



**Training Program:**

**Major Generator Inspection And Testing**

[www.btsconsultant.com](http://www.btsconsultant.com)

## Introduction:

This seminar will provide a comprehensive understanding of the various types of generators, exciters, automatic voltage regulators (AVR's), and protective systems. This seminar will focus on maximizing the efficiency, reliability, and longevity of this type equipment by providing an understanding of the characteristics, selection criteria, common problems and repair techniques, preventive and predictive maintenance.

This seminar is a MUST for anyone who is involved in the selection, applications, or maintenance of generators, exciters, automatic voltage regulators (AVR's), and protective systems because it covers how this equipment operates, the latest maintenance techniques, and provides guidelines and rules that ensure the successful operation of this equipment. In addition, this seminar will cover in detail the basic design, operating characteristics, specification, selection criteria, advanced fault detection techniques, critical components and all preventive and predictive maintenance methods in order to increase reliability of the equipment and reduce the operation and maintenance cost.

This seminar will provide the following information for all types of generators, exciters, automatic voltage regulators (AVR's), and protective systems:

- Basic Design
- Specification
- Selection Criteria
- Sizing Calculations

- Enclosures and Sealing Arrangements
- Codes and Standards
- Common Operational Problems
- All Diagnostics, Troubleshooting, Testing, and Maintenance

## Who Should Attend?

- Engineers of all disciplines
- Managers
- Technicians
- Maintenance personnel
- Other technical individuals (this seminar is suitable for individuals who do not have an electrical background)

## Training Methodology

The instructor relies on a highly interactive training method to enhance the learning process. This method ensures that all the delegates gain a complete understanding of all the topics covered. The training environment is highly stimulating, challenging, and effective because the participants will learn by case studies which will allow them to apply the material taught to their own organization.

## Special feature

Each delegate will receive a copy of the following materials written by the instructor:

1. "ELECTRICAL EQUIPMENT HANDBOOK" published by McGraw-Hill in 2003 (600 pages)
2. Practical manual (300 pages)

## Course Objectives:

- Equipment Operation: Gain a thorough understanding of the operating characteristics of generators, exciters, automatic voltage regulators (AVR's), and protective systems
- Equipment Diagnostics and Inspection: Learn in detail all the diagnostic techniques and inspections required of critical components of generators, exciters, automatic voltage regulators (AVR's), and protective systems
- Equipment Testing: Understand thoroughly all the tests required for the various types of generators, exciters, automatic voltage regulators (AVR's), and protective systems
- Equipment Maintenance and Troubleshooting: Determine all the maintenance and troubleshooting activities required to minimize the downtime and operating cost of generators, exciters, automatic voltage regulators (AVR's), and protective systems
- Equipment Repair and Refurbishment: Gain a detailed understanding of the various methods used to repair and refurbish generators, exciters, automatic voltage regulators (AVR's), and protective systems

- Efficiency, Reliability, and Longevity: Learn the various methods used to maximize the efficiency, reliability, and longevity of generators, exciters, automatic voltage regulators (AVR's), and protective systems
- Equipment Sizing: Gain a detailed understanding of all the calculations and sizing techniques used for generators, exciters, automatic voltage regulators (AVR's), and protective systems
- Design Features: Understand all the design features that improve the efficiency and reliability of generators, exciters, automatic voltage regulators (AVR's), and protective systems
- Equipment Selection: Learn how to select generators, exciters, automatic voltage regulators (AVR's), and protective systems by using the performance characteristics and selection criteria that you will learn in this seminar
- Equipment Enclosures and Sealing Methods Learn about the various types of enclosures and sealing arrangements used for generators, exciters, automatic voltage regulators (AVR's), and protective systems
- Equipment Commissioning: Understand all the commissioning requirements for generators, exciters, automatic voltage regulators (AVR's), and protective systems
- Equipment Codes and Standards: Learn all the codes and standards applicable for generators, exciters, automatic voltage regulators (AVR's), and protective systems
- Equipment Causes and Modes of Failure: Understand causes and modes of failure of generators, exciters, automatic voltage regulators (AVR's), and protective systems
- System Design: Learn all the requirements for designing different types of generators, exciters, automatic voltage regulators (AVR's), and protective systems

## Course Outline

### **Module 1 – Fundamentals of Electrical Systems, Synchronous Machines, Synchronou Generators**

- Inductors, capacitors, alternating current, Faraday's law, magnetic field, three-phase system
- Machinery principles, magnetic behavior of ferromagnetic materials, energy losses in a ferromagnetic core, core losses, permanent magnets
- Rotating magnetic field, relationship between electrical frequency and the speed of magnetic field rotation, RMS voltage in a three-phase stator, induced torque in a three-phase machine, winding insulation in ac machines, ac machine power flow and losses
- Synchronous machines, physical description, pole pitch: electrical degrees, synchronous machine windings, field excitation, rotating rectifier excitation, series excitation, no-load and short-circuit values, torque tests, speed-torque characteristic, excitation of a synchronous machine, machine losses
- Synchronous generators, construction, speed of rotation of a synchronous generator, equivalent circuit of a synchronous generator, power and torque in a synchronous generator, synchronous generator operating alone, parallel operation of ac generators, frequency-power and voltage-reactive power characteristics, synchronous generator ratings, synchronous generator capability curves, short-time operation and service factor

### **Module 2 – Generator Components, Auxiliaries and Excitation, Generator Main Generators**

- Connections, Double-Feed Generators, Performance and Operation of

- Generator components, auxiliaries and excitation, the rotor, rotor windings, rotor end rings, wedges and dampers, sliprings, brushgear and shaft grounding, fans, rotor and threading alignment, vibration, bearings and seals,
- The stator, stator core, core frame, stator windings, end winding support, electrical connections and terminals, stator winding cooling components, hydrogen cooling components, stator casing,
- Cooling systems, hydrogen cooling, hydrogen cooling systems, shaft seals and seal oil systems, thrust-type seal, journal-type seal, stator winding water cooling systems,
- Excitation, AC excitation systems, exciter transient performance, pilot exciter, main exciter, exciter performance testing, pilot exciter protection, brushless excitation systems, rotating armature main exciter
- The voltage regulator, the power system stabilizer, characteristics of generator exciter power systems (GEP), generator operation,
- Generator main connections, isolated phase bus bar circulatory currents, system description
- Double-feed generators, system configuration, equivalent circuit for the brushless double-fed machine, parameter extraction, generator operation, converter rating, machine control
- Generator systems, condition monitoring, operation limitations, fault conditions

**Module 3 – Generator Surveillance and Testing, Generator Inspection and Maintenance, Generator Rotor Reliability and Life Expectancy, Bearings and Lubrication, Used Oil Analysis, Vibration Analysis, Power Station Electrical Systems and Design Requirements, Power Station Protective Systems, Frequently Asked Questions**

- Generator surveillance and testing, generator operational checks (surveillance and monitoring), generator diagnostic testing, insulation resistance and polarization index, dc hipot test, ac tests for stator windings, synchronous machine rotor windings, partial discharge tests, mechanical tests

- Generator inspection and maintenance, on-load maintenance and monitoring, off-load maintenance, generator testing
- Generator operational problems, and refurbishment options, typical generator operational problems
- Generator rotor reliability and life expectancy, generator rotor refurbishment, generator rotor modifications, upgrades, and uprates
- Bearings and Lubrication, Types of bearings, ball and roller bearings, thrust bearings, lubrication, viscosity of lubricants, greases, VI improved oils
- Used oil analysis, test description and significance, visual and sensory inspection, chemical and physical tests
- Vibration analysis, resonance, vibration instrumentation, vibration analysis, vibration causes, vibration severity
- Power station electrical systems, and design requirements, system requirements, electrical system description, system performance, unit start-up, synchronization, shutdown and power trip, power plant outages and faults, uninterruptible power supply systems, dc systems
- Power station protective systems, design criteria, generator protection, dc tripping systems
- Frequently asked questions

## Accreditation:

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