Auxiliary Generator Operations, Maintenance and Troubleshooting

Auxiliary Generator Operations, Maintenance and Troubleshooting

This course covers fundamentals of electric generation, a practical understanding of electric switchgear and protective devices, and the basic operating theory behind electric synchronization and load sharing, the trainee will understand and be able to start, stop, synchronize, load share, and monitor the operation of an electric generator. The trainee will also understand electrical power generation and be able to operate, maintain, and trouble-shoot auxiliary generators, related electrical switchgear controls and metering, and devices.

I. Operate, Maintain and Troubleshoot Auxiliary Generators

- Understand the general functionality of a facility's electrical system.
- Understand the basic operation of an auxiliary generator.
- Understand the operating theory of the major components of the auxiliary generator set and electrical switchgear.
- Read and interpret 1-Line and 3-Line electrical schematics of generator systems.
- Define the major components of the auxiliary generator set and electrical switchgear.
- Understand the basic theory of power generation.
- Understand the impact of each generator control and metering device.
- Explain the electrical effects of controlling the governor and exciter voltage on a synchronous generator.
- Interpret the basic instrumentation on electric panels.
- Define the basic instrumentation and switches on the generator controlpanels.
- Define the basic instrumentation and controls on the synchronizing (swing)panel.
- Understand the function and operation of control breakers and resets.
- Explain the function, operation, and basic calibration of protective devices.
- Understand the concept of breaker selectivity.
- Define the purpose of synchronizing the generators.
- Explain the basic process of electrical synchronization.
- Define the purpose of electrical power load sharing.
- Identify and quantify unbalanced load sharing.
- Explain the basic process to adjust and correct load sharing between generators.
- Understand the load sharing concepts of droop and isochronous operation.
- Explain basic operating procedures to start the prime mover and establish electric power generation.

- Explain basic operating procedures to deenergize and shutdown a generator set.
- Determine need to add generators and perform operating procedures to start the prime mover and establish electric power generation.
- Understand and perform basic generator maintenance.
- Explain basic monitoring requirements during generator operation.

Balance of Plant

Balance of Plant

This ten-day overview course describes the portion of the sub-systems that support the overall combined cycle plant operation. This is a technician-level course for both operating and maintenance personnel, providing the knowledge base necessary to begin working on equipment.

I. Review of Combined Cycle Operation

II. Balance of Plant Overview

- Auxiliary Steam System
- HRSG Blowdown System
- Circulating Water System
- Closed Cycle Cooling Water System
- Compressed Air System
- Compressed Gases System
- Condensate System
- Demineralized Water System
- Feed Water System
- Fire Protection System
- Potable Water System
- Service Water System
- HP, HRH, CRH, and LP Steam Systems
- Condenser Air Removal System
- Fuel Gas System

Continuous Emissions Monitoring System

Continuous Emissions Monitoring System

CEM is the continuous measurement of pollutants emitted into the atmosphere in exhaust gases from combustion or industrial processes. The EPA has established requirements for continuous monitoring of various contaminating constituents. The CEM rule also contains requirements for equipment performance specifications, certification procedures, and recordkeeping and reporting. This 2 ½ day course covers these requirements, specifications, and procedures.

I. Introduction and Overview

- Terms and Acronyms
- General Safety Requirements
- Air Pollution Fundamentals

II. Continuous Emissions Monitoring

- Components of CEMS Systems
- Usage of CEMS Systems
- Maintenance of CEMS Systems
- Miscellaneous Discussion Items

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GE Frame 7EA Turbine

GE Frame 7EA Turbine

This five-day course begins with a review of gas turbine theory. Next, the major components of the GE Frame 7EA turbine are described then reviewing the air inlet/filtration system, compressor, combustion system, turbine section, support systems, and protection system. Finally, we discuss common turbine failures, how to troubleshoot various turbine problems and Gas Turbine Maintenance.

I. Gas Turbine Theory

- Basic Gas Turbine Cycle
- Comparison to Four-Cycle Engine
- Simple Open-Cycle Gas-Turbine Engine
- Actual Simple Open-Cycle Performance
- Gas Path

II. Air Inlet and Exhaust System

- Air Filtration Needs
- Inlet Compartment
- Inlet Ducting And Silencing
- Exhaust System
- Performance Monitoring System
- Evaporative Cooling System

III. Compressor Section

- Rotor
- Stator
- Variable Inlet Guide Vanes
- Pulsation Protection Control
- Compressor Casing
- Blading

IV. Combustion System

- Combustion Chambers
- Spark Plugs
- Ultraviolet Flame Detectors
- Crossfire Tubes
- Fuel Nozzles

V. Turbine Section

- Turbine Rotor
- Cooling
- Wheelspace Assemblies
- Turbine Stator
- Turbine Nozzles
- Bearings
- Couplings
- Gear Assemblies

VI. Support Systems

- Cooling and Sealing Air System
- Control Air System
- Liquid Fuel System
- Atomizing Air System
- Water Injection System
- Purge Air System
- Gas Fuel System
- Fuel Control System
- Lube Oil System
- Hydraulic Oil System
- Trip Oil System
- Fire Protection System
- Cooling Water System
- Water Wash System
- Ventilation and Heating System
- Inlet Fogging System
- Inlet Chilling System

VII. Protection Systems

- Overspeed Protection
- Overtemperature Protection
- Flame Detection and Protection System
- Vibration Protection
- Combustion Monitoring

VIII. Common Turbine Failures

- Turbine Blade Distress (Erosion/ Corrosion/Impact Damage)
- Compressor Fouling
- Combustor Distress and Plugged Fuel Nozzles
- Foreign/Domestic Object Damage
- Worn Air/Oil Seals
- Fuel Control Problems

IX. Gas Turbine Maintenance

- Borescope Inspections
- Maintenance Inspections
- Combustion Inspection
- Hot Gas Path Inspection
- Major Inspection

GE Frame 7FA Turbine

GE Frame 7FA Turbine

This five-day course begins with a review of gas turbine theory. Next, the major components of the GE Frame 7FA turbine are described before reviewing the air inlet/filtration system, compressor, combustion system, turbine section, support systems, operations and controls, operator commands, control system, and protection system. Finally, we review common turbine failures and how to troubleshoot various turbine problems

I. Gas Turbine Theory

II. General Characteristics

- Basic Gas Turbine Cycle
- Comparison to Four-Cycle Engine
- Simple Open-Cycle Gas-Turbine Engine
- Actual Simple Open-Cycle Performance
- Gas Path

III. Major Components

- Air Inlet System
- Compressor
- Combustion Section
- Turbine
- Exhaust System
- Support Systems
- Base and Supports

IV. Air Inlet and Filtration System

- Inlet Compartment
- Inlet Ducting And Silencing

V. Compressor Section

- Rotor
- Stator
- Blading

VI. Combustion System

- Outer Combustion Chambers and Flow Sleeves
- Crossfire Tubes
- Fuel Nozzle End Covers
- Cap and Liner Assemblies
- DLN 2.6 Gas Fuel System Differences
- Spark Plugs
- Ultraviolet Flame Detectors

VII. Turbine Section

- Turbine Rotor
- Cooling
- Turbine Stator
- Bearings
- Load Coupling

VIII. Support Systems

- Cooling and Sealing Air System
- Inlet Bleed Heat System
- DLN-2.6 Gas Fuel Control System
- Liquid Fuel System
- Water Injection System
- Atomizing Air System
- Purge Air and Control System
- Lube Oil System
- Combined Hydraulic and Lift Oil System
- Seal Oil System
- Hydrogen and CO2 Gas Control System

- Fire Protection System
- Cooling Water System
- Water Wash System
- Ventillationand Heating System
- Hazardous Gas Detection System

IX. Generator

- Basic Theory of Operation
- Construction of AC Generators
- Major Generator Parts
- Starting System
- Generator System
- Generator Ventilation

X. Plant Operations and Controls

- Operating Procedures
- Turbine Control Panel (TCP)
- Definition of Terms
- Generator Control Panel (Typical)
- Motor Control Center
- Supervisory Remote Equipment
- Annunciator System

XI. Gas Turbine Operator Commands

- Operating Mode Commands
- Cooldown Cycle Commands
- Gas Turbine Unit Commands
- Gas Turbine Load Commands
- Governor Commands
- Fuel Commands

XII.Control System

- Startup/Shutdown Sequence and Control
- Startup Control
- Speed Control
- Acceleration Control
- Temperature Control

XIII.Protection Systems

- Trip Oil
- Overspeed Protection
- Overtemperature Protection
- Flame Detection and Protection System
- Vibration Protection
- Combustion Monitoring

XIV. Common Turbine Failures

- Turbine Blade Distress (Erosion/ Corrosion/Impact Damage)
- Compressor Fouling
- Combustor Distress and Plugged Fuel Nozzles
- Foreign/Domestic Object Damage
- Worn Air/Oil Seals
- Fuel Control Problems

XV. Compressor Troubleshooting

- Maintenance Checklist
- Check Mechanical Operating Data
- Compressor Inspect

XVI. Gas Turbine Maintenance

- Borescope Inspections
- Maintenance Inspections
- Combustion Inspection
- Hot Gas Path Inspection
- Major Inspection

GE LM 2500 Gas Turbine

GE LM 2500 Gas Turbine

This five-day course begins with a review of gas turbine theory. Next, the major components of the GE LM 2500 turbine are described before reviewing the air inlet/filtration system, compressor, combustion system, turbine section, support systems, and protection system. Finally, we discuss common turbine failures and how to troubleshoot various turbine problems.

I. Gas Turbine Theory

- Laws and Principles
- Terms

II. General Characteristics

- Basic Gas Turbine Cycle

III. Major Components

- Compressor Front Frame
- Compressor
- Combustor
- Turbine Mid Frame
- High Pressure Turbine
- Accessory Drive Section
- Low Pressure Turbine
- Turbine Rear Frame
- High Speed Flexible
- Bearings and Sumps
- Air Seals
- Oil Seals
- Engine Fuel System
- Engine Oil System
- Sensors

IV. Principles of Operation

- Controls
- Start up
- Shutdown
- Emergency

V. Parameters / Operating Limits

- Gas Generator Speed
- Power Turbine Speed
- Turbine Temperature
- Vibration
- Lube Oil Pressure
- Fuel Manifold Pressure
- Start Air Pressure
- Lube Oil Temperature
- Inlet Air Temperature (Icing)
- Module Temperature
- Cooling and Combustion Air Differential
- Pressure

VI. System Interface

- Gas Generator Speed
- Power Turbine Speed
- Turbine Temperature
- Vibration
- Lube Oil Pressure
- Fuel Manifold Pressure
- Start Air Pressure
- Lube Oil Temperature
- Inlet Air Temperature (Icing)
- Module Temperature
- Cooling and Combustion Air Differential
- Pressure

VII. Safety Precautions

- Handling Synthetic Lube Oil
- When Operating This System

VIII. Gas Turbine Module System

- Air inlet System
- Inlet air Chamber
- Inlet Duct
- Cooling Duct
- Gas Turbine Module (GTM)
- Inlet Plenum Chamber
- Base
- Engine Compartment
- Combustion Air System
- Exhaust System
- Exhaust Duct
- Vent Damper
- Flame Detectors
- Enclosure Heaters
- Ice Detectors
- Lighting
- Temperature Detectors
- Moisture Separator (Demister Pads)

IX. Support / Site System

- Water Wash System
- Power Supplies
- Starting System
- Cooling System
- Service Air

X. Maintenance

- Maintenance Planning
- Maintenance Inspections
- Levels of Maintenance
- Standard Maintenance Practices

XI. General Inspections

- Intake Air System
- Inlet Plenum
- Module
- Cooling System
- Service Air

XII. Generator

- Generator
- Generator Cooling System
- Generator Oil System
- Enclosure
- Reduction Gear

Heat Rate: Optimizing Your Power Plant

Heat Rate & Plant Efficiency

This three day course covers the fundamentals of heat rate and the impact of changing heat rate on operating cost. The course includes an overview of heat rate concepts, controllable and non-controllable losses, and the effects of component performance on operating cost.

I. Heat Rate Basics

- What is Heat Rate?
- Plant Heat Rate
- Conversion Factors for Standard Cubic Foot (scf) to Pounds Mass (lbm)
- Why is Heat Rate Important?
- Heat Rate Deviation
- Cost of Heat Rate Deviations

II. Gas Turbine

- Gas Turbine Theory
- Gas Turbine Components
- Air Inlet Equipment
- Compressor
- Combustion Section
- Turbine Section

III. Steam and Feed System

- Thermodynamics
- First Law of Thermodynamics
- Second Law of Thermodynamics
- Heat and Temperature
- Heat and Work
- Cooling Towers

IV. Boiler

- Boiler Efficiency
- Boiler Degradation
- Fuel Issues
- Environmental Concerns
- Maximizing Boiler Efficiency

V. Heat Recovery Steam Generator

- HRSG Cycling
- HRSG Thermodynamics
- HRSG Design
- Steam Generation
- Duct Burners
- Stack Temperature
- Selective Catalytic Reduction (SCR)

VI. Steam Turbine

- Steam Turbine Types
- Turbine Efficiency
- Turbine Cycle Heat Rate
- Steam Turbine Degradation
- Controlling Turbine Efficiency

VII. Miscellaneous Major Equipment

- Feedwater Heater
- Condenser
- Cooling Tower (Heat Rejection)
- Miscellaneous Equipment
- Optimizing Heat Rate and Efficiency

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Heat Rate: Optimizing Your Power Plant

Heat Rate & Plant Efficiency Combined Cycle

This two and one half day course covers the fundamentals of heat rate and the impact of changing heat rate on operating cost. The course includes an overview of heat rate concepts, controllable and non-controllable losses, and the effects of component performance on operating cost.

I. Heat Rate Basics

- What is Heat Rate?
- Plant Heat Rate
- Conversion Factors for Standard Cubic Foot (scf) to Pounds Mass (lbm)
- Why is Heat Rate Important?
- Heat Rate Deviation
- Cost of Heat Rate Deviations

II. Gas Turbine

- Gas Turbine Theory
- Gas Turbine Components
- Air Inlet Equipment
- Compressor
- Combustion Section
- Turbine Section

III. Boiler

- Boiler Efficiency
- Boiler Degradation
- Fuel Issues
- Environmental Concerns
- Maximizing Boiler Efficiency

IV. Heat Recovery Steam Generator

- HRSG Cycling
- HRSG Thermodynamics
- HRSG Design
- Steam Generation
- Duct Burners
- Stack Temperature
- Selective Catalytic Reduction (SCR)

V. Steam Turbine

- Steam Turbine Types
- Turbine Efficiency
- Turbine Cycle Heat Rate
- Steam Turbine Degradation
- Controlling Turbine Efficiency

VI. Miscellaneous Major Equipment

- Feedwater Heater
- Condenser
- Cooling Tower (Heat Rejection)
- Miscellaneous Equipment
- Optimizing Heat Rate and Efficiency

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Heat Rate: Optimizing Your Power Plant

Heat Rate-Plant Efficiency Fossil Boiler Plants

This two and one half day course covers the fundamentals of heat rate and the impact of changing heat rate on operating cost. The course includes an overview of heat rate concepts, controllable and non-controllable losses, and the effects of component performance on operating cost.

I. Heat Rate Basics

- What is Heat Rate?
- Plant Heat Rate
- Conversion Factors for Standard Cubic Foot (scf) to Pounds Mass (lbm)
- Why is Heat Rate Important?
- Heat Rate Deviation
- Cost of Heat Rate Deviations

II. Gas Turbine

- Gas Turbine Theory
- Gas Turbine Components
- Air Inlet Equipment
- Compressor
- Combustion Section
- Turbine Section

III. Boiler

- Boiler Efficiency
- Boiler Degradation
- Fuel Issues
- Environmental Concerns
- Maximizing Boiler Efficiency

IV. Heat Recovery Steam Generator

- HRSG Cycling
- HRSG Thermodynamics
- HRSG Design
- Steam Generation
- Duct Burners
- Stack Temperature
- Selective Catalytic Reduction (SCR)

V. Steam Turbine

- Steam Turbine Types
- Turbine Efficiency
- Turbine Cycle Heat Rate
- Steam Turbine Degradation
- Controlling Turbine Efficiency

VI. Miscellaneous Major Equipment

- Feedwater Heater
- Condenser
- Cooling Tower (Heat Rejection)
- Miscellaneous Equipment
- Optimizing Heat Rate and Efficiency

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Heat Rate: Optimizing Your Power Plant

Heat Rate-Plant Efficiency Gas Turbine Simple Cycle

This one day course covers the fundamentals of heat rate and the impact of changing heat rate on operating cost. The course includes an overview of heat rate concepts, controllable and non-controllable losses, and the effects of component performance on operating cost.

I. Heat Rate Basics

- What is Heat Rate?
- Plant Heat Rate
- Conversion Factors for Standard Cubic Foot (scf) to Pounds Mass (lbm)
- Why is Heat Rate Important?
- Heat Rate Deviation
- Cost of Heat Rate Deviations

II. Gas Turbine

- Gas Turbine Theory
- Gas Turbine Components
- Air Inlet Equipment
- Compressor
- Combustion Section
- Turbine Section

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LM6000 Combustion Turbine

LM6000 Combustion Turbine

This twenty-day training course is for personnel concerned with day to day operations and maintenance of an LM 6000 combustion turbine. The purpose of this training is to provide knowledge for consistent and trouble-free operation. Additionally, this training will provide knowledge of preventive maintenance procedures to maintain the unit in a serviceable manner.

I. LM6000 Operation

- Aero Derivative Fundamentals
- Engine Airflow
- Lubrication & Fuel Systems
- LM 6000 Controls
- Maintenance Practices

II. LM6000 Level I Maintenance

- Aero Derivative Fundamentals
- Levels of Maintenance
- Use of Maintenance & Operation Manuals
- Preventive Maintenance
- Ancillary Components

III. LM 6000 Level II Maintenance (Hot Section)

- Low-Pressure Turbine
- Stage 2 High-Pressure Nozzle
- High-Pressure Turbine Rotor
- Stage 1 High-Pressure Nozzle
- Combustion Chamber

IV. LM 6000 Level II Maintenance (Cold Section)

- Low-Pressure Compressor Module
- Low-Pressure Comp. Rotor Blades
- Low-Pressure Comp. Stator Vanes
- Accessory Gearbox
- High-Pressure Compressor Top Case
- High-Pressure Compressor Rotor Blades

GE LM6000 Combustion Turbines

GE LM6000 Combustion Turbines

This five-day course begins with a review of gas turbine theory. Next, the major components of the GE LM6000 turbine are described before reviewing the air inlet/filtration system, compressor, combustion system, turbine section, support systems, operations and controls, operator commands, control system, and protection system. Finally, we review common turbine failures and how to troubleshoot various turbine problems.

I. LM6000 Gas Turbine Overview

II. Gas Turbines

- Basic Process and Components
- Modes of Operation
- GE LM6000
- Turbine-Generator Skid
- Turbine-Generator Skid External Modules
- Auxiliary Skid
- Liquid Fuel Boost (Pump) Skid
- Water Injection Skid
- Sprint Skid
- Fire Suppression Enclosure

III. Fuel Systems

- Dual-fuel System
- Gas/Water Fuel System
- Liquid Fuel System

IV. Air Intake System

- System Description

V. LM6000 Gas Turbine

- Gas Turbine Components
- LM6000 PA Gas Turbine

VI. Gas Turbine Auxiliaries

- Basic Components
- Turbine Lube Oil System

VII. Maintenance

- Maintenance Planning
- Maintenance Inspections
- Levels of Maintenance
- Standard Maintenance Practices

Balance of Plant

Balance of Plant

This two-day overview course describes the portion of the sub-systems that support the over-all simple cycle plant operation. This is a operator-level course for both operating and maintenance personnel, providing the knowledge base necessary to begin operating equipment.

I. Balance of Plant Overview

- Compressed Air System
- Demineralized Water System
- Fire Protection System
- Plant Drain System
- Fuel Oil System
- Fuel Gas System

UPS Systems and Battery Operations

UPS Systems and Battery Operations

This 2 ½ day course covers fundamental components of Power Converters, Inverters, and UPS. It will also cover power conditioning, basic UPS applications, principles of battery operation, power inverters and wave shaping, voltage regulation, static switching and auxiliary

I. Fundamental Concepts of Power Inverters, Converters, and UPS Systems

- Describe the relationship between AC and DC power.
- Discuss the power triangle.
- Discuss the basic operation of a semiconductor device.
- Discuss the different semiconductor devices used in an uninterruptible power supply.
- Describe the various uses of an SCR.
- State the purpose of snubbing when using SCRs.
- Discuss the use of fuses in uninterruptible power supplies.
- Describe the various components/ instruments found on a typical UPS system.

II. Power Conditioning

- Describe the different types of noise that affects electronic circuits.
- State the difference between common mode and normal mode noise.
- Describe the major causes of electrical noise.
- Discuss the methods available for protecting equipment against lighting.
- Describe the problems that exist due to electrostatic discharge and how to deal with them.
- Explain how noise can affect electronic circuits.
- Discuss the different methods of grounding equipment.
- Describe the different types of filters used to protect electronic equipment.

III. Basic UPS Applications

- Describe the purpose of an uninterruptible power supply.
- State the components that make up an uninterruptible power supply.
- Describe the three major categories of inverter systems.
- Discuss a basic block diagram of an uninterruptible power supply.

IV. Principles of Battery Operation

- Explain the basic principles of battery operation.
- State the different types of battery cells.
- Describe the construction and operation of a storage battery.
- Discuss the fundamentals of battery charges.

V. Power Inverters and Waveshaping

- Describe the basic principles of power inverters.
- State the theory of operation of power inverters.
- Discuss types of gate drive circuits.
- Discuss the different types of pulse shaping circuits.
- Describe the operation of a commutation circuit.
- Discuss pulse width modulation.
- Describe the operation of a resonant transformer.
- Describe the operation of a constant voltage transformer.