



Basic Operation and Theory of Steam and Gas Turbines, Co-Generation, and Combined Cycle Plants



Introduction:

Upon completion of this course, participants will gain a basic understanding of the main components and subsystems of gas turbine systems, steam power plants, co-generation, and combined cycle plants. Participants learn to critique the advantages, applications, performance, and economics of co-generation and combined cycle plants. They will learn about various auxiliary systems including instrumentation, controls and monitoring systems, deaerators, and feedwater heater systems and will learn some basics about transformers and generators. Participants will discover the basics required in minimizing operating cost and optimizing efficiency, reliability, and component longevity for gas turbine and steam power plants. They will learn about the monitoring and control of environmental emissions and gain some insight into predictive and preventive maintenance, reliability, and testing. Finally, they will discover some of the latest technology applicable to the areas covered and identify methods for self-improvement.

Who Should Attend?

Engineers, technologists, and other operational personnel who currently or may in the future be involved with the technology or business of running a power generation plant. Personnel can be involved in:

- Large scale commercial power production
- Small power production as a tax incentive or production for in-house needs or
- Merchant power production

- Operations, maintenance, repair and overhaul, systems optimization and performance verification, specification, retrofit design, business and management of power systems and personnel, and support of power generation trains and their support systems

While this course is of major benefit to newer people in the field, it is also valuable as a revision and technology update for more experienced personnel.

Methodology:

This interactive Training will be highly interactive, with opportunities to advance your opinions and ideas and will include:

- Lectures
- Workshop & Work Presentation
- Case Studies and Practical Exercise
- Videos and General Discussions

Certificate:

BTS attendance certificate will be issued to all attendees completing minimum of 80% of the total course duration.

Course objectives:

This course covers primarily:

- The basics of gas and steam turbine components and control/support systems
- Basic generation package selection and specification criteria
- The systems used to optimize performance
- Key maintenance considerations and pitfalls

Course outline:

✓ Review of Thermodynamics Laws

- First law of thermodynamics
- Enthalpy, property relationships, vapor-liquid phase equilibrium in a pure substance
- Second law of thermodynamics
- Entropy, Carnot cycle

✓ Steam Power Plant Basics

- Rankine cycle
- Reheaters, condensers, deaerators, regeneration
- Feedwater heating
- Efficiency and heat rate of power plants
- Co-generation, types of co-generation
- Critical steam advancements, application cases

✓ Steam Turbine Basic Components and Main Systems

- Steam turbine components
- Steam turbine control systems
- Lubrication system, bearings

✓ The Steam Turbine Governing System Basics

- Major components
- Turbine operation
- Turbine run up, tripping signals, turbine trip, load rejection, decrease in boiler pressure, hydraulic fluid

✓ **Gas Turbines**

- Advantages of Gas Turbines (GT) versus steam turbines operation
- Gas Turbine simple cycle
- Gas Turbine compressor module
 - ❖ Principles of operation of centrifugal and axial flow compressors
 - ❖ Surging, choking
 - ❖ Internal air system
 - ❖ Bleed valves, variable stator vanes, and inlet guide vanes
- Combustor module
- Turbine module
- Gas Turbine applications
- GT design for maximizing turbine inlet temperature, application cases
- Advances in GT design: "G" and "H" technology
- Accessory drives

✓ **Gas Turbine Lubrication and Fuel Systems**

- Lubricating systems
- Gas fuel systems
- Liquid fuel systems
- Dual fuel systems
- Fuel types, expanding range of usable fuels, application cases
- Treatment for trace metals and sulfur

✓ **Combined Cycles and Other GT Cycle Modifications**

- Non-ideal Brayton cycle
- Modifications to the Brayton cycle
- Closed cycles, complex cycles, combined cycles
- Regeneration, compressor intercooling, turbine reheat, water injection
- Combined heat and power

✓ **Gas Turbine Intake and Exhaust Systems**

- Intake systems, inlet air filtration (inlet air fogging: see last topic)
- Exhaust systems

✓ **Gas Turbine Instrumentation and Control (I&C) Systems**

- Gas Turbine protection (including pressure switches)
- Instrumentation and control systems
- Instrumentation used for vibration analysis
- Start-up sequence, normal operation (including temperature/PCD control sequence during start-up and normal operation, power limiting, decel limiting) and shutdown
- Black start system

✓ **Gas Turbine Emission Guidelines and Control Methods**

- Emissions from gas turbines
- General approach for a national emission guideline, NOx emission target levels
- Low NOx combustors, ultra low NOx combustors
- Power output allowance, heat recovery allowance
- Emission levels for other contaminants
- Size ranges for emission targets water and steam injection, selective catalytic reduction (SCR)

✓ **Gas Turbine Performance Verification and Maintenance**

- Gas Turbine performance verification and basics of performance analysis

- Compressor cleaning
- Gas Turbine maintenance methods (predictive, preventive)
- Basics of life cycle assessment

✓ **Generator, Exciter, and Other Electrical System Basics**

- Generator, cooling systems
- Excitation
- Grid interconnection
- Transformer lubricating oil system
- Electrical and control package, Distributed Control System (DCS)
- 28 VDC system, 125 VDC system

✓ **Combined Cycle and Co-Generation Plant Basics**

- Heat recovery steam generator basics and requirement of chrome-moly steel
- Equipment availability, maintenance cost, operational cost, turbine cost, training laws
- Heat of condensation
- Pipework to steam host, requirement of steam host
- Economics of combined cycles/cogeneration, guidelines
- Applications of co-generation and combined cycle plants

✓ **Economics of Combined Cycle and Co-Generation Plants**

- Deregulation and tax incentives, SPPs (Small Power Producers), IPPs (Independent PPs), MPPs (Merchant PPs)
- Natural gas prices and economic growth
- Financial analysis
- Capital cost, operating and maintenance cost
- Economic evaluation of different combined cycles configurations
- Electricity tariff factors