



Power System Studies Course: Load Flow, Short Circuit, Motor Starting and Arc Flash



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Introduction:

Power system studies for load flow, short circuit, motor starting and arc flash are the subject of this 10-day course for electrical design, planning and protection engineers, who build a Power System Study Package for a case industrial or substation network. Many projects and plant expansions run on network models with unverified data and outdated fault levels, so equipment is overdutied and voltage problems appear only at commissioning. Nominees already prepare designs, network data or protection inputs, and teaching is by modelling build in power system analysis software. CoreConcept Training Center delivers this power system studies course.

Course Objectives:

- Build per-unit network models of lines, cables, transformers, generators, motors and loads from verified single-line diagram data
- Run Gauss-Seidel and Newton-Raphson load flow studies and set tap, capacitor and generator voltage controls that hold bus voltages within limits
- Rank N-1 contingencies and calculate symmetrical and unsymmetrical fault currents with the IEC 60909 method to check switchgear, cable and busbar duty
- Assess motor starting voltage dips and harmonic resonance risk and recommend a starting method or mitigation
- Prepare arc flash, protection coordination, transient stability and earthing study inputs at the scope and set-up level a study team needs
- Validate network models against site measurements and issue a study report with findings, sensitivity cases and recommendations

Target Audience:

- Electrical design engineers responsible for network calculations and equipment ratings on new projects
 - Power system planning engineers responsible for load flow and fault level studies on utility and industrial networks
 - Protection engineers responsible for fault level inputs and coordination studies ahead of relay setting work
 - Consultancy and EPC engineers responsible for delivering study packages to clients and design reviewers
 - Plant electrical engineers responsible for checking network changes, large motor additions and arc flash labelling
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Course Outline:

Day 1: Per-Unit System, Network Data and Single-Line Diagram Preparation

- Per-Unit Base MVA and Base kV Selection Across Voltage Levels
- Single-Line Diagram Data Collection Sheets and Study Scope
- Nameplate, Test Report and Cable Schedule Data Verification
- Bus Numbering, Switching Configurations and Operating Scenario Definition
- Study Basis Document With Assumptions and Data Gaps Register

Day 2: Network Component Models for Lines, Cables, Transformers, Machines and Loads

- Overhead Line and Cable Positive and Zero Sequence Impedances
- Two- and Three-Winding Transformer Models With Tap Changers
- Synchronous Generator Reactances, Capability Curves and Grid Equivalents
- Induction and Synchronous Motor Models Using Locked-Rotor Data
- Constant-Power, Constant-Current and Composite Load Models for Studies

Day 3: Load Flow Solution Methods, Voltage Profiles and Reactive Power Control

- PQ Load Bus, PV Generator Bus and Slack Bus Assignment
- Gauss-Seidel Iteration and Convergence Behaviour on Radial Networks
- Newton-Raphson Jacobian Solution and Fast Decoupled Load Flow
- Transformer Tap, Capacitor Bank and Generator AVR Voltage Control
- Load Flow Result Review of Branch Loading and Losses

Day 4: Contingency Analysis and IEC 60909 Short-Circuit Calculations

- N-1 Contingency Case Lists for Transformer and Feeder Outages
- Symmetrical Components and Sequence Networks for Unsymmetrical Faults
- IEC 60909 Equivalent Voltage Source and Voltage Factor c
- Line-to-Earth, Line-to-Line and Double Line-to-Earth Fault Currents
- Motor and Generator Fault Contribution With AC and DC Decay

Day 5: Guided Case Study on Load Flow, Contingency and Fault Level Results

- Case Network Model Build in Power System Analysis Software
 - Normal and Peak Demand Load Flow Cases for Case Network
 - N-1 Contingency Ranking of Overloads and Voltage Violations
 - Maximum and Minimum Fault Level Tables at Each Switchboard
 - Switchgear Making, Breaking and Short-Time Withstand Duty Checks
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Day 6: Motor Starting Studies and Harmonic Analysis Basics

- Direct-On-Line, Soft Starter and Drive Starting Methods Compared
- Static Motor Starting Voltage Dip at Motor and Upstream Buses
- Dynamic Motor Acceleration Study With Torque-Speed Load Curves
- Harmonic Current Sources From Drives, Rectifiers and Inverters
- Frequency Scan and Parallel Resonance Check With Capacitor Banks

Day 7: Arc Flash Study, Electrical Safety Outputs and Earthing Study Overview

- IEEE 1584 Incident Energy Inputs and Working Distance Selection
- Arc Flash Boundary Determination and Equipment Warning Label Content
- NFPA 70E PPE Category Selection From Incident Energy Results
- Arc Flash Mitigation Through Faster Clearing and Maintenance Switches
- Earthing Study Overview of Grid Resistance, Step and Touch Voltages

Day 8: Protection Coordination Study Workflow and Transient Stability Study Set-Up

- Protection Coordination Study Inputs From Fault and Load Results
- Time-Current Curve Plotting for Fuses, Breakers and Overcurrent Relays
- Coordination Study Setting Tables, Curve Sets and Exception Lists
- Transient Stability Study Set-Up With Dynamic Models and Fault Events
- Generator and Large Motor Recovery Screening After Fault Clearance

Day 9: Model Validation, Study Reporting and Quality Review

- Model Validation Against Metered Loads, Bus Voltages and Fault Records
- Sensitivity Cases for Source Impedance, Tap Positions and Future Loads
- Study Report Structure With Assumptions, Results and Recommendations
- Study Peer Review Checklist and Model Version Control Log
- Study Findings Briefing for Project, Operations and Protection Teams

Day 10: Capstone Modelling Build of a Power System Study Package

- Capstone Case Network Brief for Industrial or Substation Study
 - Capstone Load Flow and Contingency Results With Remedial Actions
 - Capstone Fault Level, Equipment Duty and Arc Flash Tables
 - Capstone Motor Starting and Harmonic Screening Result Sheets
 - Power System Study Package Completion and Peer Presentation
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Skills You Will Gain:

- Per-Unit Network Modelling
- Load Flow Analysis
- Contingency Screening
- Fault Level Calculation
- Equipment Duty Verification
- Motor Starting Assessment
- Harmonic Resonance Screening
- Engineering Study Reporting

Why Attend This Course:

- Deliver a Power System Study Package for a case network to the engineering manager and the project or plant electrical lead
- Decide whether switchgear, cables and transformers can carry the load and withstand the fault levels of a planned extension
- Avoid commissioning delays, voltage complaints and arc flash exposure caused by studies run on unvalidated models
- Share study basis templates, data sheets and report structures with design, protection and operations colleagues

Conclusion:

Back at work, the participant hands the Power System Study Package to the engineering manager and the project or plant electrical lead, who use it to approve network extensions, confirm equipment ratings, plan large motor connections and set arc flash labelling priorities. Protection teams take the fault level tables and coordination inputs into their setting work. After the first study issued with this method, the unit should compare model results with measured voltages, loads and any recorded faults, then update the study basis and data register.

Frequently Asked Questions FAQ:

What should participants know before a power system studies course on load flow, short circuit, motor starting and arc flash?

Participants should already read single-line diagrams, understand three-phase circuits and impedance, and have prepared or reviewed electrical calculations at work. Bringing an anonymised single-line diagram and equipment data from their own network helps them apply the modelling build to a familiar case.

How does this power system studies course on load flow and short circuit differ from protection relaying or grid stability courses?

It centres on building and validating network models and running the study set that projects require. Relay setting calculation and testing, stability theory and blackout defence, and distribution planning belong to neighbouring courses and appear here only as study inputs or set-up steps.

Why do power system studies use the IEC 60909 method for short circuit calculations?

The IEC 60909 method gives a consistent way to calculate initial symmetrical, peak and breaking currents using an equivalent voltage source at the fault and a voltage factor c . The results feed switchgear, cable and busbar duty checks and arc flash calculations.

What do participants take back from the power system studies course on load flow, short circuit, motor starting and arc flash?

Participants return with a Power System Study Package for a case industrial or substation network, holding the study basis, load flow and contingency results, fault level and duty tables, motor starting and harmonic screening, an arc flash summary and a study report ready for peer review.
