

## NERC-APPROVED! GENERATOR OPERATIONS (FCS\_123\_GOC\_102)



Effective operation of electrical generators is often a challenge to generation and transmission system operators. This critically important component is installed with a number of protective systems and devices to ensure its safe and reliable operation, and to trip the generator when there are dangerous operating conditions or in case of a fault. Generator and Transmission Operators must have a complete and thorough understanding of Generator and Voltage Regulator operation if adequate system protection is to be maintained. To understand how the generator protective systems and devices work, it is critical that the operators understand how the generator produces electricity, what equipment and systems are installed to ensure its smooth operation, and what protective devices are installed to protect the generator from dangerous conditions and to limit damage from a fault. This two-day course is designed to improve the knowledge of Generator and Transmission Operators with the generators, generator systems, voltage regulators and generator protection associated with their areas of responsibility. A quiz will be administered at the conclusion of the course to verify that trainees learned the material in the course.

### THE FCS DIFFERENCE

What makes our programs superior to other training programs on the market? FCS experts will visit YOUR facility and examine YOUR plant documentation to customize a SITESPECIFIC course that fits YOUR needs. We go one step further than generic training courses; course participants will not only learn conceptual knowledge; they will learn the specifics of how to put those concepts into practice at YOUR facility.

Already have a training program in place? Great! We can improve your existing program to ensure that trainees learn the materials faster and better. FCS-produced, plant-specific courses are more effective than generic courses and provide a greater Return on Investment (ROI) than generic materials alone.

### WHAT OUR CLIENTS SAY ABOUT US:

*"The staff provided by FCS were professional trainers and engineers, whose technical experience and training capabilities resulted in a maximum amount of technology transfer to (our) plant operators."*

*-Plant-specific custom training for an overseas Power Plant*

*"Thanks to FCS' effective training, our employee knew exactly what to do during our emergency situation, and his quick actions prevented forced outage!"*

*-Plant-specific simulator training for a major Mid-West U.S. plant*

## NERC APPROVAL

Generator Operations (FCS\_123\_GOC\_102) is recognized by the North American Electric Reliability Corporation as an approved learning activity for which NERC CE Hours can be awarded, and that the provider adheres to NERC CE Program Criteria.

This course fulfills a total of 16.0 CE hours and 1.5 hours of Standards.

**Contact Scott Hommel, at (410) 312-6240 or [shommel@fossilconsulting.com](mailto:shommel@fossilconsulting.com) for information regarding technical content and pricing**

## COURSE OBJECTIVES:

- Describe the conversion of mechanical energy to electrical energy in AC generators.
- Describe reactive power including:
  - Why generating units need to generate or absorb reactive power
  - Different terms used to describe reactive power flow from and into a generating unit
  - How to control the generation of reactive power.
- Describe the function of the components in AC generators.
- Describe the different types of generator cooling systems – conventionally cooled vs. conductor cooled.
- Describe function, flowpaths and major components for generator auxiliary systems including:
  - Generator gas control systems
  - Seal oil systems
  - Stator Winding Cooling Systems
  - Generator Condition Monitor
- Describe the appropriate operator response to tripping of generator protective relays.
- Explain the function of instrument transformers (PTs and CTs)
- Briefly describe the function of each of the following protective relays with emphasis on whether the tripping of the relay indicates a generator failure/fault or an operational problem:
  - Instantaneous Overcurrent (50) Relay
  - Time Delay Overcurrent (51) Relay
  - Ground Overcurrent (50N, 51N)
  - Zone Protection Relays o Distance Relay (21)
  - Differential Relay (87)
  - Overvoltage Relays (59, 24)
  - Undervoltage Relay (27)
  - Frequency Related Devices
  - Frequency Relay (81)
  - Volts/Hertz Relay (24)
  - Reverse Power Protection (32)
  - Loss of Field Relay (40)
  - Out-of-Step Relay (78)
  - Negative Phase Sequence Current Relay (46)
  - Field Ground Fault (64) o Sync Check Relay (25)
  - Sudden Pressure Relay (63)

- Explain how the Lockout Relay (86) differs from other protective relays
- Describe briefly the interconnection of generating plants to the electrical power system and the impact of electrical system operation on generating unit operation
- Describe operation of common generator voltage controls including control of reactive power
- Describe NERC requirements for voltage regulator operation
- Describe how to properly synchronize a generator to the power system, including the function/use of the synchroscope.
- Describe the significance and use of the generator reactive capability curves.
- Describe NERC requirements for voltage/reactive power control and voltage/reactive power schedules
- Describe operational limits common to most generators including
  - Minimum operating temperature
  - Maximum operating temperatures
  - Cold gas temperature balance
  - Operation with a hydrogen cooler out of service
- Describe abnormal generator operations including:
  - Operation with unbalanced phase currents
  - Loss of field
  - Off-frequency operation
  - Operation of hydrogen cooled units with air

## **COURSE OUTLINE:**

- Electrical Theory Review
  - Magnetism
  - AC Generators
  - Power
  - Three Phase Power
- Generator Construction
  - Stator & Windings
    - Frame
    - Core
    - Stator Bars
    - Wedges
    - End Support
    - End Shield
  - Bearings
  - Generator Rotor
    - Forging/Winding
    - Retaining Ring
    - Fans/Blowers
    - Collector Rings
  - Exciters and Voltage Regulators
- Gen Support Systems
  - Gas Control System
  - Seal Oil System
  - Stator Winding Cooling
  - Generator Condition Monitor



- Protective Relays
  - Operator Response to Protective Relays
  - Introduction
  - Types of Relays
  - Relay Descriptions
- Synchronizing and Operating Generators
  - Electrical Power Systems
  - Reactive Power
  - Generator Voltage Controls including NERC operational requirements
  - Synchronizing the Generator
  - Generator Capability
  - Voltage/Reactive Power schedules
  - Operational Limits
  - Abnormal Operations