INDUSTRIAL ELECTRIC POWER SYSTEM ENGINEERING TRAINING

POWER SYSTEM DESIGN, PROTECTION AND SYSTEM STUDIES

THE ELECTRICITY FORUM Est 1986

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LOS ANGELES, CA | MAY 25-29, 2015
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The Power System Design Agenda

The Power System Design part of the course will teach students how to:

- Design electrical power systems more efficiently
- Better select and size power system components
- Understand the fundamentals of short circuit studies
- Understand the basics of coordination studies
- Calculate overcurrent device settings
- Understand power system design and analysis
- Provide the optimum sizing of the Electrical System for a specific application to obtain maximum performance and reliability
- Select the best electrical equipment for retrofitting an old system

The Power System Protection And Coordination Engineering Agenda

The Power System Protection and Coordination Engineering Training part of the course will:

- Teach students how to reduce unnecessary downtime
- Provide recommended settings for adjustable trip circuit breakers and relays
- Teach students how to increase coordination (selectivity) between devices
- Identify deficiencies in system protection
- Provide recommended solutions to help correct your problem areas
- Review and hold discussions on the use of protective devices with respect to Code requirements and appropriate ANSI/IEEE standards

The Electrical Power System Studies, Software Simulation and Calculations Agenda

The Electrical Power System Studies, Software Simulation and Calculations part of the course will analyze all aspects related to the:

- Electrical power flow during normal operation
- Optimization of electrical power flow and sizing
- Electrical power flow during abnormal operation, as described below
- Transients status of the electric power system
- Dynamic loads behavior and how they affect the power system
- Special investigation of the electromagnetic field
- Harmonics generated into the power system caused by switching or non-linear magnetic core saturation
- Special case of resonance or traveler waves in correlation to the grounding system

WWW.ELECTRICITYFORUM.COM/USA/POWER-SYSTEM-ENGINEERING.HTML

COURSE PROGRAM

DAY 1

Session 1: INTRODUCTION TO INDUSTRIAL/ COMMERCIAL/INSTITUTIONAL POWER SYSTEMS

- Power system fundamentals
- Power flow from generation to industrial power system
- Electrical equipment ratings
- Sustainability of the power flow in today's industrial environment
- Adapting the power system for future requirements
- Codes and standards for industrial/commercial/institutional electrical power systems

Session 2: MAJOR EQUIPMENT AND COMPONENTS OF AN INDUSTRIAL POWER SYSTEM

- Writing a design requirement for major electrical power equipment
- Example of switchgear configurations for different power and voltage levels
- Customer-owned substation design requirements
- Industrial substation design considerations and selection of configuration based on reliability
- Electrical power availability for different design topologies
- How to select and size an electrical power generator
- Major considerations for selection of power transformers
- Properly sizing and selecting circuit breakers and switchgear

Session 3: MAJOR IMPLICATION OF THE EVOLUTION OF THE SOLID STATE TECHNOLOGY ON EQUIPMENT SELECTION

Session 4: INDUSTRIAL ELECTRICAL SUBSTATION STRUCTURES AND ARRANGEMENTS

- Major substation components
- Typical one line of a substation
- Selecting the required configuration to achieve the design requirements performance parameters
- Operability, maintainability, constructability of a new substation
- Procedures to maintain the power equipment
- OEM maintenance requirements, example of a circuit breaker

Session 5: TYPICAL MAINTENANCE ISSUES

- Power factor correction units
- Protection, monitoring and control systems
- Substation grounding key points and considerations
- Power cables key points for selection and installation

DAY 2

Session 6: ELECTRICAL SYSTEM DESIGN FOR INDUSTRIAL/COMMERCIAL/INSTITUTIONAL BUILDINGS

- Low-voltage main input feeder to facilities
- Major building loads: HVAC units; illumination; fire protection and detection and process power
- Spare capacity and calculations required before detailed design start
- Separating static and dynamic loads: MCC; distribution panels and switchgear
- Tap changers to compensate for low power factor
- Power factor compensation requirements to eliminate voltage sags
- Providing backup power for critical loads
- Backup generators; UPS systems; static switches and power conditioning
- Using VFD for low inrush and how to minimize equipment stress
- ATS assessment and considerations; 3 or 4 line ATS
- Surge protection for sensitive electronic equipment
- Selecting motor control centers and distribution panels for correct loads
- Creating artificial neutrals if required
- Selecting proper transformers for the load type
- Fire alarm systems - electrical power requirements
- IT LAN and communication system backup power requirements
- Building automation system monitoring and control
- Arc flash ratings for major electrical distribution panels
- Building grounding and lightning protection
- Avoiding grounding loops
- Standards and codes applicable to building electrical systems

Session 7: PROTECTION AND MONITORING OF THE BACKUP GENERATOR UNITS

Backup generation systems overview

- Typical protection for electrical power generators
- Control of electrical power generators, the AVR system, isochronous and drooping
- Governor control units, selection and design recommendations
- Integrated protection of electrical power generators
- Characteristics of electrical generators under stress and step load condition
- Vibration monitoring, avoiding resonant effects
- SCADA systems for large transmission networks
- Grounding considerations for generator units

Session 8: ELECTRICAL LOADS

- Static and dynamic loads, e.g. electrical motors
- Short circuit rating and terminology
- Balanced fault calculation
- Overcurrent coordination fundamentals
- Protective devices time/current characteristics and protective relays

Session 9: UNBALANCED SYSTEMS AND WHAT HARM MAY BE CAUSED IN MAJOR ELECTRICAL EQUIPMENT

- Considerations for loads with high inrush power and non-linear magnetic cores
- UPS loads feed from backup generators via ATS - case study
- How to avid current circulation due to grounding loops
- Bonding needs to be assessed, may help or may not
- What helps in electrical systems to avoid EMI
- Case study of a high EMI illumination system

Session 10: TOOLS TO CONSIDER FOR THE SELECTION AND CONFIGURATION OF ELECTRICAL POWER SYSTEMS

Analytical approach of a Power System design

- Available power system design software, category, classification and level of trust
- Requirements of the software design tools for an application
- Standards incorporated in software tools
- Data validation for modeling a power system
- Output validation of a simulation using software tools
- Example of a power system calculation
- Grounding and grounding interconnections
- Power Flow - structural design correlation
- Testing, calibration and instrumentation considerations

DAY 3

Session 1: INTRODUCTION TO POWER SYSTEM PROTECTION AND COORDINATION

- Types of electrical protection for power systems
- Fuses for high voltage and medium-voltage systems
- Time current characteristics of the power fuses
- Fixed and variable tripping of a power fuse
- Expulsion-type fuse, advantage and limitations
- Cable protection in line fuses
- Reducing the arc flash in case an event happens

Session 2: ENGINEERING TOOLS FOR POWER SYSTEM ANALYSIS

- Phasors, polarity and symmetrical components
- Polarity in relay circuits
- Fault types and causes, fault characteristics

Course Instructor:

Dr. Eduard Loiczli, P.Eng.,
Electricity Forum
Engineering Specialist

COURSE TIMETABLE (ALL DAYS)
Start: 8:00 a.m.
Coffee Break: 10:00 a.m.
Lunch: 12:00 noon
Restart: 1:15 p.m.
Finish: 4:30 p.m.

- Fault evaluation methods
- Example of a calculation for power system faults

Session 3: UNDERSTANDING THE POWER SYSTEM PROTECTION RELAYS

- Classification of protection relays
- Voltage and current instrument transformers
- Zero sequence network
- Electromechanical units: magnetic units; induction units; thermal units; d'arsonval units
- Solid state units: semiconductor components; solid state logic units; fault sensing and amplification units
- Basic logic circuits and operation
- Microprocessor controlled relays

Session 4: INTEGRATED POWER SYSTEM PROTECTION DEVICES

- Bessel integrated protection units
- GE integrated relay systems-multiline G60; G30 and other GE protection integrated relay
- Switzer laboratory integrated solutions - SEL protection family
- ABB integrated relays dpu/tpu relay family
- Cooper protection relays
- Vamp protection integrated relays
- Siprotec Siemens relays
- Micom Schneider protection relay family
- Comparing the main manufacturer protection relay performance

Session 5: SYSTEM PROTECTION PHILOSOPHY, LOCATION OF THE POWER SYSTEM PROTECTION RELAY

- Defining the relay protection zone and functions
- Standards and code requirements for electrical system protection
- Integrating the protection relay to the power distribution system
- Selection of the best strategy of protecting the power system
- Correlation between the power system protection and the grounding configuration, solid grounding; resistive grounding and impedance grounding
- Strategy of replacing obsolete protection relay systems

Session 6: BALANCED AND UNBALANCED POWER SYSTEMS

- Short circuit calculation in balanced systems
- Unbalanced power system case study and vector representation
- Power transformer behavior in delta; open delta and star configuration
- Power flow circulation in unbalanced systems
- System short circuit condition in unbalanced systems

DAY 4

Session 7: POWER SYSTEM TRANSIENTS CAUSED BY INTERNAL OR EXTERNAL FACTORS

- Substation bus protection
- Substation power transformer and reactor protection relays
- Substation feeder protection coordination
- Circuit breakers and reclosers
- Differential scheme acting on external factors
- Over-current relays acting on external or internal factors
- Differential protection of generator-transformer units
- Distance relays for backup power

Session 8: POWER SYSTEM TRANSIENTS CAUSED BY INTERNAL FACTORS

- High inrush currents generated by magnetic core
- Switching power under load or no-load conditions
- Mutual induced current in adjacent circuits
- Traveling waves in electrical power transformers
- Ferro-resonance effects in power transformers
- Long line effects on substations
- Remote tripping of transformer banks
- Electrostatic and electromagnetic induction
- Differential and common mode transient compensation
- Capacitor switching systems
- Bus energization or deenergization
- Transmission line switching
- Coupling capacitor switching
- Reclosers as a source of system disturbance

Session 9: COMPENSATION AND MITIGATION OF THE ELECTRICAL POWER SYSTEM TRANSIENTS

- Separation principle applied to power systems
- Suppression systems at the source
- Suppression shielding, case study for power cables
- Control systems immunity from EMI and induced transients
- Correcting electric power quality to avoid spurious trips and nuisance alarms

Session 10: OVERVIEW OF FLOW CONTROL OF ACTIVE AND REACTIVE POWER IN ELECTRICAL SYSTEMS

- Capacitor bank protection
- Protecting solid state reactive power units
- Reactive power regulation and control
- Compensating for power factor at the industrial side

Session 11: DESIGN CONSIDERATION TO OBTAIN A ROBUST POWER SYSTEM

STEADY STATE STABILITY

- Voltage stability and on load step condition
- Voltage stability for small disturbances
- Transient stability and recovery
- Voltage instability protection
- Intelligent load shedding

Session 12: ELECTRICAL PROTECTION DESIGN STEPS AND FACTORS TO BE CONSIDERED

- Modeling a power system, data validation
- Short circuit analysis of a power system
- Analytical or software driven calculations
- Protection coordination - Time current curves
- Calibration and maintenance of protective equipment - relay calibration data sheets
- Test bench equipment for calibration and validation
- Codes and standards applicable to electrical power systems

Session 13: CASE STUDY OF A COMPLEX POWER SYSTEM PROTECTION DESIGN

- Using specialized software a complex power system will be analyzed

DAY 5

Session 1: INTRODUCTION TO THE SIMULATION & CALCULATION SOFTWARE LOAD FLOW CALCULATION

- Overview of software tools
- Software applicability and limitations
- Understanding the library major components
- Steady state simulation
- Power flow simulation
- Setting up case study for power flow calculation
- Sizing major equipment and calculating voltage drop using Easy Power
- Model example for a distributed system using Easy Power
- Voltage optimization study

Session 2: SHORT CIRCUIT ANALYSIS AND STUDIES

- Model of the electrical system for short circuit analysis
- Sources of fault contribution
- Bolted fault on 3-phase systems
- Phase-to-ground short circuit versus 3-phase short circuit
- ANSI versus IEC short circuit study
- Case study of a short circuit analysis for double feed BUS
- Report generation and results Interpretation

Session 3: PROTECTION COORDINATION STUDIES

- TCC for fuses, breakers and re-closures
- Parameter settings for circuit breakers and over current relay re-closures
- Coordination time intervals
- TCC coordination between fuses
- TCC coordination between circuit breakers
- TCC coordination fuses and breakers
- TCC coordination of grounding relays
- Example of a protection coordination for complex system using fuses, breakers and overcurrent re-closers
- Results interpretation and optimization

Session 4: ARC FLASH STUDIES AND SOFTWARE SIMULATION

- IEEE 1584 versus NFPA 70E
- Bolted fault versus arching fault
- Example of an ARC flash calculation, with different scenarios
- Interpretation of the results of the ARC flash calculations
- Active and passive methods of determining ARC flash mitigation

Session 5: OTHER STUDIES AND SOFTWARE SIMULATIONS AVAILABLE

- Ground grid modeling
- Motor acceleration studies
- Transient stability analysis
- Harmonics analysis
- Optimal capacitor placement
- Switching management
- Optimal power flow analysis
- Reliability studies
- DC load flow calculations
- DC short circuit analysis
- DC charger sizing
- EMTP electromagnetic transient simulations

Session 6: SUBSTATION MODELING AND CALCULATION

- Performing all available Easy Power simulation and calculations
- Generating report in support of the electrical design base
- Normal and upnormal operation case study

WAYS TO REGISTER

(315) 789-8323

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ON-LINE:

www.electricityforum.com/usa/power-system-engineering.html

MAIL:

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One Franklin Square, Suite 302
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ATTENDEE INFORMATION

To receive registration fee discounts, you must **REGISTER AND PREPAY** prior to the course date.

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The fee includes Course presentation materials, Electrical Protection Handbook in electronic format, $100 coupon towards future 2015-16 Electricity Forum events, refreshments and lunch.
NOTE: This course includes a FREE EasyPower Electrical Engineering Software Demo CD.

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WHEN & WHERE

(Please check the date/location where you want to attend the course)

Industrial Electric Power System Engineering Training

☐ **Los Angeles, CA - May 25-29, 2015**
Four Points By Sheraton LAX Airport Hotel
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