INDUSTRIAL POWER SYSTEM ENGINEERING TRAINING

SYSTEMATIC APPROACH TO INDUSTRIAL POWER SYSTEM DESIGN

www.electricityforum.com/forums/power-system-design.html

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October 16-17, 2014 - Edmonton, AB
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INDUSTRIAL POWER SYSTEM STUDIES, SOFTWARE SIMULATION AND CALCULATIONS

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ON-SITE TRAINING AVAILABLE

course #1

SYSTEMATIC APPROACH TO INDUSTRIAL POWER SYSTEM DESIGN

PROGRAM DETAILS:
www.electricityforum.com/forums/power-system-design.html

DAY ONE

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 point for selection and installation

DAY TWO

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

course #2

INDUSTRIAL POWER SYSTEM PROTECTION AND COORDINATION

PROGRAM DETAILS:
www.electricityforum.com/forums/power-system-protection.html

DAY ONE

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
- 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 TWO

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
- Overcurrent 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

course #3

INDUSTRIAL POWER SYSTEM STUDIES, SOFTWARE SIMULATION AND CALCULATIONS

PROGRAM DETAILS:

www.electricityforum.com/forums/power-system-studies.html

DAY ONE

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

- Overview of the 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

- 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 three 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

DAY TWO

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-closures
- Results interpretation and optimization

SESSION4: 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 result of the arc flash calculation
- Active and passive methods of arc flash mitigation

SESSION 5: OTHER STUDIES AND SOTWARE SIMULATIONS AVAILABLE

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

SESSION 6: SUBSTATION MODELING AND CALCULATIONS

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

WAYS TO REGISTER

(905) 686-1040

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ON-LINE:

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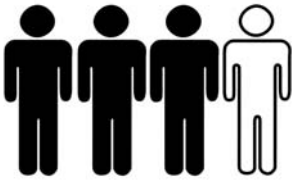

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