Switchgear and Circuit Breakers: Operation, Testing and Maintenance

1 – 5 February 2027
Amsterdam - Zuidas business district hotel



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Introduction:

Switchgear and circuit breakers must open on demand to clear a fault, yet many outages trace back to a sticking mechanism, a worn vacuum interrupter, an overheated joint or a slow SF6 leak that routine checks missed. This Core Concept course equips engineers and technicians to select and operate LV, MV and HV switchgear, understand how air, vacuum and SF6 breakers interrupt current, run and interpret contact resistance, timing and insulation tests, and apply partial discharge and thermographic monitoring. Participants produce a Switchgear and Circuit Breaker Maintenance Plan for their own substation or plant.

Course Objectives:

- Classify switchgear by voltage class, insulating medium and construction and read breaker ratings before selecting or switching equipment
- Explain how air, vacuum and SF6 circuit breakers interrupt fault current and how relays and coordination curves command them to trip
- Carry out switching and racking sequences that respect mechanical and trapped-key interlocks
- Perform and interpret contact resistance, timing and travel, and insulation resistance tests on circuit breakers against baseline results
- Detect deterioration with partial discharge measurement, infrared thermography and SF6 gas density monitoring, and handle SF6 safely
- Build a Switchgear and Circuit Breaker Maintenance Plan that ranks assets by condition and criticality and sets inspection and test intervals

Target Audience:

- Electrical engineers responsible for substation and plant switchgear operation and asset condition
- Maintenance technicians who inspect, service and test circuit breakers and switchboards
- Testing and commissioning staff who run breaker timing, contact resistance and insulation tests
- Shift operators who carry out switching, racking and interlock checks on distribution and transmission switchgear
- Reliability and maintenance planners who schedule outages and set switchgear maintenance intervals

Course Outline:

Day 1: Switchgear Types, Ratings and Circuit Breaker Construction

- Voltage Classes and Switchgear Families: LV, MV and HV Assemblies
- Air-Insulated Versus Gas-Insulated Switchgear Layouts and Footprint
- Metal-Enclosed, Metal-Clad and Withdrawable Panel Construction
- Breaker Nameplate Ratings: Rated Voltage, Normal Current, Breaking and Making Capacity
- Switchgear Asset Register Built from the Single-Line Diagram

Day 2: Arc Interruption Technologies and Protection Overview

- Arc Physics, Current Zero Extinction and Transient Recovery Voltage
- Air Circuit Breaker Arc Chutes and Low Voltage Electronic Trip Units
- Vacuum Interrupter Contact Geometry and Erosion Wear Indicators
- SF6 Puffer and Self-Blast Interrupter Principles
- Protective Relays, Current Transformers and Time-Current Coordination Curves

Day 3: Switching Operations, Interlocks and Breaker Testing

- Spring-Charged Operating Mechanisms, Trip and Close Coils and Anti-Pumping Circuits
- Racking Sequences with Mechanical and Trapped-Key Interlock Checks
- Contact Resistance Measurement with a Micro-Ohmmeter
- Timing and Travel Analysis: Opening, Closing and Pole Synchronism
- Insulation Resistance Testing Across Open Contacts and Pole to Earth

Day 4: Condition Monitoring, SF6 Handling and Failure Modes

- Partial Discharge Detection with TEV, Ultrasonic and UHF Sensors
- Infrared Thermography of Busbar Joints, Cable Terminations and Breaker Contacts
- SF6 Density Monitoring, Leak Detection and Gas Recovery Equipment
- SF6 Arc Decomposition Products and Handling Precautions
- Failure Mode Analysis: Mechanism Sticking, Contact Overheating, Insulation Tracking and Gas Loss

Day 5: Switchgear Inspection Walkthrough and Maintenance Plan

- Switchboard Inspection Walkthrough Against a Condition Checklist
- Breaker Test Record Review: Trending Results Against Commissioning Baselines
- Maintenance Strategy Selection: Time-Based, Condition-Based and Reliability-Centred
- Switchgear Criticality and Condition Ranking Matrix
- Switchgear and Circuit Breaker Maintenance Plan Presentation

Skills You Will Gain:

- Switchgear Rating Interpretation
- Interrupter Technology Comparison
- Interlock Sequence Verification
- Breaker Timing Analysis
- Contact Resistance Diagnosis
- Partial Discharge Assessment
- SF6 Gas Management
- Maintenance Interval Planning

Why Attend This Course:

- Return with a Switchgear and Circuit Breaker Maintenance Plan that ranks your panels and breakers and sets test intervals
- Tell a healthy breaker from one that is drifting by reading timing, contact resistance and insulation results against baselines
- Find loose joints, discharge activity and gas loss before they cause a failure to trip or an internal fault
- Compare switchgear practice with engineers and technicians from power networks, generation, oil and gas, water and heavy industry

Conclusion:

Switchgear stays dependable when its ratings match the duty, its breakers are tested against a baseline and its insulation, joints and gas are watched between outages. This course moves from switchgear types, ratings and construction, through air, vacuum and SF6 interruption and protection coordination, to switching, interlocks and breaker testing. It then covers partial discharge, thermography, SF6 handling and failure modes, before the final day applies an inspection walkthrough to produce a Switchgear and Circuit Breaker Maintenance Plan.