



**Training Program:**

**Troubleshooting & Maintenance Of Power Distribution  
Equipment**

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## Introduction:

This 5-day workshop is designed to provide excellent understanding on both a theoretical and practical level to attendees. 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 and distribution equipment with reference to auxiliary equipment necessary for its operation.

Maximum efficiency, reliability, and longevity of electrical distribution equipment such as the various type's transformers, generators, circuit breakers, fuses, and power station electrical and protective systems are of great concern to many industries. These objectives can only be achieved by understanding the characteristics, selection criteria, common problems and repair techniques, preventive and predictive maintenance. This course is a MUST for anyone who is involved in the selection, applications, or maintenance of electrical equipment. It provides the latest in technology. The course covers how this equipment operates and provides guidelines and rules that must be followed for a successful operation. Their basic design, operating characteristics, specification, selection criteria, advanced fault detection techniques, critical components as well as all maintenance issues are covered in detail.

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.

## Who Should Attend?

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

Participants need specific requirements other than basic understanding of Electricity and Magnetism and knowledge of nature and operation of Power supply and distribution system.

## Objective:

This course is designed to provide a comprehensive understanding of the various types of transformers, generators, circuit breakers, and protection schemes. Upon the successful completion of this course, participants will be able to specify select, commission, troubleshoot and maintain this distribution equipment for their applications. Further, participants will have enough knowledge to achieve reduced capital, operating and maintenance costs along with increase in efficiency.

**During the duration of this course, participants will understand and learn the following:**

- Refresh of Electrical Fundamentals & Basics (Power types, power factor, inductance, ...).
- The fundamentals and basics of generators.
- How to control frequency and voltage.

- Gain knowledge of synchronization methods and conditions;
- The earthing system for generators.
- The different protection needed for generators.
- Understand practical power distribution fundamentals & Different layouts.
- Determine short-circuit ratings quickly and effectively
- Assess the influence of fault levels on switchgear ratings
- Select the correct type of switchgear for the right application
- Evaluate the advantages of modern state-of-the-art switchgear protection for your applications, including most recent information
- Correctly utilize and protect power transformers
- 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
- Understand the concept of protection system discrimination and appreciate its importance in improving security of supply
- Comprehensive understanding of principles and selection of protection relays and protection schemes
- Understand diagnostic testing and inspection, advanced fault detection techniques, critical components, and common failure modes.

- Study selection criteria, commissioning requirements, predictive and preventive maintenance, reliability, testing and cost.
- Discover the maintenance required to minimize their operating cost and maximize their efficiency, reliability and longevity

## Course Outline

### **Introduction & Overview to Electrical power Distribution networks**

- Review Electrical Fundamentals.
- Power system components.
- Distribution network layout & configurations.
- Bus bars configurations.
- Choice of transmission voltage.
- Cables & overhead transmission distribution lines.
- Electrical drawings & diagrams.
- Voltage disturbances to Power networks.
- Power Quality Specifications IEEE 446.

### **Condition Based Monitoring For Electrical Distribution Equipment**

- Insulation Resistance Monitoring.
- Insulation resistance test (IR).

- Components of DC Leakage Current.
- Megger test.
- Polarization index test.
- AC & DC hi-pot test.
- Measuring insulation degradation.
- Insulation power factor.
- On line measuring partial discharge activity for insulation.
- PDA Curves.
- On-Line Monitoring of Transformers.
- Local Indications.
- Thermography.
- PDA - Partial Discharge Analysis.
- Insulating Oil Properties And Tests
- Test for Dielectric Strength.
- Water Content in Oil.
- Acidity Test (Neutralization Number).
- Oxidation Inhibitor.
- Interfacial Tension Test (IFT).
- Oil Color.
- Oil Power Factor Test.

- Insulating Oil Dissolved Gas Analysis (DGA).

### **Generator Fundamentals Maintenance, Testing and Trouble Shooting**

- Generator Basics & principle of operations.
- Synchronous Generator Construction.
- The Speed of Rotation of a Synchronous Generator.
- The Internal Generated Voltage of a Synchronous Generator.
- The Equivalent Circuit of a Synchronous Generator.
- The Phasor Diagram of a Synchronous Generator.
- The Synchronous Generator Operating Alone.
- The Effect of Load Change on a Synchronous Generator Operating Alone.
- Parallel Operation of AC Generators.
- The Conditions Required for Paralleling.
- The General Procedure for Paralleling Generators.
- Frequency-Power and Voltage-Reactive Power Characteristics of a Synchronous Generator.
- Operation of Generators in Parallel with Large Power Systems.
- Synchronous Generator Ratings.
- The Voltage, Speed, and Frequency Ratings.
- Apparent Power and Power-Factor Ratings.

- Synchronous Generator Capability Curves.
- Generator excitation and voltage control.
- Preventative Maintenance & Trouble Shooting.

### **Transformer Fundamentals, Maintenance, Testing and Troubleshooting**

- Principles of Transformers.
- Saturation Curve & Voltage Ratio of Transformers.
- Current Ratio & Impedance of Transformers.
- Transformer Construction.
- Transformer losses and efficiency.
- Transformer Cooling & Types.
- Transformer Polarity & Vector group.
- Transformer Applications
- Transformer Accessories.
- Maintaining Transformers.
- K-Factor Transformers.
- Dry & Oil types.
- Preventative Maintenance.
- Transformer Inspection.
- Transformer Liquids.



- Dielectric Test.
- General Testing.
- Other Important Tests.
- Transformer Failure.
- Disassembly for Inspection.
- Common Transformer Abnormalities.
- Transformer Oil Tests.
- Fault Analysis.

### **Earthing Systems**

- Introduction.
- Equipment Earthing.
- System Earthing.
- Unearthed systems.
- Solid earthing.
- Resistance earthing.
- Reactance earthing.
- Classification of Supply / Installation System Earthing.
- 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.

### **Circuit Breaker Fundamentals, Maintenance, Service, Testing and Troubleshooting**

- Switching Operations & TRRV.
- Breaking & Making currents.
- Fundamentals, features, merits & Demerits of breakers.
- Air Circuit Breakers.
- Vacuum Circuit Breaker.
- SF6 Circuit breaker.
- Oil Circuit Breaker Ratings.
- Fuses & Is-limiters.
- Trip Circuit Supervision.
- Circuit-Breaker Control.
- Low Voltage Circuit Breakers (ACB, MCCB & mcb).
- HV Circuit Breakers Maintenance.
- H.V Circuit-Breakers Tests.
- Low voltage Circuit Breaker Maintenance.

## Protection and Protective Relays

- Instrument Transformers (CT & VT).
- Electrical Faults and Protection Schemes and Principles, Purpose of protective relays, Overcurrent and Earth Fault protection, etc....
- Fuses, High breaking Capacity Fuses (HRC).
- Generator protection schemes.
- Feeder protection cable feeders and overhead lines.
- Transformer protection schemes.
- Switchgear (busbar) protection.
- Motor protection relays.
- Coordinated distribution networks.
- Recommended protection schemes of international standards and some brand name manufactures (Siemens, Schneider, etc...).

## Accreditation:

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