

**Training Title**

**PROTECTION RELAY MAINTENANCE APPLICATION & TESTING**

**Training Duration**

5 days

**Training Venue and Dates**

EE079	PROTECTION RELAY MAINTENANCE APPLICATION & TESTING	5	18 – 22 August, 2019	\$4,000	Dubai, UAE
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In any of the 5 star hotels. The exact venue will be informed once finalized.

**Training Fees**

- 4,000 US\$ per participant for Public Training includes Materials/Handouts, tea/coffee breaks, refreshments & Buffet Lunch.

**Training Certificate**

Define Management Consultancy & Training Certificate of course completion will be issued to all attendees.

**TRAINING OVERVIEW**

**TRAINING DESCRIPTION**

- Fundamental of Protective Relays
- Fundamental of Circuit Breaker
- Types of Protective Relays
- Types of Low and Medium Voltage Circuit Breaker
- HV
- Switch Gears
- Insulation and maintenance of CB
- Over current trip equipment
- Testing of Protective Relays, Low and High Voltage CB

**TRAINING OBJECTIVES**

This course introduces the basis of understanding the theory of high voltage switchgear covering LV/MV/HV circuit breakers and the equipment included in the switch gears. It also introduces the practice and testing of switchgear & by the end of this course the trainee should be able to:

- Operate and perform preventive, predictive (condition based) and corrective (breakdown) maintenance activities on 11KV substation equipment i\ switchgears, protection relays, transformers, fire fighting systems etc

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- Operate and perform preventive, predictive (condition based) and corrective (breakdown) maintenance activities on 132KV and 33KV sub-station equipment
- Demonstrate the components of different voltage switchgear
- Demonstrate the maintenance, testing procedures used for different voltage switchgear
- Apply the safety precautions of P.M. on switchgear
- The transient phenomena in power systems
- Understand the arc phenomena and circuit interruption
- Know the different types of circuit breakers and industrial switchgears
- Be able to select the proper specifications of CB and switchgears
- Know the maintenance procedures
- Be able to do all tests on Protective Relays circuit breakers.
- Be able to detect circuit breakers troubleshooting.
- Know the methods of system earthing and protection requirements.
- Be able to control circuit breakers with associated relaying systems.

### WHO SHOULD ATTEND?

Managers, Engineers and Technicians, responsible for the design, installation, testing and operation of electrical substations and power stations, who require to refresh their knowledge and skills in working with circuit breakers at low and medium voltage level. Technicians and engineers who are responsible for maintaining, testing and troubleshooting of HV/MV/LV switchgear

### TRAINING METHODOLOGY:

A highly interactive combination of lectures and discussion sessions will be managed to maximize the amount and quality of information and knowledge transfer. The sessions will start by raising the most relevant questions, and motivate everybody find the right answers. You will also be encouraged to raise your own questions and to share in the development of the right answers using your own analysis and experiences. Tests of multiple-choice type will be made available on daily basis to examine the effectiveness of delivering the course. Very useful Course Materials will be given.

- 30% Lectures
- 30% Workshops and work presentation
- 20% Group Work & Practical Exercises
- 20% Videos & General Discussions

### TOPICS COVERED

- Application of Protection relays (selection of protection schemes and protection gears) for high voltage feeders & transformers

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- Operation, maintenance & testing of protection relays & associated gears

## COURSE OUTLINE

### **DAY 1**

#### **I. Introduction**

1. Electrical engineering basic concepts
2. Three phase review and per unit
3. Voltage levels
4. One line and three line diagram
5. Generation system layout
6. Transmission system layout
7. Substation system layout
8. Distribution system layout

#### **II. PROTECTION RELAYS BASICS**

##### **1. Classifications**

- 1.1. Type
- 1.2. Application
- 1.3. Characteristics

##### **2. Types & Characteristics**

- 2.1. Control relays
- 2.2. Protection relays
- 2.3. Electromechanical Relays
  - 2.3.1. Attracted-armature
    - 2.3.1.1. Hinged armature relay
    - 2.3.1.2. Plunger (solenoid) relay
  - 2.3.2. Induction Disc
    - 2.3.2.1. Inverse-time-Over-current (OCIT)
    - 2.3.2.2. Instantaneous Current –Voltage Relays
    - 2.3.2.3. Very Inverse and Extremely Inverse Over-current
    - 2.3.2.4. Inverse Definite Minimum Time Over-current (OCI DMT)
    - 2.3.2.5. Directional -Sensing Power Relays
    - 2.3.2.6. Polar Unit
    - 2.3.2.7. Distance Relays (Source Impedance Ratio)
    - 2.3.2.8. Directional Comparison Relaying
    - 2.3.2.9. Phase Comparison Relaying
    - 2.3.2.10. Ground Over-current Relays (Earth fault relays)

##### **2.4. Introduction To The Transition From Electromechanical To Digital Microprocessor based Relay**

- 2.4.1. Using Microprocessor-Based Relays Reduces And Simplifies Wiring

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- 2.4.2. Using Programmable Logic to Implement a Fuse-Saving Scheme
- 2.4.3. Using Programmable Logic and Control Inputs to Provide Fast Bus Protection
- 2.4.4. Simplifying Transformer Differential CT Connections

**2.5. Electronic Relays:**

**2.6. Miscellaneous Relays**

- 2.6.1. Reed Relay
- 2.6.2. Moving-coil Relay
- 2.6.3. Thermal Relay
- 2.6.4. Solid-state Relay
- 2.6.5. Buchholz Relay

**3. Improved Protection And Control For Common Distribution Problems**

- 3.1. Backup Protection
- 3.2. Breaker Failure Protection
- 3.3. Change Protection Based on Day/Date/Hour
- 3.4. Change Protection Based on System Conditions
- 3.5. Detecting High-Side Fuse Operations
- 3.6. Coordination With Other Devices

**DAY 2**

**III. Industrial Switchgears**

- 1. Fuses
- 2. Auto-reclosers
- 3. Circuit Breakers
- 4. Isolator switches
- 5. Load switches
- 6. Current transformers
- 7. Voltage transformers

**IV. MAINTENANCE OF PROTECTIVE DEVICES**

- 1. Bases of Maintenance and Testing of Protective Devices
- 2. Failure Statistics
- 3. Flash Hazard Analysis
- 4. Maintenance and Testing of Low-Voltage Protective Devices
  - 4.1. Power Circuit Breaker Over-current Trip Devices
  - 4.2. Over-current Trip Units
  - 4.3. Molded-Case Breaker Trips
  - 4.4. Protective Trip Testing
  - 4.5. Verification Testing

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- 4.6. Overload Relays
- 4.7. Testing of Ground Fault Sensing and Relaying Equipment
- 4.8. Preparation for Fielding Training
- 4.9. Field Testing
- 4.10. Select a heater element for R type overload relay for a certain motor using available tables, and test the relay
- 4.11. The basic elements of P&B Golds relay.
- 4.12. Set that relay for certain motor load & test it and fill the test report.
- 5. Testing and Commissioning of Protective Relays
  - 5.1. Types of Relay Tests
  - 5.2. Testing and Maintenance of Electromechanical Protective Relays
    - 5.2.1. Primary Injection Test Equipment
    - 5.2.2. Secondary Injection
  - 5.3. Relay Inspection and Tests
  - 5.4. Protective Relay Test Procedures and Circuits
  - 5.5. Relay Test Points and Test Circuits
  - 5.6. Testing and Commissioning of Static and Digital Relays
  - 5.7. Test Methods
  - 5.8. Event Reporting
- 6. Maintenance For Microprocessor Relays
  - 6.1. Maintenance period
    - 6.1.1. Example for Recommended Maintenance Checks
    - 6.1.2. Opto-isolators
    - 6.1.3. Output relays
    - 6.1.4. Method of repair
    - 6.1.5. Replacing the complete relay
    - 6.1.6. Changing the relay battery
    - 6.1.7. Instructions for replacing the battery
    - 6.1.8. Battery Status reads 'Healthy'.
    - 6.1.9. Battery disposal
    - 6.1.10. Cleaning
- 7. Troubleshooting
  - 7.1. Introduction
  - 7.2. Troubleshooting Charts

### **DAY 3**

- V. CB Design Specification Based on Arc Phenomena and Circuit Interruption
  - 1. Arc phenomena
  - 2. Maintenance of the Arc
  - 3. Properties of Arc

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4. Arc Interruption theory
5. Circuit Breaker Rating
6. Circuit constants and circuit conditions
7. Conditions of severity
8. Restriking voltage transient
9. Switching transients
10. Duties of Switchgear

**VI. Condition Monitoring For Electrical Equipment**

- **Approaches Based On Mathematical Models**
  - Reliability Centered Maintenance (RCM)
  - Condition Based Maintenance (CBM)
  - Partial Discharge
- **Insulation Resistance Monitoring**
  - Insulation resistance test (IR)
  - Megger test
  - Polarization index test
  - Dc hi-pot test
  - Measuring insulation degradation
  - Insulation power factor
  - On line measuring partial discharge activity for insulation

**VII. 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)

**DAY 4**

**VIII. LV Circuit Breakers**

- Low voltage molded case current limiting circuit breakers
- Low voltage molded case circuit breakers with high breaking capacity
- Insulated case circuit breakers

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- Low voltage air circuit breakers
- Low voltage circuit breakers specification

**IX. Modern MV and HV Vacuum CB**

- Introduction
- Advantages of vacuum interruption
- Vacuum contactors and interrupters
- The vacuum medium
- The vacuum arc
- Vacuum arc stability
- Vacuum break down
- Vacuum switch construction
- Applications of vacuum circuit breakers

**X. Modern MV and HV SF6 CB Introduction**

- Basic Features of SF6 Breakers
- Dielectric properties of SF6
- Quenching properties of SF6
- Construction of SF6 breaker
- SF6 CB types
- Puffer type SF6 breakers
- Double Pressure System
- Single Pressure Puffer-Piston System
- Single Pressure Self Blast System
- Improvement in SF6 Breakers for HV

**DAY 5**

**XI. Other Type of Circuit Breakers**

**a) Air Circuit Breakers**

- Method of increasing arc resistance
- Plan break type
- Magnetic blow out type
- Arc splitter type
- Application
- Construction and operation
- Axial air CB
- Blast air CB

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- b) 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

## XII. Circuit Breaker Inspection, 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
- Equipments used in testing
- Testing procedure
- Direct testing
- Contact resistance test.
- Insulation resistance test
- Test report
- Indirect testing
- One hour Video, HV CB Maintenance and Repair)

### TRAINING OUTCOME

By the end of this course the participants will gain the following;

- The transient phenomena in power systems.
- Understand the different types of protective Relays
- Understand the arc phenomena and circuit interruption.
- Know the different types of circuit breakers and industrial switchgears.
- Be able to select the proper specifications of CB and switchgears.
- Know the maintenance procedures.
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**NOTE:**

**Pre & Post Tests will be conducted**

**Case Studies, Group Exercises, Group Discussions, Last Day Review & Assessments will be carried out.**

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