



Training Program:

Electric Power Substation Maintenance And Safety

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Introduction:

Switchgear (and circuit breakers) are obviously critical components in electrical distribution systems and their operation significantly affects the overall operation of the system safely. The workshop will discuss application, installation, maintenance and testing issues relating to low and high voltage switchgear and circuit breakers. Attendees will receive a thorough safety grounding in switchgear theory and standards. The arc flash hazardous will be discussed. The focus here is on air blast, oil, SF6 and vacuum circuit breakers. After the successful start-up and subsequent continued operation, electrical equipment requires periodic inspection and testing. This will ensure the electrical equipment operates correctly so that production is maximized in a safe, cost effective and efficient and safety manner.

This course covers all aspects of safety issues of Electrical power system, general design considerations, application of switching and power equipment, and safe grounding design.

Who Should Attend?

Electrical power generation systems and distribution engineers and technicians in utilities and industrial plants, managers of private electricity producers and large power consumers, substation engineers, consulting engineers, manufacturers of power equipment and technologists and other technical personnel involved in the design, operation and maintenance of high/medium/low voltage power systems.

Methodology

This interactive Training will be highly interactive, with opportunities to advance your opinions and ideas and will include;

- Lectures
- Workshop & Work Presentation
- Case Studies and Practical Exercise
- Videos and General Discussions

Certificate

BTS attendance certificate will be issued to all attendees completing minimum of 80% of the total course duration

Course Objectives:

By the end of this course delegates will be able to:

- Fundamentals of operation of switchgear.
- To demonstrate the earthing systems Safety and Risk Assessment.
- To provide a practical understanding of electrical power system safety.
- To indicate arc flash hazard and mitigation.
- To explain the relation between maintenance activities for various equipment and safety.
- Switchgear components (CTs, VTs, relays, cable terminations)
- Safe operational policies including safety rules and safety documents.

- Diagnostic tools and test equipment for switchgears.
- Safe maintenance policies including safe working in switch rooms, indoor and outdoor substation
- A better understanding of troubleshooting procedures
- An improved capability in testing equipment
- A better understanding of safety issues.
- A refreshed outlook on reading electrical drawings

Course Outline

- Power System Introduction
- Electrical engineering basic concepts
- Three phase review and per unit
- Voltage levels
- One line and three line diagram
- Generation system layout
- Transmission system layout
- Substation system layout
- Distribution system layout
- Interlocking and Inter tripping of Distribution system
- Power System Faults, Protection Basics And Schemes
- Need For Protection
- Principles of protection
- Disconnection Devices

- Protection and system design
- Nature of short circuit currents
- Sources Of Short Circuits
- Short Circuit Protection Philosophy
- Short Circuit Calculations Basics
- Categories of Protection
- Relays Basic Design Principles And Applications
- Improved Protection And Control For Common Distribution Problems
- Different Sizes Generator Protection Schemes
- Different Sizes Motors Protection Schemes
- Different Sizes Transformers Protection Schemes
- Bus Bar Protection Schemes
- Substation Protection
- Capacitor Protection
- Hazards of Electricity
- Hazard Analysis
- Shock
- Arc definition, description and characteristics
- Arc Burns
- Blast
- Affected Body Parts (Skin, The Nervous System, Muscular System Heart , The Pulmonary System)
- Summary of Causes—Injury and Death
- Shock Effect

- Arc Flash Effect
- Causes of Injury
- Causes of Death
- Protective Strategies
- Earthing Systems Safety, Risk Assessment and Surge arrestors
- Equipment Earthing
- System Earthing
- Unearthed systems
- Solid earthing
- Resistance earthing
- Reactance earthing
- Classification Of Supply / Installation System Earthing
- Earthing Via Neutral Earthing Compensator
- Distribution transformers
- Zig Zag transformers
- Comparison of Methods (Advantages/Disadvantages)
- Evaluation of earthing methods
- Touch And Step Voltage
- Effect of electric shock on human beings
- Electric shock and sensitive earth leakage protection
- Sensitive earth leakage protection
- Risk assessment principals
- How to assess the risks in your workplace?

- How to conduct risk assessment?
- Risk assessment Job Briefing and Planning Checklist
- Case Studies
- Drawing and Symbols
- Surge Arrestors
- Arrester Types and Auxiliary Equipment
- Surge arrestors Applications
- Surge Arresters Ratings and Tests
- Electrical Safety Equipment
- General Inspection and Testing Requirements for Electrical Safety Equipment
- Flash and Thermal Protection (Clothing and materials)
- Head, Eye, and Hand Protection
- Rubber-Insulating Equipment (Gloves, Mats, Covers,....)
- Hot Sticks (description, application , testing)
- Insulated Tools
- Barriers and Signs
- Safety Tags, Locks, and Locking Devices
- Voltage-Measuring Instruments
- Proximity Testers
- Contact Testers
- Selecting Voltage-Measuring Instruments
- Instrument Condition
- Low Voltage Voltmeter Safety Standards

- Three-Step Voltage Measurement Process
- General Considerations for Low-Voltage Measuring Instruments
- Safety Grounding Equipment
- The Need for Safety Grounding
- Safety Grounding Switches
- Safety Grounding Jumpers
- Selecting Safety Grounding Jumpers
- Installation and Location
- Ground Fault Circuit Interrupters
- Operating Principles
- Applications
- Safety Electrical One-Line Diagram
- The Electrician's Safety Kit
- Arc Flash Hazard Analysis And Mitigation
- Short history of arc flash research
- NFPA-70E-2004 application
- Calculating the Required Level of Arc Protection (Flash Hazard Calculations)
- The Lee Method
- Methods Outlined in NFPA 70E
- IEEE Standard Std 1584-2002 /
- Required PPE for Crossing the Flash Hazard Boundary
- A Simplified Approach to the Selection of Protective Clothing
- Arc flash hazard assessment

- Traditional methods for reducing arc flash
- New strategies for reducing arc flash hazards and suggestions for Limiting Arc-flash and Shock Hazards
- Standardizing Arc Flash Hazard Labels
- The Role of Over-current Protective
- Devices In Electrical Safety
- Staged arc-flash tests
- Industrial Switchgears
- Fuses
- Auto-reclosers
- Automatic sectionalizer
- Circuit Breakers
- Isolator switches
- Load switches
- Relays
- Current transformers
- Voltage transformers
- Capacitors Connections and Basic Considerations
- Low Voltage Circuit Breakers
- Low voltage molded case current limiting circuit breakers
- Low voltage molded case circuit breakers with high breaking capacity
- Insulated case circuit breakers
- Low voltage air circuit breakers
- Low voltage circuit breakers specification

- Air Circuit Breakers
- Method of increasing arc resistance
- Plan break type
- Magnetic blow out type
- Arc splitter type
- Application
- Construction and operation
- Oil Circuit Breakers
- Arc rupture under oil
- Advantages of oil
- Disadvantages of oil
- Plan break oil circuit breakers
- Arc control circuit oil breakers
- Minimum oil circuit breakers
- Construction and operation
- SF6 Circuit Breakers
- Basic Features of SF6 Breakers
- Dielectric properties of SF6
- Quenching properties of SF6
- Construction of SF6 breaker
- Puffer type breakers
- Vacuum Circuit Breakers
- The vacuum medium
- The vacuum arc

- Vacuum arc stability
- Vacuum break down
- Vacuum switch construction
- Applications of vacuum circuit breakers
- Circuit Breaker Maintenance and Services
- Inspection
- General inspection technical procedure
- Daily inspection of circuit breakers
- Monthly inspection of circuit breakers
- Annual inspection of circuit breakers
- Disassembly
- Cleaning
- Tightening
- Lubrication
- Adjustment
- Circuit Breakers Testing
- Classification
- Description of a simple testing station
- Equipments used in testing
- Testing procedure
- Circuit Breaker Troubleshooting
- Transformers Fundamentals and Maintenance
- Principles of Transformers

- Transformer Construction
- Transformer losses and efficiency
- Transformer Applications
- Transformer Polarity
- Transformer Cooling & Types
- Transformers Tap Changers
- On-Line Monitoring Of Transformers
- Local Indications
- Thermography
- PDA - Partial Discharge Analysis
- Insulating Oil Properties and Tests
- Test for Dielectric Strength
- Water Content in Oil
- Acidity Test (Neutralization Number)
- Oxidation Inhibitor
- Interfacial Tension Test (IFT)
- Oil Color
- Oil Power Factor Test
- Insulating Oil Dissolved Gas Analysis (DGA)
- Generators Basics and Operation
- Uninterruptable Power Supply Basics, Types and Operation