Generator Excitation Systems and AVR: Operation, Diagnostic Testing and Maintenance

7 – 11 June 2027
Paris - Right Bank business hotel



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Introduction:

Generator excitation systems decide whether a synchronous generator holds terminal voltage, shares reactive load and rides through grid disturbances, yet many plants run with AVR limiters never checked, brush gear worn and insulation tests trended by no one. This Core Concept course prepares plant electrical staff to operate, test and maintain static and brushless excitation, place the generator on its capability curve, synchronise units safely and read insulation, partial discharge and rotor test results. Participants build a Generator Condition Assessment and Overhaul Plan for a unit at their own site.

Course Objectives:

- Interpret generator construction, nameplate ratings and the capability curve to keep a unit inside its stator, rotor and under-excitation limits
- Explain and check static and brushless excitation hardware, AVR control loops and excitation limiters, and describe the power system stabiliser role at overview
- Carry out synchronising and parallel operation, and share reactive power between units with droop or power factor control
- Supervise generator cooling systems and recognise abnormal air, hydrogen and stator water conditions before they limit output
- Perform and interpret insulation resistance, polarisation index, partial discharge and rotor winding tests and trend the results over time
- Plan minor and major inspections, trace excitation and winding faults to root cause and compile a Generator Condition Assessment and Overhaul Plan

Target Audience:

- Power plant electrical engineers responsible for generator and excitation system availability
- Generator maintenance engineers and technicians who inspect, test and overhaul stators, rotors and exciters
- Control room and unit operators who synchronise generators and control voltage and reactive power
- Industrial and cogeneration plant engineers responsible for on-site generating units
- Condition monitoring specialists who collect and trend insulation and partial discharge data

Course Outline:

Day 1: Synchronous Generator Construction, Ratings and Operating Limits

- Cylindrical Rotor and Salient Pole Construction: Stator Core, Windings and Retaining Rings
- Nameplate Ratings, Short-Circuit Ratio and Synchronous Reactance
- Generator Capability Curve: Stator Heating, Rotor Heating and Under-Excitation Boundaries
- Phasor Diagram Reading for Load Angle, Power Factor and Field Current
- Unit Baseline Review Using Operating Logs and Previous Inspection Reports

Day 2: Excitation System Architecture and AVR Control Functions

- Static Excitation: Thyristor Bridge, Excitation Transformer, Slip Rings and Field Flashing
- Brushless Excitation: AC Exciter, Rotating Diode Rectifier and Permanent-Magnet Pilot Exciter
- AVR Control Loop: Voltage Set Point, Error Signal, Gain and Response Tuning
- Over-Excitation, Under-Excitation and Volts per Hertz Limiters in the AVR
- Power System Stabiliser Purpose and Reactive Current Compensation at Overview

Day 3: Synchronising, Parallel Operation, Reactive Power and Cooling

- Synchronising Checks: Voltage, Frequency and Phase Angle Matching with Synchroscope and Check Relay
- Auto-Synchroniser Sequence and Consequences of Out-of-Phase Closure
- Reactive Load Sharing Between Parallel Units Using Droop and Power Factor Control
- Station Voltage and VAr Dispatch Instructions and Joint Reactive Control
- Cooling Circuit Operation: Air, Hydrogen and Stator Water Systems with Seal Oil Monitoring

Day 4: Insulation Diagnostics, Condition Monitoring and Fault Cases

- Insulation Resistance and Polarisation Index Testing of Stator and Rotor Windings
- Off-Line Partial Discharge Measurement to IEC 60034-27 and IEC 60270
- On-Line Partial Discharge Monitoring with HFCT Sensors and IEEE 1434 Trending
- Rotor Winding Tests: Shorted Turn Detection, Recurrent Surge Oscillation and Pole Drop Test
- Troubleshooting Field Failure, Diode Failure and Voltage Hunting with Protection Trip Records

Day 5: Major Inspection Case Work and Generator Condition Assessment Plan

- Major Inspection Scope Case: Rotor Removal, Wedge Tightness and Stator Core Findings
- Post-Overhaul Test Sequence Case: Open-Circuit Characteristic, AVR Step Response and Limiter Checks
- Inspection Walkthrough Case: Stator End-Winding, Brush Gear and Cooler Condition
- Generator Condition Assessment and Overhaul Plan Drafting
- Overhaul Plan Peer Review and Outage Scope Challenge

Skills You Will Gain:

- Capability Curve Interpretation
- Excitation System Diagnostics
- AVR Limiter Verification
- Generator Synchronising Practice
- Reactive Power Sharing
- Winding Insulation Assessment
- Partial Discharge Trending
- Overhaul Scope Planning

Why Attend This Course:

- Return with a Generator Condition Assessment and Overhaul Plan built from test data and inspection findings for a unit at your site
- Recognise the early signs of diode, brush gear and insulation deterioration before they force an unplanned outage
- Explain to operations why a unit must stay inside its capability limits and how excitation settings affect grid voltage
- Compare generator operating and maintenance practice with engineers from utilities, oil and gas, petrochemicals and industrial cogeneration

Conclusion:

A generator stays available when its excitation is understood, its operating limits are respected and its insulation is tested and trended. The course moves from construction, ratings and the capability curve, through static and brushless excitation and AVR functions, to synchronising, reactive power control and cooling, and then to insulation, partial discharge and rotor diagnostics with fault cases. The final day applies this to inspection and overhaul cases and produces a Generator Condition Assessment and Overhaul Plan for the next outage.