



## Course Information Letter ---- DG402

### On-Site **GENERATORS: THEORY, CONTROLS, OPERATIONS, MAINTENANCE & TESTING** DG402

On-Site and Standby generators have become increasingly important. Weather patterns and concerns over security are certainly two large driving forces for this need. Many have an appreciation for how the prime mover functions, but few understand the generator. This course is designed to give the participant a practical understanding of generator operation and maintenance, along with the prime mover and generator control devices. This course, once a thorough review of theory has been completed, emphasizes practical knowledge, with safety always an issue. This course is of great benefit to technicians and engineers who are responsible for ensuring the availability of their emergency, standby, or remote generators as a reliable source of emergency power.

#### LEARN....

- How does a generator function?
- Should generator components be high potential tested?
- How can we avoid accidental injury when testing the generator?
- How should the generator should be wired and controlled for providing emergency power?
- ...And the list of answered questions goes on!!

**Topical Outline** includes: Generator Theory (Overview), Generator Construction, Governor Operation, Excitation, Transfer Switch, Functional Checks, Normal Operations, Abnormal Operations, Mechanical Maintenance, and Electrical Tests.

**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 generator components and how these components are at risk during while in service.
4. Learn what protective relaying is typically used to protect the generator operation.
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. Describe typical functional checks to be performed on 'built-in' speed governor and voltage regulators.
9. Discuss the causes and effects of both voltage and frequency oscillations and the impact they have on power system dynamics.
10. Describe generator normal/safe startup and shutdown procedures as well as those circuits, which accomplish this automatically.
11. Describe the major activities associated with generator maintenance.
12. Describe the procedures for cleaning generator components.
13. Describe the procedures for inspection of generator components.
14. Given any generator component, describe types of damage that might be found, and what are probable causes of that damage.
15. List all those electrical tests commonly performed on distributed generators.
16. 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?
17. Describe the procedures for the various generator tests.
18. List and describe safety precautions for the conducting of these electrical tests.

## COURSE OUTLINE

### Day One

- **Generator Theory Overview:** Alternating Current, Three Phase Power, Stator Armature Windings, Armature Reaction, Rotor Magnetic Field, Load Applications, Active Power (kW), Reactive Power (kVAR), Losses, Net Air Gap Magnetic Fields, Power Transfer and Load Angle, Power Triangle, Performance Curves, Power System
- **Generator Construction:** Stator Frame, Core, Windings, Enclosure, Rotor Body, Field Windings, Retaining Rings, Collector Rings or Rotating Rectifier Assembly

### Day Two

- **Governor Operation:** Purpose of Governor, Synchronous vs. Isochronous Operation, Control Concepts and Sensing Components.
- **Excitation Systems:** Purpose of Voltage Regulator, Response to Voltage Deviation, Manual Regulation, Impedance Compensation, Types of Exciters, Use of Silicon Controlled Rectifiers in Firing Circuits, Limiters.
- **Automatic Transfer Switch**
- **Functional Checks**

### Day Three

- **Normal Operations:** Startup, Synchronizing, Shutdown, Capability Curves
- **Abnormal Operations and Protective Relays:** 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, Local Overheating, Unbalanced Armature Currents, Breaker Failures, System Back Up, Voltage Surges, Transmission Line Planned Switching, High Speed Reclosing
- **Mechanical Maintenance:** Special Tools, Spare Parts, Safety Precautions, Disassembly/Reassembly Procedure, Cleaning and Checklists.
  - Stator Visual Inspection
  - Rotor Visual Inspection

### Day Four

- **Generator Electrical Tests:** Safety Considerations
  - STATOR: Winding Resistance, Insulation Resistance, Dielectric Absorption, Direct Current Leakage, Dissipation Factor Test, Radio Noise (Corona), High Potential Test, Ring Test.
  - ROTOR: Resistance Test, PI, Impedance Testing, Pole Drop.

## COURSE DATES/LOCATION/FEE

For current dates / locations / prices, please see HPC's website, [www.hpcnet.com](http://www.hpcnet.com).

## 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](mailto: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? It will be available in the near future.
- 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.

## WHAT YOU WILL RECEIVE:

1. 1 copy of HPC Technical Services' textbook, On-Site Generators.
2. A "Certificate of Completion" with 2.9 CEUs, authorized for issue by the International Associate of Continuing Education/Training.

## HPC INSTRUCTOR (S):



**Tom McKinney.** Mr. McKinney is an electrical engineer with over 25 years of experience in utility and industrial power systems. He earned his B.S.E.E. from the Virginia Military Institute. His experience includes the design, installation, and start-up of a wide variety power equipment, including turbine and diesel-generators, excitation systems, protective relaying, transformers and circuit breakers. Tom worked in the corporate engineering offices of American Electric Power supporting plant operation and maintenance needs. Most recently, before joining HPC Technical Services as a consultant, he worked for First Energy at the Bayshore Plant. Mr. McKinney has a unique ability to present technically complex subjects in an understandable and simple manner. Mr. McKinney is another primary contributor to the development of this text. Tom resides in Ohio.

**Bill Poisson.** Mr. Poisson is a retiree of the US Navy where he served as an Electrician responsible for the operation and maintenance of onboard ship diesel generator sets. He also was based at the Orlando Technical Center for the Nuclear Groups where he instructed courses relevant to this topic. Mr. Poisson has been instructing courses, as an associate, for HPC since 1997, specializing in diesel generators and controls. Bill resides in central Florida.

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**REGISTRATION FORM**

Company: \_\_\_\_\_

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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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