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COURSE BROCHURE

# Advanced Protection of Electrical Power Systems Training Course

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Registered in the United Kingdom and Saudi Arabia

# Advanced Protection of Electrical Power Systems Training Course

Protection of Electrical Power Systems is a 2-week training course for protection engineers, substation engineers and relay testing specialists who select, set and coordinate relays on transmission, distribution and industrial networks, and who leave with a Protection Coordination Study and relay setting sheet for one real network section. Faster clearing, selective tripping and digital substations now decide how reliably power reaches customers. Jupiter Prime Training delivers this course on protection of electrical power systems.

## Why Protection of Electrical Power Systems Matters Now

Three forces reshape protection of electrical power systems today. Numerical relays and digital substations bring hundreds of settings per device, so a single wrong parameter can cause a wide-area blackout or a missed trip. Network topologies change constantly as new feeders, cables and generation arrive, leaving older coordination studies out of date. Asset owners, operators and industrial customers expect fewer nuisance trips and shorter outages. A utility that keeps its protection philosophy current isolates faults selectively and protects equipment; one that does not suffers cascading trips, damaged transformers and safety incidents. The course draws on established protection principles and on IEC 61850 for substation communication.

## Who Gains Most from Protection of Electrical Power Systems

- Protection engineers who calculate settings and approve coordination for transmission and distribution feeders
- Substation engineers responsible for current and voltage transformer selection and scheme wiring
- Relay testing specialists who commission schemes and run secondary injection and end-to-end tests
- Industrial electrical engineers who coordinate plant protection with the utility intake
- Asset engineers who review relay performance after disturbances

A protection and control department in a transmission utility or a large industrial complex gains most when its setting engineers and testers attend together.

## Protection of Electrical Power Systems Capabilities

Participants move from individual relay functions to a coordinated protection philosophy that balances speed, selectivity, sensitivity and security.

- Calculate inverse-time overcurrent and earth fault settings with grading margins — radial feeder coordination
- Design distance protection zones and reach settings for lines and cables — transmission line security
- Specify transformer, generator and busbar differential schemes — equipment protection decisions
- Assess current transformer saturation and accuracy class adequacy — scheme reliability
- Build numerical relay setting files and logic — commissioning and change control
- Test protection schemes by secondary injection and end-to-end methods — energisation approval

## Key Protection of Electrical Power Systems Terms

- Selectivity — the ability of a protection system to trip only the breakers nearest the fault, leaving healthy sections in service.
- Grading margin — the time interval between successive relays that lets the downstream device clear a fault first.
- Distance zone — a reach setting expressed in impedance that defines how far along a line a relay operates instantaneously or with delay.
- Differential protection — a scheme comparing currents entering and leaving equipment and tripping when they differ beyond a set bias.
- Knee-point voltage — the current transformer secondary voltage above which the core begins to saturate.
- Breaker failure protection — a backup function that trips adjacent breakers when a breaker fails to interrupt a fault.

## Protection of Electrical Power Systems Day by Day

## Day 1: Protection Philosophy and System Context

- Protection Objectives — Speed, Selectivity, Sensitivity and Security Balance
- Zones of Protection and Overlap — No Unprotected Gaps Between Equipment
- Main and Backup Protection Philosophy — Redundancy Level Decisions
- Network Earthing and Fault Levels — Inputs to Every Setting
- Protection Performance Indicators — Correct, Unwanted and Failed Operations

## Day 2: Instrument Transformers

- Current Transformer Accuracy Classes — Protection Versus Metering Cores
- Saturation and Knee-Point Calculation — Burden and Fault Current Checks
- Voltage Transformer Connections — Open Delta and Residual Voltage Use
- Polarity and Wiring Verification — Avoiding Reversed Directional Elements
- Low-Power Instrument Transformers — Merging Units in Digital Substations

## Day 3: Overcurrent and Earth Fault Protection

- Inverse-Time Characteristic Curves — Standard, Very and Extremely Inverse Choice
- Time-Current Grading Studies — Margins Between Fuses, Relays and Breakers
- Directional Overcurrent Elements — Ring Mains and Parallel Feeders
- Sensitive and Restricted Earth Fault Settings — High-Impedance Earthing Cases
- Auto-Reclosing Schemes — Transient Fault Restoration on Overhead Lines

## Day 4: Distance Protection

- Impedance Measurement Principles — Mho and Quadrilateral Characteristics
- Zone Reach and Time Settings — Underreach and Overreach Trade-Off
- Infeed, Mutual Coupling and Fault Resistance — Reach Error Corrections
- Power Swing Blocking and Out-of-Step Tripping — Stability Event Response
- Series-Compensated and Cable Line Challenges — Special Setting Rules

## Day 5: Teleprotection and Line Differential

- Permissive and Blocking Schemes — Communication-Aided Fast Clearing
- Line Current Differential Protection — Channel Delay and Alignment
- Communication Media Options — Fibre, Microwave and Power Line Carrier
- Weak Infeed and Echo Logic — Ends with Little Fault Current
- Teleprotection Performance Testing — Channel Availability Records

## Day 6: Transformer and Generator Protection

- Transformer Biased Differential Settings — Inrush and Overexcitation Restraint
- Buchholz and Pressure Relief Devices — Internal Fault Detection
- Generator Stator and Rotor Earth Fault Protection — Winding Coverage Choice
- Loss of Excitation and Reverse Power — Machine Abnormal Conditions
- Unit Protection Tripping Matrix — Mapping Functions to Breakers

## Day 7: Busbar and Breaker Failure Protection

- High-Impedance Busbar Differential — Stabilising Resistor Calculation
- Low-Impedance Numerical Busbar Schemes — Dynamic Zone Selection
- Breaker Failure Timers and Retrip — Backup Clearing Speed
- Dead Zone and End Fault Protection — Faults Between CT and Breaker
- Busbar Scheme Isolation for Maintenance — Safe Testing Procedures

## Day 8: Numerical Relays and Digital Substations

- Numerical Relay Architecture — Sampling, Filtering and Function Blocks
- Setting File Management — Version Control and Change Approval
- Programmable Scheme Logic — Interlocks and Custom Tripping Conditions
- IEC 61850 GOOSE and Sampled Values — Replacing Copper Wiring
- Cyber Security of Protection Devices — Access Control and Patching

## Day 9: Testing, Commissioning and Performance

- Secondary Injection Testing — Pickup, Timing and Characteristic Checks
- End-to-End Satellite-Synchronised Tests — Teleprotection Scheme Proof
- Commissioning Records and Acceptance — Energisation Readiness Decision
- Post-Disturbance Relay Performance Review — Correct Operation Assessment
- Periodic Maintenance Testing Intervals — Risk-Based Test Planning

## Day 10: Practising the Protection Coordination Study

- Applying Instrument Transformer Checks — Selected Network CT Adequacy
- Applying Overcurrent Grading — Time-Current Curves for the Case
- Applying Distance and Differential Settings — Line and Transformer Schemes
- Applying Breaker Failure and Busbar Logic — Substation Tripping Matrix
- Protection Coordination Study — Relay Setting Sheet for Peer Review

## Applying Protection of Electrical Power Systems After the Course

- Re-run the time-current grading for one feeder whose network has changed since its last study and record any lost margins.
- Check current transformer knee-point voltages on one transformer differential scheme against the latest fault levels and report any saturation risk.

## Protection of Electrical Power Systems Questions FAQ

### What is protection of electrical power systems, and why does it matter now?

Protection of electrical power systems is the design, setting and testing of relays that detect faults and isolate only the affected equipment. It matters now because numerical relays, digital substations and changing networks make coordination errors both more likely and more costly.

### Which roles gain most from protection of electrical power systems training?

Protection engineers, substation engineers, relay testing specialists and industrial electrical engineers gain most. You benefit if you calculate settings, select instrument transformers, commission schemes or review relay behaviour after disturbances.

### How does protection of electrical power systems differ from a fault analysis course?

A fault analysis course explains why a fault happened and how to find it. This course designs the relays that respond to faults, covering overcurrent, distance, differential, busbar and breaker failure schemes, coordination studies, numerical settings and commissioning tests.

## What do you bring back from protection of electrical power systems training?

You bring back a coordination study and setting sheet for one network section, with grading curves, zone reaches and differential settings. It gives your department a verified template for the next feeder, substation or plant extension.

## Protection of Electrical Power Systems: The Way Forward

The Protection Coordination Study first informs whether existing relay settings stay valid after a network change. Protection engineers and relay testers use it to update setting files and test plans. After its first use, revisit the IEC 61850 logic and breaker failure timings it assumes, since digital substation upgrades and new generation alter fault levels and tripping paths.