Protection Schemes For Generators and Recommended Settings Course

Venue Information

Venue: London UK

Place:

Start Date: 2026-08-18

End Date: 2026-08-22

Course Details

Net Fee: £4750.00

Duration: 1 Week

Category ID: EAPET

Course Code: EAPET-58

Syllabus

Course Description

Protection of Electrical Power Systems requires an understanding of system faults and their detection, as well as their safe disconnection from the power system. This course presents a comprehensive and systematic description of the concepts and principles of operation and application of protection schemes for power generators. The course begins with an overview of power system faults and the protection scheme requirements for the detection and coordinated clearance of these faults. 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.

then moves onto more detailed applications. The workshop features an introduction covering the need for protection, fault types and their effects, simple calculations of short circuit currents and Generator neutral grounding configurations. The workshop also includes some Simulation work using ETAP power station for simple fault calculations, and recommended relay settings for generators as per recommended practice and based on setting rules.

Course Objective

The aim of this course is to provide in-depth discussions of the major electrical protection schemes associated with synchronous generators. The principles and criteria presented are applicable to both large and small machines. The discussions include analysis of the damage and damaging mechanisms relating to each protective function. An understanding of these parameters is important not only for the application of protection but also when operability issues arise during or after abnormal operating events.

Recommended settings applied to any protective device represent a balance between adequate sensitivity to detect a damaging condition and the security required to prevent false tripping during events that do not threaten the protected equipment. The importance of this balance at generation facilities is highlighted by the intense scrutiny given these protection schemes in the wake of large-scale system outages.

Course Outline

Generator Short Circuit Calculations

- Introduction
- Short-Circuit Current Characteristics
- Generator Internal Magnetics
- Generator Magnetic Structures
- Generator Constants
- Fault Current Calculations
- Initial Load
- Fault Calculation Overview
- Determination of Xf and Fault Currents
- Three-Phase Short Circuit
- Phase-to-Phase Short Circuit
- Phase-to-Ground Fault
- Other Fault Conditions
- DC Component of Short-Circuit Current
- RMS Asymmetrical Current
- Voltage Regulator

- Effects of the Automatic Voltage Regulator

Generator Differential Relay (87G)

- Introduction
- Ideal Differential Relay
- Practical Considerations
- CT Ratings
- CT Saturation
- CTs and Fault Current Replication
- Percentage Differential Relay
- Relay Characteristics
- Electromechanical Relays
- Solid-State and Microprocessor Relays
- Minimum Operating Current Setting
- Slope Setting
- Requirements for Slope Setting
- Advantage of Low Slope
- Sensitivity and Load Current
- Relay Response to Saturation
- Methods of Choosing Slope Settings
- Manufacturer's Recommendations
- Qualitative Determination of Slope
- Error Current Calculations for Unsaturated CT
- Mason's Method
- Example of Mason's Method
- Fundamental Frequency Analysis
- Sample System Differential Relay
- Sample System Differential Circuit
- Electromechanical Relay
- Specifications for Relay Chosen
- Choosing Slope Static and Microprocessor Relays
- Stabilizing Resistor
- Balancing Burden
- Time Delay
- Frequency Response
- Backup Fault Protection

- Voltage Supervised Overcurrent Relays
- Voltage-Controlled and Voltage-Restrained Relays
- Application Options and Fault Sensitivity
- Scheme Sensitivity vs. PT and CT Connection
- Delta Relay Currents
- Settings Considerations
- Automatic Voltage Regulator in Service
- 51 V Transmission System Backup Limitations
- Effects of Wye-Delta Transformer
- Self-Excitation Generators
- Relay Response to Transient Current
- Equipment Protection
- Relay Current and Voltage Calculations
- Sample System 51 V Relay Settings
- Auxiliary PTs to Correct for Wye-Delta Phase Shift
- Distance Relays
- Distance Relay Characteristics
- Mho Distance Relay
- Other Distance Relay Applications

Generator Ground Fault Protection

- Introduction
- Generator Grounding Considerations
- Ground Fault Current Limitation
- Overvoltage Concerns
- Core Damage Caused by Ground Fault
- Methods of Grounding
- Ungrounded System
- Solidly Grounded/Effectively Grounded
- High-Impedance Grounding
- High-Resistance Grounding
- Low-Impedance Grounding
- Grounding Transformers
- Ground Fault Protection
- 100% Stator Protection Schemes
- Third-Harmonic Schemes

- Introduction
- What Is Negative-Sequence Current?
- Effects of Negative-Sequence Current
- Generator Negative-Sequence Capability
- Sources of Negative Sequence Current
- Unbalanced Faults
- Unbalanced Current Protection
- Negative-Sequence Relay Settings

Motoring Protection

- Introduction
- Effects of Motoring
- Consequences for Prime Movers
- Protection
- Mechanical Protection
- Electrical Protection
- Sequential Trip Logic
- Backup Protection

Field Winding Protection

- Field Ground Protection
- Field Overcurrent Protection
- Relay Settings

Overexcitation

- Introduction
- Causes of Overexcitation
- Damage
- V/Hz Limits
- Protection
- Settings

Abnormal Frequency Protection

- Introduction
- Effects on Generator

Minimum Excitation Limiter (MEL)

- Overview
- Operation in Leading Mode
- Setting Criteria
- Stability Limits
- MEL Dynamic Performance

Loss of Synchronism

- Introduction
- Turbine Generator Damage
- Transient Stability
- Out-of-Step Protection
- Relay Schemes

Loss of Field (LOF) Protection

- General
- System Impact
- Generator Damage
- LOF Protection Devices
- Relay Schemes
- Special Considerations

Protection Elements & Main Settings Criteria

- Differential Protection
- Undervoltage Protection
- Overvoltage Protection
- Reverse Power Protection
- Loss of Excitation
- Time Overcurrent with Voltage Control
- Unbalance Protection
- Third Harmonic Neutral Undervoltage
- Stator Ground Fault/Restricted Ground Fault
- Neutral Overvoltage
- Under Frequency Protection
- Over Frequency Protection