



Training Program:

**Generator Excitation Systems: Design, Commissioning,
Operation, Maintenance, Performance Analysis,
Testing, Tuning, Repair & Troubleshooting**

Introduction:

This 5 days seminar is designed to provide excellent understanding on both a theoretical and practical level for power generators. The workshop starts at a basic level, to ease the engineer and technician into the perhaps forgotten art of studying, and provide a refresher to those who are more familiar with the basic topics covered.

This course focuses mainly on the operation and maintenance of Generation equipment with reference to auxiliary equipment necessary for its operation.

The course covers generator theory, operation, protection and application, and troubleshooting. Different excitation systems, prime movers and generator earthing systems generator voltage and frequency control are included. In addition condition monitoring and maintenance are explained. This course is a must for anyone who is involved in the selection, operation, protection and applications, or maintenance of generators.

An overview of power system layouts, configurations, faults and the protection scheme requirements for the detection and coordinated clearance of these faults will be covered in more details. This course deals with protection systems from a practical perspective, and includes important functional aspects such as testing and coordination of protection systems. It is specially designed for industries and utilities, which depend on proper system protection for operational efficiency and minimizing damage to equipment.

Accreditation:

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

Who Should Attend?

Engineers and Technicians from Electrical Power Utilities Companies, Manufactures, Engineering Professional, Petrochemical Companies, and Commercial Buildings are recommended to attend.

Participants need to have some specific basic understanding of Electricity and Magnetism and knowledge of nature and operation of Power supply and distribution system.

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

Objective:

Participants will have enough knowledge to achieve reduced capital, operating and maintenance costs along with increase in efficiency of power generation. During the duration of this course, participants will understand and learn the following:-

- Refresh of Electrical Fundamentals & Basics (Power types, power factor, inductance, ...).

- Understand practical power distribution fundamentals & Different layouts.
- The fundamentals and basics of generators.
- How to control frequency and voltage.
- Gain knowledge of synchronization methods and conditions;
- Understand the need for load sharing & shedding processes.
- The earthing system for generators.
- The different protection needed for generators.
- Determine short-circuit ratings quickly and effectively
- Assess and specify correct grounding throughout your electrical network.
- Understand the electrical characteristics of various electrical faults.
- Recognize modern protective relays and understand their basic operation.
- Appreciate the characteristics and importance of voltage transformers and current transformers in achieving dependable and accurate electrical protection systems.
- Comprehensive understanding of principles and selection of protection relays and protection schemes for generators.
- Understand diagnostic testing and inspection, advanced fault detection techniques, critical components, and common failure modes.
- Discover the maintenance required to minimize their operating cost and maximize generator's efficiency, reliability and longevity.

Course Outline

Review Electrical Parameters & Fundamentals

- DC Circuits.
- Kirchoff's Laws.
- Circuit Analysis.
- Power and Energy Dissipation.
- Bridge Measurements.
- Inductance.
 - Faraday's Law.
 - Energy stored in an inductor.
- Capacitance
 - Energy Stored in a capacitor.
- AC Circuits & Power Factor.
- Power Dissipation.
- Power Supplies & Power types (Triangle).
- Three Phase Connections (Delta/Star).
- Magnetic Circuits.

AC Generators Basics, Theories & Construction

- Prime mover (Gas Turbines & Diesel).
- Generator Basics.
- The Synchronous Machine: Preliminaries.
 - P-Pole Machines.
 - Cylindrical vs. Salient-Pole Construction.
- Generator Field MMF.
- Synchronous Generator Construction.
- The Speed of Rotation of a Synchronous Generator.
- The Equivalent Circuit of a Synchronous Generator.
- The Phasor Diagram of a Synchronous Generator.
- Power in Synchronous Generators.
- The Synchronous Generator Operating Alone.
- Principal Steady State Characteristics.
- General.
 - Winding Insulation.
 - Cooling of Generators.
 - Insulated Bearings.

- Synchronous generators & Short circuit.
- Machine Reactance Modeling.

Synchronous Generator Ratings & Capability Diagram

- Synchronous Generator Ratings & Capability Diagram.
- Machine Ratings.
 - Apparent Power.
 - Power Factor.
 - Real Power.
 - Terminal Voltage.
 - Stator Current.
 - Field Voltage.
 - Field Current.
- The Voltage, Speed, and Frequency Ratings.
- Synchronous Generator Capability Curves.
- The Generator's Capability Diagram – Typical Case.
- Short-Time Operation and Service Factor.
- Generator Machine Losses.

- Monitored Parameters.
 - Generator Electrical Parameters.
- Example of using Capability curve.

Earthing Systems & Neutral Earthing of Generator

- Equipment Earthing.
- System Earthing.
 - Unearthed systems.
 - Solid earthing.
 - Resistance earthing.
 - Reactance earthing.
- Classification of Supply / Installation System Earthing.
- Sensing of Ground/Earth faults
- Earthing Via Neutral Earthing Compensator.
 - Distribution transformers.
 - Zig-Zag transformers.
- Comparison of Methods (Advantages/Disadvantages).
 - Evaluation of earthing methods.

- Testing the earthing electrode Resistance & Earthing grids.

Excitation System, AVR & PSS

- Excitation Systems.
- Excitation System Requirements.
 - Generator considerations.
 - Power system considerations.
- Elements of an Excitation System.

Types of Generator Excitation Systems and Voltage Control