experienced operational personnel", plant technicians and engineers.

Topics include: Generator Theory (Lite) • Systems Operation • Generator Auxiliaries • Generator Excitation Systems & Controls • Normal Operations • Abnormal Operations • Generator Construction • Planning and Scheduling Generator Outages • Disassembly • Visual Inspection • Reassembly • Resistance Testing • Dielectric • Absorption Testing • DC Current Leakage Test • Dissipation Factor Test • Radio Noise Test • High Potential Testing • Ring Test • Polarization • Index • EL CID

- How does a generator function?
- Why is it designed as it is?
- What happens if the generator is synchronized out-of-phase? Or any of the other abnormal conditions that may occur?
- How can we avoid such an error?
- How should the generator respond to frequency or voltage deviations?
- Which electrical tests should be performed, how do you avoid accidents, and when should these tests be performed?
- How do you repair commonly found mechanical problems within the generator components?
- How can we avoid accidental injury when testing the generator?
- What are the probable causes of grounded fields?
- Why have we (recently) heard of hydrogen explosions? How do we avoid?
- **...**And the list of answered questions goes on!!

WHAT YOU WILL RECEIVE:

1. 1 copy of HPC Technical Services' textbook, Utility Generators: Theory, Controls Operations, Maintenance & Testing, a $295 value, as written by Harold Parker, with technical support by via HPC's Advanced Generator Maintenance Seminar personnel, primarily AGT Services. This text contains a significant number of equipment photographs, graphics and data tables. It is a valuable desktop reference in addition to being able to enhance the learning process. (This valuable text is available for purchase if you cannot attend – US$295).
2. A "Certificate of Completion" with 2.9 CEUs, authorized for issue by the International Associate of Continuing Education/Training.
3. One Letter of Accomplishment for those requesting the Certification Examination. Participants who are active in HPC's Certification Program will be required to complete a comprehensive examination upon course completion. As usual, there is a 80% passing requirement.

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COURSE DATES/LOCATION/FEE

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

*Schedule Notes: The first 3-days of G401 is also Generator Control Concepts (G301), and the last two days are Generator Maintenance (G305). Operations personnel may want to take the first 3-days only.

** Please consult website for latest revisions to price/location/dates.

*** Class begins at 0800hrs and ends at 1630hrs daily (except Friday when class ends at noon).

OBJECTIVES: Upon completion of this course, participants will be able to:

1. Describe how a generator functions. (Learn why and how the voltage drops with an application of a load and learn why and how the rotor speed and angle change as that load is applied).
2. Describe active and reactive power. (Learn how active power is generated, how reactive power is generated, and how these loads are shared from one generator to another.)
3. Describe the major components used in the construction of an AC generator.
4. Learn how these components are at risk during mis- or abnormal operations.
5. Explain operation and maintenance of the most common excitation systems.
6. Explain how a speed governor alters generator output in response to a frequency deviation. (Learn why the speed changes when a load is applied. Learn what is the role of the governor is response to this speed/frequency change).
7. Explain how the voltage regulator alters generator output in response to a voltage deviation. (Furthermore, learn why the voltage drops, how a voltage drop is detected, where it is detected, and how the voltage regulator responds as it does).
8. Discuss the causes and effects of both voltage and frequency oscillations and the impact they each have on power system dynamics.
9. Describe generator normal/safe startup and shutdown procedures.
10. Describe why the generator synchronizing process is as it is. (Learn what are the results of not checking phase rotation, of mismatching voltages, of mismatching frequencies, and closing the circuit breaker out-of-phase.)
11. Discuss abnormal generator operation and recommended actions for generator protection.
12. Given an unfortunate abnormal condition, describe possible results to equipment and/or system.
13. Describe the major activities associated with generator maintenance.
14. Describe proper generator disassembly and reassembly sequences.
15. Describe the procedures for cleaning generator components.
16. Describe the procedures for inspection of generator components.
17. Given any generator component, describe the types of damage that might be found, and what are probable causes of that damage.
18. Describe the various repair methods for defective component condition.
19. List all those electrical tests commonly performed on large AC generators.
20. For each electrical test listed, describe the purpose of conducting that test; i.e., what are we looking for as a result of the test?
21. Describe the procedures for the various generator tests.
22. List and describe safety precautions for the conducting of these electrical tests.

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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. $219 + S&H.
- 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 the planning and implementation of our outages? Yes we can. Call or contact Harold Parker, hparker@hpcnet.com for our rate sheets and any further information required.

COURSE SYNOPSIS

Monday

- **Generator Theory:** Armature Reaction, Resistive Loads, Inductive Loads, Capacitive Loads, Power Transfer and Load Angle, Reactive Power, Net Air Gap, Developed Torque, Watt and VAR Control, Power Transfer Between Generator Rotor and Stator
- **System Operations**: Structure of the Power System, Interconnections, Power Balance, Operation of the System, State of the Power System.

Tuesday

- **Generator Construction:** Stator Frame, Core, Windings, End Shield, Rotor Body, Field Windings, Retaining Rings, Collector Rings, Diesel and Hydroelectric Differences
- **Excitation Systems, Voltage & Frequency Control:** Speed Governor Response to Frequency Deviations, Automatic Voltage Regulator Response to Voltage Deviations, Manual Regulator, URAL, Impedance Compensator, Volts/Hertz, Maximum Excitation Limit, Transfer & Tracking, PSS, De-Excitation, Steady State Operation, Transient Conditions, Earlier Excitation Systems, Rotating AC Exciters, Alterrex, SCRs, Brushless Excitation Systems, Static Excitation Systems, SCPT, SCT-PPT, Bus Fed Exciters
- **Generator Auxiliary Systems**: Purpose and Operations of the Generator Hydrogen Control System, Generator Seal Oil System, and Stator Liquid Cooling System (as required).

Wednesday

- **Normal Operations:** Preparation for Start-Up, Synchronizing, Load Changes, Use of Reactive Capability Curve, V-Curve, Performance Curves, Shutdown.
- **Abnormal Operations:** Relationships Between Operations, Protection and Alarms; Alarms, Protection when Off-Line, Tripping Methods, Protective Actions for Generator Faults and Abnormal Operations & Protection Recommendations: System Steady & Dynamic Conditions, Frequency Deviations, Voltage Deviations, Instabilities, Loss of Synchronism, Stator Overcurrent, Field Ground, Stator Ground Fault, Stator Phase-to-Phase Fault, Over Voltage, Over Volts-per-Hertz, Field Overheating, Loss of Excitation, Bearing Vibration, Synchronizing Errors, Motoring, Seal Oil System Pressure, Stator Coolant System, Local Overheating, Unbalanced Armature Currents, Breaker Failures, System Back Up, Voltage Surges, Transmission Line Planned Switching, High Speed Reclosing, Accidental Energization

Thursday

- **Outage Planning & Scheduling:** Why Maintenance, Preparation, Tooling, Documentation, Pre-Shutdown Maintenance, Decision Making
- **Generator Mechanical Maintenance Activities:** Why Generators Fail, Special Tools, Spare Parts, Safety Precautions, Disassembly/Reassembly Procedure, Cleaning and Checklists. Stator Visual Inspection to include; Loose Slot Wedges, Discoloration, Loose Punchings, Bar Vibration, Girth Cracks, Corona, Loose/Broken Ties, Liquid Connections, Air Baffles, Oil Deflectors, and Hydrogen Seals. Rotor Visual Inspection to include Collector Rings, Rotor Journal Surface, Terminal Studs, Hydrogen Seal areas, Axial Flow Fans, End Turns, Field Slot Wedges, Retaining Rings.
- **Purpose of Generator Electrical Tests:** Safety Considerations

Friday

- **Generator Electrical Tests:**
  - STATOR: Winding Resistance, Insulation Resistance, Dielectric Absorption, Direct Current Leakage, Dissipation Factor Test, Radio Noise (Corona), High Potential Test, Ring Test, EL-CID
  - ROTOR: Resistance Test, PI, Impedance Testing, Flux Pattern Test, Pole Drop, High Potential Testing, Air Gap Flux Probe Testing.
- **Certification Examination**

GENERATOR MAINTENANCE CERTIFICATION:

There are three levels of certification (All levels require this course):

1. Engineer
2. Mechanical Maintenance Technician
3. Electrical Maintenance Technician

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.

RECENTLY SATISFIED CLIENTS:

AES, Alstom Power, AmerGen Energy, Arizona PSC, Associated Electric Cooperative, ATCO Electric, Braintree (MA) Electric Lighting Dept., BC Hydro, BP Products, Cardinal Operating Company, Cayman Islands Utilities, Chelan County PUD, Chevron Geothermal Salak, Connectiv Operating Services, Consolidated Edison, Detroit Edison, Doosan Heavy Industries, Dynegy Power, Duke Energy, Eastman Chemical, Edison Mission Energy, El Paso Electric, Enron, Entergy-Arkansas, Entergy-Louisiana, Entertainment & Engineering Operations, Exelon Nuclear, Exxon-Mobil, Foster Wheeler, Georgia Power, Hawthorne Power Services, Hovensa Oil Refinery, Iberdola (Spain), Institute for Nuclear Power Operators (INPO), International Paper, Kansas City Board of Public Utilities, Korea East West Power, Korea Midland Power Company, Korea Nuclear & Hydro Company, Korea Plant Services & Engineering, Korea Southern Power, L&S Industries, Madison Gas & Electric, MidAmerican Energy, New England Power, North America Energy Services, Northern Star Generation, NRG, Nuclenor (Spain), Oklahoma Gas & Electric, Orange County Sanitation Department, Orrville City (OH) Utilities, Ottumwa (IA) Water Works, Portland G&E, Progress Energy, Pyro-Pacific Cogen, SaskPower (Canada), Seattle City Lighting, Sierra Pacific Power, Sithe Energies, Southern California Edison, Southwestern Electric Power, Standard Aero Energy (Canada), Syncrude Canada, Tampa Electric, Tennessee Valley Authority, Texas Municipal Power Agency, Tolko (Canada), University of Texas, TransAlta Utilities, Trigen Cinergy Solutions, US Army Corps of Engineers, US Bureau of Reclamation, US Navy, US Power Gen, Vermont Yankee, Wisconsin Public Service, Xcel Energy

HPC INSTRUCTOR / CONSULTANT (S):

Harold Parker is the founder & President of H Parker & Company, Inc. Mr. Parker has worked in the "Power Generation" industry for 40 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, IEEE and ASTD. 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 Doughty. Mr. Doughty has more than 30 years of experience in start up, maintenance and operation of both large and small turbine-generators. Bob started his career as a power plant instrumentation technician while he completed his BS degree in Engineering Technology (1976) at the University of Houston. He has worked as a start up and field engineer for one of the major turbine-generator OEM's and as a consulting engineer, supporting the initial operation of two nuclear fueled power plants. His most recent position (1999) as the President of Turbine Services, Inc., has allowed him to continue to provide on site technical direction, start up and controls adjustments for several major turbine inspections in the range of 35 to 835 MW. Bob is a member of ASME (18 years) and has worked closely with HPC on multiple projects, training as well as field service. Bob currently resides in Pittsburgh.

Robert Johndrow. Bob Johndrow hired into GE as a field engineer on the same day as HPC's founder, Harold Parker. That was 36-syears 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 and has been involved in many generator design issues, mechanical maintenance, electrical testing, and troubleshooting O&M problems since then. 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 Connecticut.

Bob Fleming. Provides support in electrical engineering topical areas. Specifically instructs HPC generator ops/maintenance and voltage regulator courses such as the Westinghouse WTA, WMA, and WDR Exciters. Up until mid-2004 Bob was employed by TCSA and was responsible for developing voltage regulator upgrades, troubleshooting system problems, calibrating WTA/PRX systems as well as Basler systems. From 1969 thru 1996 Mr. Fleming worked for Westinghouse Electric Corporation, Power Generation Service Division. Here he was a Generator/Exciter Specialist with extensive experience with installation, testing, rewinds and repairs of generators from 1-MW to 1500-MW. Bob resides near Pittsburgh PA.

John Marshall. Mr. Marshall, worked for GE 35 years in the power system service and installation business. 25 years of this time was in the international service business. During his career, Mr. Marshall's positions included Field Engineer, Service Supervisor, Technical Training Instructor and Senior Application Engineer. Mr. Marshall's work covered electrical power distribution and control of power generation equipment. His expertise is GE manufactured excitation systems for large and medium size generators used on gas and steam powered turbines. As a Technical Training Instructor for over 20 years, Mr. Marshall developed and presented training programs for GE manufactured excitation systems. As a Senior Application Engineer, Mr. Marshall's work included the upgrading/replacement of older excitation systems with GE's digital excitation system. His Field Service work was worldwide. BSEE degree from Virginia Polytechnic Institute and State University in Blacksburg, Virginia. John resides in Schenectady NY.

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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:_____ Email: _____

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