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Petroleum Consultancy

Electrical & HV Eng

Titles ***Page***

CABLE SELECTION & LV JOINTING

Course Introduction:

The transfer of electricity from generating sources is carried out using many components and sub-systems. When the components are connected together to supply various types and levels of electrical load, the result is usually referred to as a NETWORK. This course addresses one of the principle components in Electrical Networks the Cables.

Voltage levels from mains (220 or 415V phase-to-phase) up to 33kV will be considered. In addition cables for other than power delivery, instrumentation and control are also considered.

Who Should Attend

The Seminar is designed for Engineers and Technicians who are responsible for the:-

- Design, Specification and Project Management
- Operation and Maintenance
- Cable Jointing for Repair and Extensions

Also of great benefit for those in Industrial Networks who may require to refresh their
knowledge and acquaint themselves with latest developments.

Seminar Objectives:

To ensure delegates develop their existing knowledge and are acquainted with latest developments in Cable Selection and LV Jointing techniques

Training Support & Methodology:

The course includes highly interactive discussions and case studies to give the attendees the maximum benefit from the speaker's experiences and is designed to maximise delegate participation. Questions and Answers are encouraged throughout and at the daily wrap-up sessions. The course is also highly charged with graphical explanations and practical demonstrations.

Course Daily Contents:

Day One:

- **Introducing Industrial Network Layouts – The Single Line Diagram**
- **Cable Types and Classification**
    - Conductors
    - Insulation
    - Binding
    - Armor
    - Jacket
- **Cable Selection for Environmental Conditions (Hazardous Areas)**
- **Cross-Linked Polyethylene Insulation (XLPE)**
- **Cable Selection for Industrial Plants**
    - Trends in Cable Selection
    - Cable Grouping – Purchasing Systems
    - Fire Hazard Issues

Day Two:

- **Economic Aspects LV Cable Selection**
    - Environment
    - Buildings
    - Conductor Size
- **Current Ratings**
    - Network Considerations
    - Load Current
    - Load Characteristics
    - Inductive Loads
    - The Power Triangle
    - Continuous Ratings
    - Cable Ratings for Short-Circuit Ratings
    - Introducing Per-Units Values
    - Calculations for Current Rating, Losses and Volt Drop
- **Installation Underground**
- **Buried Cables in Steel, Concrete or PVC Pipes**
- **Troughs and Trenches**
- **Installation in Buildings and Basements**

Making a 3-Core LV Epoxy Resin Filled Joint

- **Cable Laying**

- Cable Fault Location Techniques
- Indication and diagnosis of faults
- New Methods for locating faults

Day Three:

- **Cable Terminations**
  - Cable Gland Standards
  - Cable Seals and New Materials
  - Ingress Protection
  - Termination of Polymeric Cables

- **Case Studies and Group Exercises**
- **Group Discussions**
- **Course Review and Evaluation**
- **Course Summary**

Circuit Breakers, Operations and Maintenance

Course Introduction:

Electric Power Systems are designed to serve loads in a safe and reliable manner. One of the major considerations in the design of any power network is adequate control of short-circuits or “faults” as they are generally referred to. If faults are not controlled they can cause unnecessary loss of electricity service with all of its many ramifications.

Electric Power Systems are designed to be as fault free as possible through appropriate network design, equipment design, proper installation and on-going maintenance. The Circuit breaker and its associated fault detection equipment, protective relaying, is an extremely important device, through its role of clearing short-circuit currents, disconnecting faulty elements from the power network, and thus maintaining the overall integrity of the power network.

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Course Learning Objectives:

On completion of the course the trainees will understand

- The Role and basic principles of the Circuit Breaker
- Types of circuit breakers and selection including those specifically employed by the client
- Testing and Maintenance policies
- Safe working practices

Course Duration: Four Days

Training Methodology

The latest educational methods and strategies are employed. The course is designed to maximize delegate participation. From the outset, the goals of each participant are discussed to ensure needs are fulfilled as far as possible. Questions and Answers are encouraged throughout, during the case studies, practical demonstrations and at the daily wrap-up sessions

Course Contents

- Introduction - Reasons for Faults - and Classification of Faults
  - Distinction between Load and Fault Current
  - Sources of Short-Circuit Current
  - Rotating Machine Reactance Changes
- Introduction to Fault Calculations

- Overview of Power System Protection

- Measurement - Voltage and Current Transformers
- Protective Device Characteristics
- Principles of Co-ordination
- Types of Protection Systems

- The Role and importance of the Circuit Breaker in Power Systems
- General Principles of Operation of Circuit Breakers
- Introduction to types of Circuit Breaker and Selection Principles
  - Oil
  - Vacuum
  - Air Break
  - Gas-Insulated Breakers
- Design, Construction and Operation of Circuit Breakers employed by Client
  - Testing Procedures and Test Equipment
  - Maintenance Procedures
  - Troubleshooting
  - Refurbishing a low oil and vacuum type circuit breakers
- Other Related Switching Devices
- Motor Starting Systems employed by the client.
  - Testing Procedures and Test Equipment
  - Maintenance Procedures
  - Troubleshooting
- Introduction to Safe Working
- Alternative Circuit Breaker Maintenance Strategies and Selection

- **Case studies, exercises and discussions**

Course Evaluation & Summary

Who Should Attend:

Engineers and Technicians who are directly involved in the design, specification, purchasing, maintenance or day to day Operation of Circuit Breakers

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DESIGN OF ELECTRICAL DISTRIBUTION SYSTEM USING COMPUTERS

Course Introduction

In 1882 Sir Thomas Edison built the world's first electricity generating station in New York. The supply of Electricity spread rapidly across the globe in the ensuing years. Today, over a century later, the use of electrical energy has become commonplace.

Global economics is rapidly changing methodology in the Distribution of Electricity throughout the world. Many Distribution Electricity Utilities have changed from State Ownership to Private Ownership and the trend is increasing worldwide.

Regulatory and shareholder pressures are now driving Utilities to deliver an improved supply performance and demonstrate a more commercial approach to their activities.

An important step is to ensure that decision-making personnel possess sufficient up-to-date knowledge of distribution system behaviour and modern distribution network design.

Course Learning Objectives:

On completion of the course the trainee/s will be competent in:

- The behaviour of Modern Electrical Distribution Networks
- Constraints on Distribution Network Design
- Choice of Correct Components and Network Layouts
- Using Computers for secure and economic network design.

Course Duration: **Five Days**

Who Should Attend:

The Course is designed for Engineers and Technicians from Electrical Transmission and Distribution Utilities or Major Consumers with Power Distribution Networks, such as those for oil and gas production, who are directly involved in design, specification and purchasing.

It is also of great benefit to personnel who require a broad understanding of Distribution Network Design due to their employment in related activities, e.g. government agencies, loan agencies etc.

Design and Marketing Personnel from manufacturers of Distribution Network Equipment should also benefit greatly from the course.

Course Contents:

- Introduction and Revision of Basic Relevant Electrical Technology
- Revision of the Measurement Units in Electrical Distribution Networks.
    - Resistance
    - Reactance
    - Capacitance
    - Impedance
    - Current
    - Voltage
    - Real Power
    - Reactive Power
    - Power Factor
- Review of Basic Distribution Network Components
    - Overhead Lines (Types in Use)
    - Underground Cables (Types in Use)
    - Transformers (Star-Star, Star-Delta, Phasing considerations)
    - Series Reactors (Purpose)
    - Capacitor Banks (Purpose)
    - Switchgear
    - Protection (Relaying)
    - Metering
- Principles for choice of components
- Standard Voltage Levels for Distribution Networks
    - Principles for choice of Voltage Level
- Basic Principles for Network Design (Peak Loads - Minimum Loads)
- Introduction to Distribution Network Constraints
    - Load Flow (Circuit Ratings)
    - Short-Circuit (Switchgear Ratings)
    - Voltage Levels
- Modelling Network Components for Distribution Network Design
    - Representation of Components using the Pi-Circuit
    - Representation of 3-ph systems by the one-line (single line diagram)
    - Representation of Network Parameters (Resistance, Reactance, Capacitance) by per-unit values (percentage) to a common Volt-Ampere base. Conversion to same from actual values of system components.
- The Concept of an Electrical Node in an Electrical Distribution Network
    - Modelling Nodal Loads - Types of Load - Power Factor considerations
        - Domestic
        - Commercial
        - Industrial
            - Real Power
            - Reactive Power

- Data-base requirements for Computer Modelling
    - Network Connectivity (The single line diagram)
    - System Components - Modelled on per-unit values.
    - Nodal Loads - Modelled as:-
        - KW(MW) and KVAr(MVAr)
        - KVA(MVA) and Power Factor
- An Isolated Distribution Network with its own Generation
    - Representation of Generator (Sub-Transient Reactance)
- A Distribution Network Fed from another Utility with or without embedded generation.
    - The concept of the “Infinite Bus”.
- Overview of Distribution Network Design Criteria
    - Safety (Maintenance and Repair Considerations)
    - Security (The n-1 criteria)
    - Economic Criteria
- Distribution Network Layout Considerations
    - Isolated Distribution Network with its own Generation
        - Radial
        - Ring circuits (open point principles)
    - Distribution Network Fed from another Utility(s)
        - More than one infeed
            - Radial with open points
            - Operating Interconnected
- DC Load Flow Studies and Security Assessment (A fast approach)
- AC Balanced Load Flow Studies / Voltage Levels, Circuit Loadings, n-1
- AC 3-ph Unbalanced Load Flow Studies
- Short Circuit Studies (Fault-Levels – Switchgear/Fuse Rating)
- Designing a completely New Distribution Network
    - Describing each “step” to be taken
        - Studies Required for Secure and Economic Operation
        - How to Run Studies
        - How to Interpret results
        - How to find a solution to a problem
- Designing a re-inforcement to an existing network
    - New Loads – Increasing Loads – Overloads and Voltage Drops

- **Case studies, exercises and discussions**

- **Course Evaluation & Summary**

ELECTRICAL MAINTENANCE, COMMISSIONING & TROUBLESHOOTING

Introduction

Planned maintenance inspections that are regularly implemented ensure that safe operations are effected and those losses of production due to fault outages are minimized. Maintenance inspections can inform the Technician of the current status and operability of the organization's Electrical systems and record the expected performance of the equipment life cycle.

The maintenance inspection methods, also indicates when spare parts are likely to be required and give greater accuracy of predictability necessary to forecast future planned maintenance schedules

Who Should Attend

Managers, Engineers and Technicians involved in the maintenance and operations of HV and LV Electrical Equipment.

It is also of great benefit to personnel who require a broad understanding of Electrical Maintenance Procedures due to their employment in related activities, e.g. government agencies, loan agencies etc. Design, Marketing and Project Management Personnel from manufacturers of electrical equipment should also benefit greatly from the seminar.

Seminar Objectives

This course is designed to give the skills and knowledge necessary for planning maintenance activities in Electrical Power Industry in accordance with International standards and also gives the engineers or technician a greater understanding of maintenance procedures post installation. It also covers "Preventative Maintenance" incorporating planning and scheduling of maintenance programs and Trouble Shooting techniques. Case studies are included for interactive discussions

Training Methodology

The latest educational methods and strategies are employed. The course is designed to maximise delegate participation. From the outset, the goals of each participant are discussed to ensure needs are fulfilled as far as possible. Questions and Answers are encourages throughout and at the daily wrap-up sessions. This gives participants the opportunity to discuss with other delegates and the presenter their specific problems and appropriate solutions. All delegates take away a manual of all the material presented. Only minimum note taking is encouraged to ensure maximum delegate attention during the seminars

Seminar Contents

- Introduction to Maintenance concepts planned and unplanned.
- Maintenance Techniques and Methods
- The Economical Effects of Down Time and Loss
- Electrical Safety Hazards
- Electrical Protection
- Risk Analysis : Economics versus Safety, in Maintenance Programs
- Maintenance Planning and Control
  - ⇒ Inventories
  - ⇒ Marking methods
  - ⇒ Maintenance schedules, controls and records.
- Planned Overhauls
  - ⇒ Manpower Allocation,
  - ⇒ Downtime analysis
  - ⇒ Shut-down costs
  - ⇒ Health and Safety
  - ⇒ Computerization
  - ⇒ Planned Maintenance Records
  - ⇒ Facility registers
  - ⇒ Inspection periods
  - ⇒ Visible record cards.

- Maintenance Programs
  - ⇒ Work time-spans
  - ⇒ Planning Charts and the control cycle.
  - ⇒ Manpower and resource allocation,
  - ⇒ Job and Critical Path Analysis (CPA).
  - ⇒ Documentation Flow, Maintenance of Maintenance Records

- Failure Analysis
- Troubleshooting
- Problem Solving Sequences
- Failure Reporting

Case Studies

- Failure Reduction Programs
- Maintenance Techniques,
  - ⇒ Maintenance schedules and programs
  - ⇒ Planning for Technical Meetings and Briefings
  - ⇒ Delivery of Technical Briefings and Meetings
  - ⇒ Follow Through of Reports and Implementation of Plans
  - ⇒ Action Plans and Delegation

Case Studies

- **Review Session**
- **Course Evaluation & Summary**

Electrical Power Equipment, Maintenance and Planning

Introduction

Planned maintenance inspections that are regularly implemented ensure that safe operations are effected and that loss of production due to fault outages on electrical equipment is minimised. Maintenance inspections can inform the client of the current status and operability of its electrical systems and record the expected performance of the equipment life cycle.

The maintenance inspection methods, also indicates when spare parts are likely to be required and give greater accuracy of predictability necessary to forecast future planned maintenance schedules

Who Should Attend

Managers, Engineers, Supervisors and Technicians involved in the maintenance of Electrical Equipment.

It is also of great benefit to personnel who require a broad understanding of Electrical Maintenance Procedures due to their employment in related activities.

Course Outline: **Five Days**

Seminar Objectives

This course is designed to give the skills and knowledge necessary for planning electrical maintenance activities in accordance with international standards and also gives the engineers or technician a greater understanding of maintenance procedures post installation. It also covers “Preventative and Predictive Maintenance” incorporating planning and scheduling of maintenance. Case studies are included for interactive discussions

The latest educational methods and strategies are employed. The course is designed to maximise delegate participation. Questions and Answers are encouraged throughout and at the daily wrap-up sessions. This gives participants the opportunity to discuss with other delegates and the presenter their specific problems and appropriate solutions. All delegates take away a manual of all the material presented. Only minimum note taking is encouraged to ensure maximum delegate attention during the seminars.

The instructor is John Bailey, a Power System Engineer, with many years’ practical experience with Utilities and Manufacturers, notably in the United Kingdom, Saudi Arabia, Canada and the USA. He is a Graduate of the University of Durham; King’s College and a Member of the Institution of Electrical Engineers, London.

DAY 1

Introductions
Goals – Discussion

Electrical Equipment Overview
Electrical Safety Hazards and Protection

- Hazardous Area Classification
- Nature of Hazardous Substances
- Sources of Ignition
- Equipment Design and Construction

Personal and Equipment Safety

- Installation Safety Requirements
- Examination and use of Equipment *Guarding*
- Overcurrent Protection
- Grounding of equipment connected to cord and plug
- Safety Related Work Practices
- Safety Related Maintenance and Environmental Considerations
- Safety requirements for special equipment
- Personal Protective Equipment

Case Studies and Group Exercises
Further Explanations as required

DAY 2

Causes of Electrical Equipment Failure

- Motors and Generators
- Switchgear
- Cables
- Power Transformers
- Measurement Transformers
- Protection Relaying
- Batteries and Chargers, UPS
- ***Any Additional and Special Equipment on Client's System***

DAY 3

The Economic Effects of Down Time and Loss

Maintenance Policies General

- Reactive Maintenance
- Proactive Maintenance

- Predictive and Preventative Maintenance (P/PM)
- Equipment Condition Monitoring
- Failure Reporting
- IR Technology

Case Studies and Group Exercises
Further Explanations as required

Maintenance Policies relating to the Client's Electrical Equipment

Spares Policies

Case Studies and Group Exercises
Further Explanations as required

Troubleshooting, Problem Solving Sequences

- Fault Finding for Electrical Equipment currently in use at the client's sites
- Using Troubleshooting Charts
- Using Flow Charts
- Test Equipment

Case Studies and Group Exercises
Further Explanations as required

DAY 4

Maintenance Planning and Control
- Inventories
- Marking methods
- Maintenance schedules
- Controls and records.

Planned Shutdowns and Overhauls
- Manpower allocation
- Downtime analysis
- Shut-down costs

Planned Maintenance Records:
- Facility registers
- Inspection periods
- Visible record cards.

Case Studies and Group Exercises
Further Explanations as required

DAY 5

Maintenance Programs

Work time-spans
Planning charts and the control cycle.
Manpower and resource allocation,
Job and Critical Path Analysis (CPA).
Documentation Flow
Keeping adequate Maintenance Records

Case Studies and Group Exercises
Further Explanations as required

Wrap-up Session

Course Summary & Evaluation

Electrical Safety and the OSHA Requirements for Non Electrical Technologists

Introduction:

Electricity is high-grade energy. However working in the proximity of electrical equipment involves danger. Whether such electrical apparatus is static or mobile, all staff whether managers, administrators, engineers or technicians need to understand the potential dangers, and how to keep matters under control in order to avoid injuries or fatalities. All staff must therefore be aware of the protection available and the regulations and advisory information governing this important area of concern.

Safety is the responsibility of everyone and begins at the personal level. This course is designed to raise the level of competence and electrical safety awareness within the company. It covers International Safety Standards and in particular those of OSHA including electrical equipment installed in hazardous areas

Seminar Objectives

To develop existing and improve an overall understanding of the dangers of electricity at all voltage levels.

To be acquainted with International Regulations applicable to the use of Electrical Equipment in normal and in hazardous locations

To examine the company's existing electrical safety procedures and current practices relating to incident reporting.

Examine ways to improve the company's existing electrical safety record.

Who Should Attend

Managers, Administrators, Engineering Supervisors and Foremen from all disciplines.

Course Duration: Five Days

Training Methodology

The latest educational methods and strategies are employed. The course is designed to maximise delegate participation. From the outset, the goals of each participant are discussed to ensure needs are fulfilled as far as possible. Questions and Answers are encouraged throughout and at the daily wrap-up sessions. This gives participants the opportunity to discuss with other delegates and the presenter their specific problems and appropriate solutions.

All delegates take away a manual of all the material presented. Only minimum note taking is encouraged to ensure maximum delegate attention during the seminars.

DAY 1

- Introduction to Electricity for Non-Technical Personnel
- Defining the dangers and hazards from all types of Electrical Apparatus
- Worldwide Standards for Safety in the Electrical Environment
- Introduction to Occupational Safety and Health Administration (OSHA)
- Case Studies and Work Sessions

DAY 2

- Understanding how Electricity Acts - Introduction to Electric Shock
- Factors Affecting the Severity of Electric Shock
- The Treatment of Electrical Injuries

Case Studies and Work Sessions

- The important issue of diagrams and other documentation
- Introduction to electrical protection systems for non-electrical personnel. How they are employed and why

    Fuses
    Circuit Breakers
    Contactors
    The Earth Leakage Circuit Breaker

Case Studies and Work Sessions

DAY 3

- Hazardous Area Classifications
- Identification of Electrical Hazards in the company's electrical networks
- Case Studies and Work Sessions
- Introduction to Building Wiring Regulations for non-electrical personnel
- Personal Protection Equipment and Training in its use

    Headgear
    Eye and Face Protection
    Ear Protection
    Respiratory Protection
    Torso Protection
    Arm and Hand Protection
    Foot and Leg Protection

- The correct Tools and Usage

Case Studies and Work Sessions

DAY 4

- Introduction to Electrical Safety Rules for non-electrical personnel.
- Isolation and Earthing Procedures
- Guarding Electrical Apparatus
- International Standards for danger signs and appropriate application

Case Studies and Work Sessions
Examining Ways to improve the Company's Existing Electrical Safety Record

DAY 5

- Electrical Safety Committees
- Work Supervision for safety
- Accident Reporting and Follow Up

- Handling Human Errors and Accidents

Case Studies and Work Sessions

- Hazardous Areas, Indoor and Outdoor, Precautions
- Avoiding Electrical Fires, Design and Operations
- Fire Appliances/Actions

Case Studies and Work Sessions

- **Review Session**
- **Course Evaluation**
- **Course Summary**

Electrical Distribution Operation & Maintenance

INTRODUCTION

In 1882 Sir Thomas Edison built the world's first electricity generating station in New York. The supply of Electricity spread rapidly across the globe in the ensuing years. Today, over a century later, the use of electrical energy has become commonplace.

Global economics is rapidly changing methodology in the Distribution of Electricity throughout the world. Many Distribution Electricity Utilities have changed from State Ownership to Private Ownership and the trend is increasing worldwide.

Regulatory and shareholder pressures are now driving Utilities to deliver an improved supply performance and demonstrate a more commercial approach to their activities. At the same time manufacturers, particularly those involved in distribution management systems are also being driven by this trend.

A first step for all concerned is to ensure that decision-making personnel possess sufficient up-to-date knowledge of distribution system behaviour and modern distribution management technology.

WHO SHOULD ATTEND

The Seminar is designed for Utility Managers, Engineers and Technicians who are responsible for the:-

- Design, Specification and Project Management
- Operation and Maintenance
- System Operation and Control
- Overall Enterprise Management

of Distribution Networks, who may require to refresh their knowledge and acquaint themselves with latest developments.

It is also of benefit to non-utility personnel who require a good understanding of distribution systems due to employment in related activities, e.g. government agencies, loan agencies etc. Design, Marketing and Project Management Personnel from manufacturers of Distribution Equipment should also benefit greatly from the seminar.

SEMINAR OBJECTIVES

To ensure delegates develop their existing knowledge and are acquainted with latest developments in Distribution Management Technology. In addition that the principles can be appropriately applied in every day work to improve their personal effectiveness and efficiency throughout the whole enterprise.

TRAINING METHODOLOGY

The latest educational methods and strategies are employed. The course is designed to maximise delegate participation. From the outset, the goals of each participant are discussed to ensure needs are fulfilled as far as possible. Questions and Answers are encourages throughout and at the daily wrap-up sessions. This gives participants the opportunity to discuss with other delegates and the presenter their specific problems and appropriate solutions. All delegates take away a manual of all the material presented. Only minimum note taking is encouraged to ensure maximum delegate attention during the seminars.

OUTLINE

DAY 1

Revision of Basic Technology

Overview of Distribution Utility's Activities

- Consumer Connections and Upgrades
- Consumer Meter Reading and Billing
- Network Design and Upgrades
- Network Construction
- Equipment and Network Operation
- Equipment Maintenance
- Network Control and Fault Restoration
- Equipment Fault Repairs

DAY 2

Distribution Network Components, Function and Maintenance Requirements

- General
- Overhead Line
- Underground Cable
- Transformer
- Circuit Breaker
- Line Switches and Auto-reclosers
- Ring Main Units
- LV Distribution Boards
- Fuses
- Line Capacitors
- Voltage and Current Transformers
- Protection Relaying
- Principles for choice of components

DAY 3

Distribution System Design Considerations

- Standard Voltage Levels
  - Main Distribution Networks
  - Consumer Voltage

- Power Supply Sources
  - Generation/Transmission Utilities
    - Distribution Company Owned Generation
  - Consumer Owned Generation

- Basic Design Principles
  - Peak Load
  - Minimum Load

- Introduction to System Constraints
  - Load Flow (Equipment Ratings)
  - Short-Circuit (Switchgear Ratings)
  - Voltage Levels (Network & Consumer Requirements)

Network Modelling

- Network Components using the Pi-Circuit
- 3-ph systems by the one-line diagram
- Network Parameters by per-unit values
- The concept of an Electrical Node
- Types of Consumer Load
  - Domestic
  - Commercial
  - Industrial
- Network Topology and Connectivity

Distribution System Analysis

- Load Forecasting & Nodal Distribution
- 3-ph Balanced Load-flow
- 3-ph Unbalanced Load-flow
- Short-circuit Studies
- Protection Co-ordination
- Optimum Capacitor Placement
- Transformer Optimisation

DAY 4

Network Control and Operations

- Control Philosophies
  - Centralised Control
  - Hierarchical Control
  - Distributed Control
- Normal Operation
- Safety Rules and Switching Co-ordination
- Outage and Switch-order Planning
- Fault Detection, Isolation and Restoration
- Introduction to SCADA/DMS/DA
- Graphical Information Systems (GIS)
- Role of field staff - Engineers/Technicians
- Integrated AM/FM

The Heart of the Business

- The Principles of Variable Tariffs
- Meter Reading and Customer Billing
  - Historical - The Manual Meter Reader
  - Financial Implications
  - Centralised billing systems
  - Meter-Reader's Hand-Held Computers
  - Remote Meter Reading
- The Cost of Consumer Interruptions
- Supply Quality Considerations
- Response to Consumer Complaints
  - Modern Trouble Call Analysis (TCA)
  - Integration into SCADA/DMS
  - Financial Advantages
- Centralised Consumer Information Systems (CIS)
- Integration of CIS with GIS

DAY 5

Overall Utility Management

- Identification of Critical Issues
- Staffing Principles
  - Optimal use of Manpower
- Organisational Structures
- Effective Materials Management Systems
- Equipment Maintenance Strategies
  - Periodic
  - Condition
  - Economic Solutions
- Concise Procedural Documentation
- Management Reporting Systems

Substation and Network Control Systems

- The Synoptic or Mimic Panel
- Use of Intelligent Electronic Devices
  - Protection Relaying
  - Metering
  - Fault Detection
  - Supply Quality
- Network and Feeder Terminal Units
- Modern Graphical User Interfaces
- Alarm Data Handling
- Application of Substation and Feeder Automation Technology
  - Problems
  - Financial advantages

INTO THE FUTURE

ADVANCED SUBSTATION AUTOMATION
INTEGRATION OF COMPUTER SOLUTIONS TO THE COMPLETE ENTERPRISE

MANUALS AND INFORMATION SOURCES
INDUSTRIAL STANDARDS

- CLOSE-UP SESSION
- COURSE EVALUATION

ELECTRICAL MAINTENANCE & TROUBLE SHOOTING

Introduction:

Planned maintenance inspections that are regularly implemented ensure that safe operations are effected and that loss of production due to fault outages is minimised. Maintenance inspections can inform the client of the current status and operability of its electrical systems and record the expected performance of the equipment life cycle.

The maintenance inspection methods, also indicates when spare parts are likely to be required and give greater accuracy of predictability necessary to forecast future planned maintenance schedules

Who Should Attend:

Managers, Engineers, Supervisors and Technicians involved in the maintenance of HV and LV Electrical Equipment.

It is also of great benefit to personnel who require a broad understanding of Electrical Maintenance Procedures due to their employment in related activities.

Seminar Objectives:

This course is designed to give the skills and knowledge necessary for planning electrical maintenance activities in accordance with international standards and also gives the engineers or technician a greater understanding of maintenance procedures post installation. It also covers “Preventative and Predictive Maintenance” incorporating planning and scheduling of maintenance programs and Trouble Shooting techniques. Case studies are included for interactive discussions

The latest educational methods and strategies are employed. The course is designed to maximise delegate participation. Questions and Answers are encouraged throughout and at the daily wrap-up sessions. This gives participants the opportunity to discuss with other delegates and the presenter their specific problems and appropriate solutions. All delegates take away a manual of all the material presented. Only minimum note taking is encouraged to ensure maximum delegate attention during the seminars.

Course Outline:

DAY 1

Introductions
Goals – Discussion

Electrical Equipment Overview
Electrical Safety Hazards and Protection
- Hazardous Area Classification
- Nature of Hazardous Substances
- Sources of Ignition
- Equipment Design and Construction

Personal and Equipment Safety
- Installation Safety Requirements
- Examination and use of Equipment

Guarding
- Overcurrent Protection
- Grounding of equipment connected to cord and plug
- Safety Related Work Practices
- Safety Related Maintenance and Environmental Considerations
- Safety requirements for special equipment
- Personal Protective Equipment

Case Studies and Group Exercises
Further Explanations as required

DAY 2

Introduction to Maintenance concepts planned and unplanned.
Maintenance Policies
- Reactive Maintenance
- Proactive Maintenance
- **Introduction to P/PM**

The Economic Effects of Down Time and Loss
Maintenance Policies relating to the Client's Electrical Equipment

Case Studies and Group Exercises
Further Explanations as required

DAY 3

Maintenance Planning and Control

- Inventories
- Marking methods
- Maintenance schedules
- Controls and records.

Planned Shutdowns and Overhauls

- Manpower allocation
- Downtime analysis
- Shut-down costs
- Health and safety

Planned Maintenance Records:

- Facility registers
- Inspection periods
- Visible record cards.

Case Studies and Group Exercises
Further Explanations as required

DAY 4

Maintenance Programs

- Work time-spans
- Planning charts and the control cycle.
- Manpower and resource allocation,
- Job and Critical Path Analysis (CPA).
- Documentation Flow
- Keeping adequate Maintenance Records

Case Studies and Group Exercises
Further Explanations as required

DAY 5

Causes of Electrical Equipment Failure

- Motors and Generators
- Switchgear
- Cables
- Power Transformers
- Measurement Transformers
- Protection Relaying
- Batteries and Chargers, UPS

DAY 5 (Continued)

Troubleshooting, Problem Solving Sequences

Fault Finding for Electrical Equipment currently in use at the client's sites
Using Troubleshooting Charts
Using Flow Charts
Test Equipment

Predictive and Preventative Maintenance (P/PM)

Equipment Condition Monitoring
Failure Reporting
IR Technology

Case Studies and Group Exercises
Further Explanations as required

Close-up Session

Course Summary & Evaluation

ELECTRICAL SAFETY

Introduction

Electricity is high-grade energy. However working in the proximity of electrical equipment involves danger. Whether such electrical apparatus is static or mobile, all staff whether managers, administrators, engineers or technicians need to understand the potential dangers and how to keep matters under control in order to avoid injuries or fatalities. All staff must therefore be aware of the protection available and the regulations and advisory information governing this important area of concern.

Safety is the responsibility of everyone and begins at the personal level. This course is designed to raise the level of competence and electrical safety awareness within the company. It covers major International Safety Standards including electrical equipment installed in hazardous areas

Seminar Objectives:

- To develop existing and improve an overall understanding of the dangers of electricity at all voltage levels.
- To be acquainted with International Regulations applicable to the use of Electrical Equipment in normal and in hazardous locations
- To examine the company's existing electrical safety procedures and current practices relating to incident reporting.
- Examine ways to improve the company's existing electrical safety record.

Who Should Attend:

Managers, Administrators, Engineering Supervisors and Foremen from all disciplines employed in Utilities, Oil Gas & Petrochemical Process Plants, and Electrical Equipment Manufacturing.

Course Duration: Five Days

Training Methodology

The latest educational methods and strategies are employed. The course is designed to maximise delegate participation. From the outset, the goals of each participant are discussed to ensure needs are fulfilled as far as possible. Questions and Answers are encouraged throughout and at the daily wrap-up sessions. This gives participants the opportunity to discuss with other delegates and the presenter their specific problems and appropriate solutions. All delegates take away a manual of all the material presented. Only minimum note taking is encouraged to ensure maximum delegate attention during the seminars.

DAY 1

- Introduction to Electricity for Non-Technical Personnel
- Defining the dangers and hazards from all types of Electrical Apparatus
- Worldwide Standards for Safety in the Electrical Environment
- Introduction to Safety Aspects of IEE Wiring Regulations
- Introduction to Occupational Safety and Health Administration (OSHA)

Case Studies and Work Sessions

DAY 2

- Understanding how Electricity Acts - Introduction to Electric Shock
- Factors Affecting the Severity of Electric Shock
- The Treatment of Electrical Injuries

Case Studies and Work Sessions

- The important issue of diagrams and other documentation
- Introduction to electrical protection systems. How they are employed and why

  Fuses
  Circuit Breakers
  Contactors
  The Earth Leakage Circuit Breaker

Case Studies and Work Sessions

DAY 3

- Hazardous Area Classifications
- Identification of Electrical Hazards in the company's electrical networks
- Case Studies and Work Sessions
- Safety Aspects in Inspection & Testing (Ref IEE Guidance Note 3 – BS7671)
- Personal Protection Equipment and Training in its use

Headgear
Eye and Face Protection
Ear Protection
Respiratory Protection
Torso Protection
Arm and Hand Protection
Foot and Leg Protection

- The correct Tools and Usage

Case Studies and Work Sessions

DAY 4

- Electrical Safety Rules.
- Isolation and Earthing Procedures
- Guarding Electrical Apparatus
- International Standards for danger signs and appropriate application

Case Studies and Work Sessions
Examining Ways to improve the Company's Existing Electrical Safety Record

DAY 5

- Electrical Safety Committees
- Work Supervision for safety
- Accident Reporting and Follow Up
- Handling Human Errors and Accidents

Case Studies and Work Sessions

- Hazardous Areas, Indoor and Outdoor, Precautions
- Avoiding Electrical Fires, Design and Operations
- Fire Appliances/Actions

Case Studies and Work Sessions

- Review Session
- Course Evaluation
- Course summary

High Voltage (HV) Engineering Systems

Course Objectives:

On completion of the course the trainee/s will be competent in:

- High voltage systems and the network demands and the International
- Standard's of acceptance for expected performance.
- The potential dangers and how to work safely in the High Voltage (HV) and Extra High Voltage (EHV) environments.
- HV tools, testing equipment usage and maintenance.

Course Duration: Five Days

Course Contents:

- The Institute of Electrical Engineers (IEE) and introduction to publications and electrical supply information
- HV Regulations and the working environment
- Health and Safety Regulations
- HV Fundamentals: Corona, Gas Discharge and Wave Forms
- Basic Insulation
- Level and Selection of HV Static and rotary Equipment's
- Concepts of Electrical Systems and Insulation in HV and Extra High Voltage
- Lightening and other External Hazards
- Ground Systems and Induced Voltages
- High Voltage Insulators
- Power Bus Sections
- Circuit Breakers
- Switches
- Sectionalizers
- Generators
- Distribution Equipment
- Cabling and Associated Equipment
- HV Testing and Standard Practices
- Electrical Safety Management
- Case studies, discussions and exercises

Who Should Attend:

Potential and existing electrical engineers who have at least three years experience of working in with electrical supplies and the electrical environments.

HV and LV Power System Protection

Course Introduction:

Electric power systems are designed to serve loads in a safe and reliable manner. One of the major considerations in the design of any power network is adequate control of short-circuits or “faults” as they are generally referred to. If faults are not controlled they can cause unnecessary loss of electricity service with all of its many ramifications and damage to equipment. Faults on system elements are removed from networks by means of equipment referred to as “Power System Protection”.

This course is designed to give delegates a broad understanding of the nature of power network faults and the principles of Protection System Protection, Design, Operation and Maintenance.

Course Learning Objectives:

On completion of the course the trainee/s will be competent in:

- The skills involved and the principles applied to power system protection
- Interpreting system faults from protection system alarms and indications and determine the necessary corrective actions
- Information and instruction in safe operating procedures in electrical protection schemes, including elements of maintenance of HV and LV protection relay systems.

Course Duration: Five Days

Who Should Attend:

Engineers and Technicians from Electrical Transmission and Distribution Utilities or Major Consumers with Power Distribution Networks, such as those for oil and gas production, who are directly involved in the design, specification, purchasing, maintenance or day to day Operation of System Protection.

It is also of great benefit to personnel who require a broad understanding of power system protection due to their employment in related activities, e.g. government agencies, loan agencies etc.

Design, Marketing and Project Management Personnel from manufacturers of power system protection equipment should also benefit greatly from the seminar.

Personnel should ideally have at least two years experience related to the electrical power industry.

Course Contents:

- Introduction to HV & LV Protection Systems
  - Distinction between Load and Fault Currents
  - Sources of Short-circuit current
- Faults and Fault Levels
  - Variation of Short-Circuit Current with Time
- Classification of Faults and Protection Philosophy
  - Fuses
  - Circuit Breakers and Relaying
- Principles of Power Network Earthing (Grounding)
- Fault Level Calculations
  - Balanced
  - Unbalanced
- Measurement Devices (CT's and PT's) and their characteristics
- Principles of Protection Co-ordination, Discrimination and Relay Settings
  - Generator Protection
  - Transformer Protection
  - Line Protection
  - Cable Protection
  - Motor Protection
- Operating Techniques
- Primary & Secondary Test Methods
- Fault Indications (Alarms) & Corrective Action
- Procedures for the correct operation of Protection Schemes
- Maintenance of Protection Relays and Systems for Reliability
  - Periodic
  - Predictive
- Integration of Power System Protection in Modern Substation Applications and Automation

- **Case studies, exercises and discussions**

- **Course Evaluation & Summary**

HV and LV Power System Protection (Protection Relays)

Course Introduction:

Efficient and Safe HV and LV Power Protection systems are vital to ensure no overload may occur and a smooth current is maintained at the level determined for the demand required. Safety systems also demand the highest standards of operations and maintenance and therefore Relay Protection Systems play a large part in the Electrical Power Process.

This course is designed to inform participants how HV and LV Power systems operate and safely maintain Protection Systems.

Course Learning Objectives:

On completion of the course the trainee/s will be competent in:

- The skills involved and the principles applied in power systems protection
- and the safety tests applicable.
- Interpretation of protection fault indication and determine corrective actions
- Information and instruction in safe operating procedures in platform electrical protection schemes, including elements of maintenance of HV / LV protection relays.

Course Duration: Four Days

Who Should Attend:

Electrical personnel involved in the day to day running of day to day operation / maintenance of power systems protection scheme with at least two years experience in the electrical power industry.

Course Contents:

- Introduction to HV & LV power Protection Systems

- Faults and Fault Levels
- Principle Operating Techniques
- Principle of Setting Procedures
- Primary & Secondary Test Methods
- Protective Fault Indication & Corrective Action
- Safe Operating Procedures in Platform
- Electrical Protection Schemes
- Elements of Maintenance of HV/LV Protection Relays
- Principles of Discrimination
- Measurement
- Relap
- Earth Fault & Leakage Protection
- Different Protection
- Generation Protection
- Transformer Protection
- Motor Protection

- **Case studies, exercises and discussions**

- **Course Evaluation & Summary**

HV EQUIPMENT, MOTORS & ALTERNATORS

Course Introduction:

It is important that maintenance personnel possess a reasonable understanding of how HV electrical equipment such as motors and alternators work, in order that they can be maintained in an adequate and safe manner.

Course Learning Objectives:

On completion of the course the trainees will have improved their understanding in the following respects:-

- Basic Single Phase and Three-Phase AC Circuit Theory
- Calculating Single Phase and Three Phase Loads
- The Role and basic principles of Electric Motors and Alternators
- Advanced Instrumentation for HV Machinery
- Modern Testing Procedures and Maintenance policies
- Why and How modern computer-based maintenance systems are employed
- Safe working practices ad precautions including IEE Regulations, PTW's, Protective Clothing

Course Duration: Three Days

Training Methodology

The latest educational methods and strategies are employed. The course is designed to maximise delegate participation. From the outset, the goals of each participant are discussed to ensure needs are fulfilled as far as possible. Questions and Answers are encouraged throughout, during the case studies, practical demonstrations, using actual equipment where possible and at the daily wrap-up sessions.

Who Should Attend:

Engineers and Technicians involved in the day to day maintenance of HV Electrical Equipment, Motors and Alternators at ADMA.

Course Contents

- Review of Electrical Fundamentals for Engineers and Technicians
- The effects of Resistance, Capacitance and Inductance – The Power Triangle – Real Power and Reactive power
- Single Phase and Three Phase Loads – How to Calculate – Worked Examples and Exercises

- Understanding HV equipment, Induction Motors and Alternators – How They Work and What can go wrong – Worked Examples and Exercises
- Power Quality and the effects on HV Machinery.
- Test Procedures – What to look for - Examples and Exercises
- Developing an understanding of advanced instrumentation equipment
- Programmable Logic Controllers and Distributed Control Systems
- Modern Maintenance Philosophies and Practices
- Computer-based Maintenance Programs – How they work and instructions on how to use them effectively.
- The Permit to Work System – Why is it necessary? – How to work safely – Worked Examples and Exercises
- Equipment Guarding
- Classification Codes (IEC and IEE)
- Electrical Equipment in Classified Areas – Effect on Testing and Maintenance Procedures. - Worked Examples and Exercises
- Protective Clothing – a sensible approach.
- Accident Reporting - Worked Examples and Exercises
- Latest IEE recommendations for Installation and Testing

  - Course Evaluation
  - Course Summary

HV EQUIPMENT, MOTORS & ALTERNATORS

Course Introduction:

It is important that operations personnel possess a reasonable understanding of how electrical equipment such as motors and alternators work, in order that they can be maintained in an adequate and safe manner.

Course Learning Objectives:

On completion of the course the trainees will have improved their understanding in the following respects:-

- The Role and basic principles of Electric Motors and Alternators
- Calculating Single Phase and Three Phase Loads
- Metering Equipment for HV Machinery
- Testing and Maintenance policies
- Why and How modern computer-based maintenance systems are employed
- Safe working practices ad precautions including IEE Regulations, PTW's, Protective Clothing

Course Duration: Two Days

Training Methodology

The latest educational methods and strategies are employed. The course is designed to maximise delegate participation. From the outset, the goals of each participant are discussed to ensure needs are fulfilled as far as possible. Questions and Answers are encouraged throughout, during the case studies, practical demonstrations, using actual equipment where possible and at the daily wrap-up sessions.

Course Contents

- Review of Electrical Fundamentals for Engineers and Technicians
- Single Phase and Three Phase Loads – How to Calculate – Worked Examples and Exercises
- Understanding HV equipment, Induction Motors and Alternators – How They Work and What can go wrong – Worked Examples and Exercises
- Test Procedures – What to look for - Examples and Exercises

- Understand modern metering equipment
- Modern Maintenance Philosophies and Practices
- Computer-based Maintenance Programs – How they work and how to use them effectively
- The Permit to Work System – Why is it necessary? – How to work safely – Worked Examples and Exercises
- Protective Clothing – a sensible approach
- Accident Reporting - Worked Examples and Exercises
- Latest IEE recommendations for Installation and Testing

- **Case studies,**
- **Exercises and Discussions**
- **Course Evaluation**
- **Course Summary**

HV / LV PROTECTION APPLICATIONS

Course Introduction:

Trouble Shooting, Fault and Electrical Maintenance can be extremely hazardous and requires and a full understanding of the HV / LV power systems and the safety systems involved. This also requires knowledge of the latest techniques and ensuring that all safety procedure are followed and that the work is carried out efficiently and effectively.

This course has been designed to give a full understanding of the operations involved during the Trouble Shooting, Fault Finding and Maintenance process. The course is presented using computerized display and excellent images to help the participants understand HV / LV systems, it is also highly interactive with discussion and problem solving group activities and encouragement.

The latest Technology and Fault Finding Techniques are also included to update the participants.

Course Duration: **Five Days**

Who Should Attend:

This course is specifically designed for Electrical Supervisors, Foremen & Technicians.

Course Outline:

DAY 1

Revision of Associated Electrical Fundamentals
Exercises
Further Explanations as required

Reasons for faults
Distinction between load current and fault current
Sources of short-circuit current
Symmetrical and Asymmetrical currents, X/R ratio and the DC component.
Fault Current Calculations
Balanced Faults
Unbalanced Faults
Case Studies and Group Exercises
Further Explanations as required

The Role of Protection Relaying in supply reliability

- Power System Protection and Philosophy
- Principles of the Circuit Breaker
- Principles of System Earthing Arrangements
- Relevance of Network, Substation and Switchboard Arrangements
- Overview of Measurement Transformers
- Categories of Protection
- Properties of Protection, Zones of Protection, Back-up Protection

DAY 2

Main forms of Protection Relaying Systems for Networks
Instantaneous Overcurrent Relays
Time/Overcurrent Relays
Directional Overcurrent Relays
Pilot Wire Relaying
Directional Comparison Relaying
Distance Relaying
Phase Comparison Relaying

Case Studies and Group Exercises
Further Explanations as required

Overhead Line Protection

- Relay Setting Procedures
- Fault Finding and Rectification

equipment/system
Further Explanations as required

Underground Cable Protection

- Relay Setting Procedures
- Fault Finding and Rectification

DAY 3

Introduction to Differential Protection for: -

- Generators
- Transformers
- Motors
- Switchboards/Busbars

Power Transformer Protection:

- Overcurrent and Differential
- Standby Earth Fault
- Bucholtz Gas
- Winding Temperature
- Oil Temperature
- Auxiliaries (Tap Changers, Pumps and Fans etc)
- Relay Setting Procedures
- Fault Finding and Rectification

DAY 4

Generator and Motor Protection:

- Short-Circuit Protection (Differential, Overcurrent, Earth-Fault etc)
- Overspeed and Under Speed Protection

Network Under-Frequency Protection:

- Reasons, Principles and Philosophy
- Appropriate Relay Settings and Procedures

New Protection Relaying Equipment

- Manufacturers Testing
- Principles of Project Management
- Commissioning Procedures
- Primary Injection
- Secondary Injection
- Documentation Requirements

DAY 5

Maintenance of Existing Protection Relaying Equipment

- Appropriate Policies
- Periodic Requirements
- P/PM
- Test Equipment

Network Control Systems (DCS and SCADA) and the Interfaces to Relaying

Numerical and Solid State Relays

- Relay Setting Procedures
- Test Equipment
- Fault Finding and Rectification

New Protection Relaying Technology

- IED Interfaces
- Protocols
- Maintenance Requirements
- New Switchboard and Network Control Philosophies

- **Case Studies**
- **Discussions**
- **Course Summary and Evaluation**

IEE Wiring Regulations

Course Objectives:

On completion of the course the trainee/s will be competent in:

- The latest requirements of the IEE Regulations and the required Electrical Design concepts.
- Working within an environment controlled by IEE Regulations.

Course Duration: Five Days

Course Contents:

- Changes in Numbering System, Definitions, Scope
- Outline Guidance on EAW Regulations
- Assessment of General Characteristics
- Shock Protection Requirements
- Protective Conductors, Earthing and Bonding
- Overcurrent Protection
- Selection of Cables
- Isolation and Switching Requirements
- Selection and Erection of Equipment's
- Special Installations
- Inspection and Testing with Practical Content
- Discussion's and Summary

Who Should Attend:

Electrical Managers, Electrical Supervisors, Electricians and personnel involved in the design of Electrical Systems with at least two years experience in the electrical power industry.

Industrial Power and Lighting Installation

Course Objectives:

On completion of the course the trainee/s will be competent in:

- Industrial electrical circuitry and supply systems installation, repair and
- maintenance.
- The relevant regulations and IEE rules applicable according to expected work practices.
- The safety rules applicable to working within the environment and the essential precautions before commencing work.

Course Duration: Five Days

Who should attend:

Potential Industrial electrical engineers who have at least three years experience of electrical installations and who will work under initial supervision before attempting individual projects.

Course Contents:

- Introduction to industrial electrical supply and circuitry systems
- IEE Regulations legislation and standards applicable to working standards
- Safety rules applicable to the electrical environment
- Insulation and protective clothing
- Care / Use of tools and equipment
- Electrical Manuals and Information sources
- Isolating and Control of the System
- Industrial Power Sockets
- Radial, Low Power and bi-phase Circuits
- Power Distribution/ Cables and Earth Installation
- Fuses and Other Protective devices
- Conduit and Trunking
- Test Equipment
- Types of Lighting and Industrial Switches
- Earth's and Earth Bonding
- Distribution Boards / Strobing effect and it's avoidance
- Recognition and Drawing of Block / Circuit, Location and Wiring Diagrams to BS 3939
- Dismantling and Assembling AC/DC Motors, Single and 3 Phase
- Costing and estimating jobs and installations
- Case studies, demonstrations,
- Exercises and discussion periods
- Course Evaluation
- Course Summary

Managing Generation & Transmission Systems

Introduction

In 1882 Sir Thomas Edison built the world's first electricity generating station in New York. The supply of Electricity spread rapidly across the globe in the ensuing years. Today, over a century later, the use of electrical energy has become commonplace. Generating stations of varying types and size are installed and High Voltage and Extra High Voltage Interconnected Transmission networks are evident in most parts of the world.

Global economics is rapidly changing methodology in Generation and Transmission Network Utilities throughout the world. Many Electricity Utilities have changed from State Ownership to Private Ownership and the trend is increasing worldwide.

Regulatory and shareholder pressures are now driving Electricity Utilities to deliver an improved supply performance and demonstrate a more commercial approach to their activities. At the same time equipment manufacturers, particularly those involved in energy management systems are also being driven by this trend.

A first step for all concerned is to ensure that decision-making personnel possess sufficient up-to-date knowledge of interconnected power system behaviour together with the latest in SCADA/EMS Technology.

Who Should Attend

The Seminar is designed for Utility Managers, Engineers and Technicians who are responsible for the:-

- Design, Specification and Project Management
- Operation and Maintenance
- System Operation
- Overall Enterprise Management

of Interconnected Power Generation and Transmission Networks, who may require to refresh their knowledge and acquaint themselves with latest developments.

It is also of benefit to non-utility personnel who require a good understanding of power systems due to employment in related activities, e.g. government agencies, loan agencies etc. Design, Marketing and Project Management Personnel from manufacturers of Power Generation and Transmission equipment should also benefit greatly from the seminar.

Seminar Objectives

To ensure delegates develop their existing knowledge and are acquainted with latest developments in Generation and Transmission System

Management. In addition that the principles can be appropriately applied in every day work to improve their personal effectiveness and efficiency throughout the whole enterprise.

Training Methodology

The latest educational methods and strategies are employed. The course is designed to maximise delegate participation. From the outset, the goals of each participant are discussed to ensure needs are fulfilled as far as possible. Questions and Answers are encourages throughout and at the daily wrap-up sessions. This gives participants the opportunity to discuss with other delegates and the presenter their specific problems and appropriate solutions. All delegates take away a manual of all the material presented. Only minimum note taking is encouraged to ensure maximum delegate attention during the seminars

Seminar Contents

Revision of Electrical Fundamentals
Revision on Power System Elements
Exercises

Power System Overview
- Electricity Demand and Commercial Activity
- Generating Station Siting
- Transmission Network Components and Substation Layouts,

Exercises

Generating Stations
- Classification and Overview
  - ⇒ The Three-phase Alternator
  - ⇒ Description of Prime-movers
  - ⇒ Cost of Production
  - ⇒ Governors
- Managing Unit Overhaul and Repair
- Generator Protection
- Managing Power station O&M
  - ⇒ Staffing Levels
  - ⇒ Motivation and Best Practice

Exercises and Case Studies

Transmission Operation and Maintenance
- Effective Organisations and Best Practice
- Managing the Safety Issues
- Transmission Department Staffing
- P/PM Maintenance Planning and Schedules
- Effective Materials Control and Facilities Management
- Managing Fault Repairs effectively
- Effective Fault and Incident Reporting.

Exercises and Case Studies

System Operation

- The principles of System Operation
- Reasons for Centralised Control
- Control Room Staffing
- System Constraints
- Automatic Aids
- Security Standards
- Demand Forecasting
- Generation Availability Management
- Transmission Outage Management and Co-ordination
- Economic Dispatch, and Frequency Control

Exercises and Case Studies

Communications, SCADA and EMS

- SCADA Hardware
- SCADA Software
- EMS Software
- Effective Power System Communications
- Procurement and Project Management

System States, Operating Hazards and Emergency Conditions

- Definition of System States
- Recognising System States with SCADA/EMS
- Managing Minor Shutdowns and Supply Restoration
- Managing the recovery from major black-outs
  - ⇒ Team Work
  - ⇒ Time Organisation
  - ⇒ Public Relations Issues
- Operator Training
- Operational Memorandums and Control Instructions

Exercises and Case Studies

- **Ownership and De-Regulation**
- **Advanced Substation and Network Automation**
  - ⇒ Effects on Staffing Levels and Motivation

- ***Electrical Utility Accountability***
  - ⇒ Financial Issues
  - ⇒ Public Relations and Social Issues

Review and Course Evaluation

ELECTRICAL SAFETY & OSHA

Introduction

Electricity is high-grade energy. However working in the proximity of electrical equipment involves danger. Whether such electrical apparatus is static or mobile, all staff whether managers, administrators, engineers or technicians need to understand the potential dangers, and how to keep matters under control in order to avoid injuries or fatalities. All staff must therefore be aware of the protection available and the regulations and advisory information governing this important area of concern.

Safety is the responsibility of everyone and begins at the personal level. This course is designed to raise the level of competence and electrical safety awareness within the company. It covers International Safety Standards and in particular those of OSHA including electrical equipment installed in hazardous areas

Seminar Objectives

- To develop existing and improve an overall understanding of the dangers of electricity at all voltage levels.
- To be acquainted with International Regulations applicable to the use of Electrical Equipment in normal and in hazardous locations
- To examine the company's existing electrical safety procedures and current practices relating to incident reporting.
- Examine ways to improve the company's existing electrical safety record.

Who Should Attend

Managers, Administrators, Engineering Supervisors and Foremen from all disciplines.

Course Duration: Five Days

Training Methodology

The latest educational methods and strategies are employed. The course is designed to maximise delegate participation. From the outset, the goals of each participant are discussed to ensure needs are fulfilled as far as possible. Questions and Answers are encouraged throughout and at the daily wrap-up sessions. This gives participants the opportunity to discuss with other delegates and the presenter their specific problems and appropriate solutions. All delegates take away a manual of all the material presented. Only minimum note taking is encouraged to ensure maximum delegate attention during the seminars.

DAY 1

- Introduction to Electricity for Non-Technical Personnel
- Defining the dangers and hazards from all types of Electrical Apparatus
- Worldwide Standards for Safety in the Electrical Environment
- Introduction to Occupational Safety and Health Administration (OSHA)
- Case Studies and Work Sessions

DAY 2

- Understanding how Electricity Acts - Introduction to Electric Shock
- Factors Affecting the Severity of Electric Shock
- The Treatment of Electrical Injuries

Case Studies and Work Sessions

- The important issue of diagrams and other documentation
- Introduction to electrical protection systems for non-electrical personnel. How they are employed and why

  Fuses
  Circuit Breakers
  Contactors
  The Earth Leakage Circuit Breaker

Case Studies and Work Sessions

DAY 3

- Hazardous Area Classifications
- Identification of Electrical Hazards in the company's electrical networks
- Case Studies and Work Sessions
- Introduction to Building Wiring Regulations for non-electrical personnel
- Personal Protection Equipment and Training in its use

  Headgear
  Eye and Face Protection

Ear Protection
Respiratory Protection
Torso Protection
Arm and Hand Protection
Foot and Leg Protection

- The correct Tools and Usage

Case Studies and Work Sessions

DAY 4

- Introduction to Electrical Safety Rules for non-electrical personnel.
- Isolation and Earthing Procedures
- Guarding Electrical Apparatus
- International Standards for danger signs and appropriate application

Case Studies and Work Sessions
Examining Ways to improve the Company's Existing Electrical Safety Record

DAY 5

- Electrical Safety Committees
- Work Supervision for safety
- Accident Reporting and Follow Up
- Handling Human Errors and Accidents

Case Studies and Work Sessions

- Hazardous Areas, Indoor and Outdoor, Precautions
- Avoiding Electrical Fires, Design and Operations
- Fire Appliances/Actions

Case Studies and Work Sessions

Wrap-up Session

Course Evaluation

OVERHEAD LINES

INTRODUCTION

Overhead Lines form the majority of Transmission and Distribution Circuits due to their much lower cost than equivalent cables at the same voltage and current ratings. An Overhead Line is a set of 3 wires, one for each phase, referred to as the conductors. At Transmission Voltage Levels the conductors are normally strung on steel-latticed towers of many different shapes and size. However at Distribution (lower voltages), constructions in timber and occasionally reinforced concrete are used. The seminar the technology over a wide range of voltage levels for both transmission and distribution circuits.

WHO SHOULD ATTEND

The Seminar is designed for Utility Managers, Engineers and Technicians who are responsible for Overhead Lines and their utilisation in the following categories: -

- Design, Specification and Project Management
- Operation and Maintenance
- System Operation and Control

It is for those personnel who may require to refresh their knowledge and acquaint themselves with latest developments.

It is also of benefit to non-utility personnel who require a good understanding of overhead lines due to employment in related activities, e.g. government agencies, loan agencies etc. Design, Marketing and Project Management Personnel from manufacturers Overhead Line Equipment should also benefit greatly from the seminar.

SEMINAR OBJECTIVES

To ensure delegates develop their existing knowledge and are acquainted with latest developments in Overhead Line Technology. In addition that the principles can be appropriately applied in every day work to improve their personal effectiveness and efficiency.

TRAINING METHODOLOGY

The latest educational methods and strategies are employed. The course is designed to maximise delegate participation. From the outset, the goals of each participant are discussed to ensure needs are fulfilled as far as possible. Questions and Answers are encouraged throughout and at the daily wrap-up sessions. This gives participants the opportunity to discuss with other delegates and the presenter their specific problems and appropriate solutions. All delegates take away a manual of all the material presented. Only minimum note taking is encouraged to ensure maximum delegate attention during the seminars.

COURSE DURATION: Five Days

DAY 1

- Power System Overview
- Overhead Lines versus Underground Cables
- Support Structures
- Steel Lattice Towers
- Wooden Poles
- Overhead Line Foundations
- Soil Investigation
- Foundation Types
- Foundation Design
- Site Works

Exercises and Case Studies

DAY 2

- Overhead Line Routing
- Objectives
- Preliminary Routing
- Survey Equipment Requirements
- Aerial Survey
- Ground Survey
- Ground Soil Conditions
- Wayleaves, Access and Terrain
- Optimisation
- Detailed Line Survey and Profile
- Computer-aided Techniques
- *Exercises and Case Studies*

DAY 3

- Structures, Towers & Poles
- Environmental Conditions
- Typical Parameters
- Effect on Tower or Support Design
- Conductor Loads
- Substation Gantry

Worked Example and Exercises

- Structure Design
- Lattice Steel Tower Design Considerations
- Tower Testing
- Pole and Tower Types
- Pole Structure
- Tower Structure
- Exercises and Case Studies

DAY 4

- Conductors
- Environmental Considerations
- Conductor Selection
- Types of Conductor
- Aerial bundled conductor
- Conductor Breaking Strength
- Bi-Metal Connectors
- Lightning
- Insulator arcing horn co-ordination
- Surge Divertors
- Load-Flow Constraints in Power Networks
- Calculated Ratings
- Power Carrying Capacity
- Corona Discharge
- Line Rating Calculation Worked Example and Exercises
- Design Spans

DAY 5

- Clearances and Loadings
- Distribution Voltage Clearances
- Transmission Voltage Level Clearances
- Overhead Line Clearance Calculations
- Worked Examples and Exercises
- Overhead Line Fittings
- Aerodynamic Phenomena
- Suspension Clamps
- Sag Adjusters
- Other types of Fittings
- Overhead Line Impedance
- Inductive Reactance
- Capacitive Reactance
- Resistance
- Worked Examples and Exercises
- Overhead Lone Maintenance
- CASE STUDIES
- MANUALS AND INFORMATION SOURCES
- INDUSTRIAL STANDARDS (IEE, IEEE AND IEC)
- WRAP-UP SESSION AND COURSE EVALUATION

POWER DISTRIBUTION SYSTEM (OPS, PREDICTIVE MAINT & T/SHOOTING)

Introduction

Planned maintenance inspections that are regularly implemented ensure that safe operations are effected and that loss of production due to fault outages on power Distribution Equipment is minimised. Maintenance inspections can inform the client of the current status and operability of its electrical systems and record the expected performance of the equipment life cycle.

The maintenance inspection methods, also indicates when spare parts are likely to be required and give greater accuracy of predictability necessary to forecast future planned maintenance schedules

Who Should Attend

Managers, Engineers, Supervisors and Technicians involved in the operations and maintenance of Power Distribution Equipment.

It is also of great benefit to personnel who require a broad understanding of Power Distribution Operations and Maintenance Procedures due to their employment in related activities.

Seminar Objectives

This course is designed to give the skills and knowledge necessary for operating and maintaining Power Distribution Equipment in accordance with international standards. It also gives the engineers or technician a greater understanding of "Preventative and Predictive Maintenance" incorporating planning and scheduling. Case studies are included for interactive discussions

The latest educational methods and strategies are employed. The course is designed to maximise delegate participation. Questions and Answers are encouraged throughout and at the daily wrap-up sessions. This gives participants the opportunity to discuss with other delegates and the presenter their specific problems and appropriate solutions. All delegates take away a manual of all the material presented. Only minimum note taking is encouraged to ensure maximum delegate attention during the seminars.

Course Duration: Five Days

Course Outline:

DAY 1

Introductions
Goals – Discussion

Revision of Electrical Fundamentals
Voltage Levels
The Single Line Diagram
Network Equipment Overview

- Overhead Lines
- Underground Cables
- Power Transformers
- Circuit Breakers
- Reclosers and Sectionalisers
- Ring Main Units
- LV Distribution Boards
- Fuses
- Shunt Capacitors
- Voltage Regulators
- Series and Shunt Reactors
- Measurement Transformers
- Surge Arrestors
- Fault Indicators
- Protection Relays

DAY 2

Personal and Equipment Safety

- Installation Safety Requirements
- Safety Related Maintenance and Environmental Considerations
- Safety requirements for special equipment
- Personal Protective Equipment

Case Studies and Group Exercises
Further Explanations as required

Causes of Distribution Equipment Failure

- Motors and Generators
- Switchgear
- Lines and Cables
- Power Transformers
- Protection Relaying
- Batteries and Chargers, UPS

Overall Distribution Network Reliability

DAY 3

The Economic Effects of Down Time and Loss

Maintenance Policies General

- Reactive Maintenance
- Proactive Maintenance
- Predictive and Preventative Maintenance (P/PM)
- Equipment Condition Monitoring
- Failure Reporting
- IR Technology
- Spares Policy

Case Studies and Group Exercises
Further Explanations as required

Troubleshooting, Problem Solving Sequences

- Fault Finding
- Using Troubleshooting Charts
- Using Flow Charts
- Test Equipment

Case Studies and Group Exercises
Further Explanations as required

DAY 4

Maintenance Planning and Control

- Modern Facilities Management integrated with SCADA/DMS and the Distribution Enterprise
- Maintenance schedules
- Controls and records.

Planned Shutdowns and Overhauls

- Manpower allocation
- Downtime analysis
- Shut-down costs

Case Studies and Group Exercises
Further Explanations as required

DAY 5

Maintenance Programs

- Work time-spans
- Planning charts and the control cycle.
- Manpower and resource allocation,
- Job and Critical Path Analysis
- Documentation Flow
- Keeping adequate Maintenance Records

Case Studies and Group Exercises
Further Explanations as required

Wrap-up Session
Course Summary & Evaluation

Power Distribution System

Introduction

Planned maintenance inspections that are regularly implemented ensure that safe operations are effected and that loss of production due to fault outages on power Distribution Equipment is minimized. Maintenance inspections can inform the client of the current status and operability of its electrical systems and record the expected performance of the equipment life cycle.

The maintenance inspection methods, also indicates when spare parts are likely to be required and give greater accuracy of predictability necessary to forecast future planned maintenance schedules

Seminar Objectives

This course is designed to give the skills and knowledge necessary for operating and maintaining Power Distribution Equipment in accordance with international standards. It also gives the engineers or technician a greater understanding of "Preventative and Predictive Maintenance" incorporating planning and scheduling. Case studies are included for interactive discussions

The latest educational methods and strategies are employed. The course is designed to maximise delegate participation. Questions and Answers are encouraged throughout and at the daily wrap-up sessions. This gives participants the opportunity to discuss with other delegates and the presenter their specific problems and appropriate solutions. All delegates take away a manual of all the material presented. Only minimum note taking is encouraged to ensure maximum delegate attention during the seminars.

The instructor is John Bailey, a Power System Engineer, with many years' practical experience with Utilities and Manufacturers, notably in the United Kingdom, Saudi Arabia, Canada and the USA. He is a Graduate of the University of Durham; King's College and a Member of the Institution of Electrical Engineers, London.

Who Should Attend?

Managers, Engineers, Supervisors and Technicians involved in the operations and maintenance of Power Distribution Equipment.

It is also of great benefit to personnel who require a broad understanding of Power Distribution Operations and Maintenance Procedures due to their employment in related activities.

Seminar Outline

Day One:

Introductions
Goals – Discussion

Revision of Electrical Fundamentals
Voltage Levels
The Single Line Diagram
Network Equipment Overview

- Overhead Lines
- Underground Cables
- Power Transformers
- Circuit Breakers
- Reclosers and Sectionalisers
- Ring Main Units
- LV Distribution Boards
- Fuses
- Shunt Capacitors
- Voltage Regulators
- Series and Shunt Reactors
- Measurement Transformers
- Surge Arrestors
- Fault Indicators
- Protection Relays

Day Two:

Personal and Equipment Safety

- Installation Safety Requirements
- Safety Related Maintenance and Environmental Considerations
- Safety requirements for special equipment
- Personal Protective Equipment

Case Studies and Group Exercises
Further Explanations as required

Causes of Distribution Equipment Failure

- Motors and Generators
- Switchgear
- Lines and Cables
- Power Transformers
- Protection Relaying
- Batteries and Chargers, UPS
- Overall Distribution Network Reliability

Day Three:

The Economic Effects of Down Time and Loss

Maintenance Policies General

- Reactive Maintenance
- Proactive Maintenance
- Predictive and Preventative Maintenance (P/PM)
- Equipment Condition Monitoring
- Failure Reporting
- IR Technology
- Spares Policy

Case Studies and Group Exercises
Further Explanations as required

Troubleshooting, Problem Solving Sequences

- Fault Finding
- Using Troubleshooting Charts
- Using Flow Charts
- Test Equipment

Day Four

Maintenance Planning and Control

- Modern Facilities Management integrated with SCADA/DMS and the Distribution Enterprise
- Maintenance schedules
- Controls and records.

Planned Shutdowns and Overhauls

- Manpower allocation
- Downtime analysis
- Shut-down costs

Case Studies and Group Exercises
Further Explanations as required

Day Five

Maintenance Programs

- Work time-spans
- Planning charts and the control cycle.
- Manpower and resource allocation,
- Job and Critical Path Analysis
- Documentation Flow
- Keeping adequate Maintenance Records

- Case Studies and Group Exercises
- Course Evaluation & Summary

Power Generation & Transmission

Introduction

In 1882 Sir Thomas Edison built the world's first electricity generating station in New York. The supply of Electricity spread rapidly across the globe in the ensuing years. Today, over a century later, the use of electrical energy has become commonplace. Generating stations of varying types and size are installed and High Voltage and Extra High Voltage Interconnected Transmission networks are evident in most parts of the world.

Global economics is rapidly changing methodology in Generation and Transmission Network Utilities throughout the world. Many Electricity Utilities have changed from State Ownership to Private Ownership and the trend is increasing worldwide.

Regulatory and shareholder pressures are now driving Electricity Utilities to deliver an improved supply performance and demonstrate a more commercial approach to their activities. At the same time equipment manufacturers, particularly those involved in energy management systems are also being driven by this trend.

A first step for all concerned is to ensure that decision-making personnel possess sufficient up-to-date knowledge of interconnected power system behaviour.

Who Should Attend

The Seminar is designed for Utility Managers, Engineers and Technicians who are responsible for the:-

- Design, Specification and Project Management
- Operation and Maintenance
- System Operation
- Overall Enterprise Management

of Interconnected Power Generation and Transmission Networks, who may require to refresh their knowledge and acquaint themselves with latest developments.

It is also of benefit to non-utility personnel who require a good understanding of power systems due to employment in related activities, e.g. government agencies, loan agencies etc. Design, Marketing and Project Management Personnel from manufacturers of Power Generation and Transmission equipment should also benefit greatly from the seminar.

Seminar Objectives

To ensure delegates develop their existing knowledge and are acquainted with latest developments in Generation and Transmission Systems. In

addition that the principles can be appropriately applied in every day work to improve their personal effectiveness and efficiency throughout the whole enterprise.

Training Methodology

The latest educational methods and strategies are employed. The course is designed to maximise delegate participation. From the outset, the goals of each participant are discussed to ensure needs are fulfilled as far as possible. Questions and Answers are encourages throughout and at the daily wrap-up sessions. This gives participants the opportunity to discuss with other delegates and the presenter their specific problems and appropriate solutions. All delegates take away a manual of all the material presented. Only minimum note taking is encouraged to ensure maximum delegate attention during the seminars

Seminar Contents

Revision of Electrical Fundamentals
Exercises

Power System Overview
- Electricity Demand and Commercial Activity
- Generating Station Siting
- Transmission Network Components and Substation Layouts,

Exercises

Generating Stations
- Classification
- The Three-phase Alternator
- Description of Prime-movers
- Power station O&M
- Cost of Production
- Governors
- Unit Overhaul and Repair
- Generator Protection

Transmission Operation and Maintenance
- Review of Transmission Elements
- Protection Relaying
- Transmission Department Staffing
- Maintenance Schedules
- Substation Alarms
- Fault Repairs and Switchgear Numbering.

Exercises and Case Studies

Working Safely

- Safety Rules
- Switching Co-ordination

Exercises and Case Studies

System Operation

- The principles of System Operation
- Reasons for Centralised Control
- System Constraints
- Automatic Aids
- Security Standards
- Demand Forecasting
- Generation Availability Planning
- Transmission Outage Planning
- Economic Dispatch, and Frequency Control

Exercises and Case Studies

Communications, SCADA and EMS

- SCADA Hardware
- SCADA Software
- EMS Software
- Power System Communications

System States, Operating Hazards and Emergency Conditions

- Definition of System States
- Recognising System States with SCADA/EMS
- Recovery from major disasters

Exercises and Case Studies

Review and Course Evaluation

Power Transformers
Construction, Operation, Maintenance and Testing

Introduction

In 1882 Sir Thomas Edison built the world's first electricity generating station in New York. The supply of Electricity spread rapidly across the globe in the ensuing years. Today, over a century later, the use of electrical energy has become commonplace.

The transfer of electricity from generating sources is carried out using many components and sub-systems. When the components are connected together to supply various types and levels of electrical load, the result is usually referred to as a NETWORK. This course addresses the testing and maintenance of one of the principle components in Electrical Networks i.e. Power Transformers. Voltage levels from mains (220 or 415V phase-to-phase) up to 400kV are addressed. .

Who Should Attend

The Seminar is designed for Engineers and Technicians who are responsible for the:-

- Specification, Commissioning, Operation and Maintenance

of Power Transformers in Utilities or Industrial Networks who may require to refresh their knowledge and acquaint themselves with latest developments in transformer technology.

Seminar Objectives

To ensure delegates develop their existing knowledge of power transformers and are acquainted with latest developments.

Training Methodology

The latest educational methods and strategies are employed. The course is designed to maximise delegate participation. From the outset, the goals of each participant are discussed to ensure needs are fulfilled as far as possible. Questions and Answers are encouraged throughout and at the daily wrap-up sessions. This gives participants the opportunity to discuss with other delegates and the presenter their specific problems and appropriate solutions. All delegates take away a manual of all the material presented. Only minimum note taking is encouraged to ensure maximum delegate attention during the seminars

Seminar Duration: Five Days

Seminar Contents

- **Power Transformer Fundamentals**
  - Fundamentals of Magnetic Circuits
  - Current, Flux and Inductance in Magnetic Circuits
  - Ampere's Law
  - Application of Faraday's Law
  - Magnetic Circuits
  - RMS Current
  - The Ideal Transformer
  - Transformer Equivalent Circuits
  - Power Sources and Loads
  - Effect of Transformers on Circuit Performance
  - Circuit Performance of Power Transformers

- **Power Transformer Overview**
  - Core Types
  - Single Phase
  - Three-Phase
  - Phase Relationships – Phasor Circuits
    - Delta/Star and Star/Delta
    - Star/Star
    - Interconnected-Star Connection
    - The Autotransformer
    - Volts per Turn and Flux Density
    - Tappings
    - Impedance
    - Multi-Winding Transformers including Tertiary Windings
- **Basic Materials**
  - Dielectrics
  - Core Steel
  - Winding Conductors
  - Insulation
  - Transformer Oil
    - Chemical properties
    - Electrical properties
  - Other Dielectric Liquids

- **Construction Principles**
  - Oil-filled Transformers
  - Dry type transformers
  - Auto-Transformers
  - Single-Phase and Two-phase Transformers
  - Windings
    - HV
    - LV
    - Tapping windings
  - Cooling Arrangements
  - Transformer Breathing Systems
  - Tapchangers

- Employment of Tapchangers
- Tapchanger mechanisms
- In-tank-type Tapchangers
- Off-Load Tapchangers
- Control of On-load Tapchangers

- Tanks and Ancillary Equipment
  - Transformer Tanks
  - Oil Preservation Equipment
  - Gas and oil-actuated relays
  - Bushing connections
  - Cable Box Connections
  - Tank-mounted coolers
  - Cooler control
  - Winding Temperature Indicators

❖ **Manufacturer's and Commissioning Testing**

- Manufacture's QA
- Final Testing
  - Routine tests
  - Type Tests
  - Voltage Ratio and Polarity Test
  - Ratiometer method
  - Polarity of Windings and Phasor Group Connections
  - Load-loss Test and Impedance Test
  - Insulation Resistance Test
  - Resistance of Windings
  - Iron-loss Test and No-load Current Test
  - Dielectric tests – Windings
  - Partial Discharge Measurement
  - Induced Overvoltage Withstand Test
  - Voltage Tests: Induced Overvoltage Test
  - Separate-source voltage withstand test
  - Impulse testing
  - Temperature Rise Test for Oil-immersed Transformers
  - Possible Additional Testing for Important Transformers

❖ **Protection and Alarm Supervision**

- Analysis of short-circuit currents
- Transformer Protection – An Introduction
- Protection for Faults Arising Within The Transformer
  - Circulating current protection
  - High-speed Protection by Biased Differential Harmonic Restraint
  - Duo Bias Differential Transformer Protection
  - Opposed-voltage protection
  - Overcurrent and earth leakage protection
  - The gas- and oil-actuated relay - Bucholtz
  - Interturn failures

- Relay Installation and Commissioning
  - Equipment Connections and the meaning of safety symbols
  - Equipment operating conditions
  - Current transformer circuits
  - External resistors
  - Battery replacement
  - Insulation and dielectric strength testing
  - Insertion of modules and PCB Cards
  - Fibre optic communication
  - Electrical Adjustments
  - Mechanical Adjustments
  - Draw-out Case Relays
  - Insertion and withdrawal of extender cards
  - Insertion and withdrawal of heavy current test plugs
- Relay Maintenance and Testing, Electromechanical and Solid State
  - Visual Inspection
  - Maintenance Testing
  - Trouble Shooting
  - Test Equipment for Fault Finding
  - General Procedures and Precautions
  - Inspection
  - Connections
  - Checking Voltage Supplies
  - Printed Circuit Board Tests
- Alarm Supervision
  - Substation
  - SCADA
  -
- Relay Maintenance Case Studies and Discussions

❖ Maintenance and Failures

- Network Security Considerations for Outages
- Safety Considerations
  - Isolation and Earthing Principles
  - Switching Co-ordination
  - Permits to Work
- Maintenance Policies
  - Reactive
  - Predictive and Preventative
- Maintenance Stocks (Spares)
- Maintenance Group Work before Outage Commences
  - Visual and Audio Inspection
  - Thermographic Inspection
  - Check Fault Reports for Entire Network
  - On-Load Tap-Changers

- Maintenance Group Work During the Outage
  - Oil Analysis
  - Dissolved gas analysis
  - Diagnosis in practice
  - Bushings
  - HV Sealing Ends and LV Glands
  - On-load Tap-Changers (OLTC's)
  - Fans and Pumps
  - Associated Switchgear
  - General Cleaning
- Maintenance Records
- Transformer Diagnostic Software

- Case Studies Failures
- Case Studies – Maintenance Outages

❖ In Service Operations
- Best Practice
- Loading requirements
- Response to Alarms
  - Critical
  - Non-critical

❖ Management Issues - Treating Transformer Outages as a Project
- Project Typology
- Environmental Constraints
- The Deeming Cycle
- Work Breakdown Structure
- The Project Life-Cycle
- Planning Methodology
  - Planning Accuracy versus Precision
  - Information versus Data
  - Balancing Costs and Benefits
  - Planning with Activity Models
  - The Planning Sequence
  - Network diagrams – dealing with complexity
- Critical Path Analysis and Resource Allocation

Review and Course Evaluation

ELECTRICAL PROTECTION RELAYING

Introduction

Electric power systems are designed to serve loads in a safe and reliable manner. One of the major considerations in the design of any power network is adequate control of short-circuits or “faults” as they are generally referred to. If faults are not controlled they can cause unnecessary loss of electricity service with all of its many ramifications and damage to equipment. Faults on system elements are removed from networks by means of equipment referred to as “Power System Protection”.

This course is designed to give delegates a broad understanding of the nature of power network faults and the principles of Protection System Protection, Design, Operation and Maintenance.

Who Should Attend

Engineers and Technicians from Electrical Transmission and Distribution Utilities or Major Consumers with Power Distribution Networks, such as those for oil and gas production, who are directly involved in the design, specification, purchasing, maintenance or day to day Operation of System Protection.

It is also of great benefit to personnel who require a broad understanding of power system protection due to their employment in related activities, e.g. government agencies, loan agencies etc.

Design, Marketing and Project Management Personnel from manufacturers of power system protection equipment should also benefit greatly from the seminar.

Personnel should ideally have at least two years experience related to the electrical power industry.

Seminar Objectives

To ensure delegates develop their existing knowledge and are acquainted with latest developments in Power System Protection

Interpreting system faults from protection system alarms and indications and determine the necessary corrective actions

Information and instruction in safe operating procedures in electrical protection schemes, including elements of maintenance of HV and LV protection relay systems.

Training Methodology

The latest educational methods and strategies are employed. The course is designed to maximise delegate participation. From the outset, the goals of

each participant are discussed to ensure needs are fulfilled as far as possible. Questions and Answers are encourages throughout and at the daily wrap-up sessions. This gives participants the opportunity to discuss with other delegates and the presenter their specific problems and appropriate solutions. All delegates take away a manual of all the material presented. Only minimum note taking is encouraged to ensure maximum delegate attention during the seminars

Seminar Contents

Revision of Electrical Fundamentals
Exercises

Power System Overview
- Electricity Demand and Commercial Activity
- Generating Station Siting
- Transmission Network Components and Substation Layouts,

Exercises

Faults and Fault Levels
- The reasons for faults
- Distinction between load current and fault current
- Sources of short-circuit current
- Symmetrical and asymmetrical currents
- X/R ratio and the DC component

Exercises

Fault Level Calculations
- How to calculate fault currents in power networks

Exercises

Role, Types and Selection
- Introduction to power system protection
- The classification of faults
- System earthing
- Fault Analysis
- Principles of the Circuit Breaker
- Protection Philosophy
- Substation and Network Layouts
- Categories of Protection
- Properties of Protection
- Zones of Protection
- Back-up Protection
- Main forms of Protection Relaying Systems for Networks

Exercises

Relay Applications

- Protection Discrimination
- Unit protection
- Overall protection
- Measurement transformers (PT's and CT's)
- Basic Function of Protection
- The Overcurrent Relay
- Distance Relays
- Differential Relays
- Pilot wire relaying
- Protection Philosophy
- Relay Applications

Exercises and Case Studies

Summary and Numerical Relays

- Protection systems for
  - ⇒ Overhead lines
  - ⇒ Underground cables
  - ⇒ Busbars.
  - ⇒ Transformers
  - ⇒ Motors
- Supervision relaying
- Relay Testing
- Introduction to the solid state relay
- Modern substation and control centre applications.

Exercises and Case Studies

Review and Course Evaluation

HV and LV Power System Protection (Protection Relays)

Course Introduction:

Efficient and Safe Power Protection systems are vital to ensure no overload may occur and a smooth current is maintained at the level determined for the demand required. Safety systems also demand the highest standards of operations and maintenance and therefore Relay Protection Systems play a large part in the Electrical Power Process.

This course is designed to inform participants how Power systems operate and safely maintain Protection Systems.

Course Objectives:

This course is designed to the participants:

- An Increased level of knowledge of the theoretical aspects and calculations on Protective Relays
- Familiarity with the application, basic connections and internal schematics
- Ability to test several Relays (Electromagnetic & Solid State), including type 50 / 51, type 27 / 51 type 60 and type 81
- The Safety rules applicable
- Relays Testing and Compliance

Course Duration: Five Days

Who Should Attend:

Electrical personnel involved in the day to day running of day to day operation / maintenance of power systems protection

Program Support:

This program will include a comprehensive format covering the testing, maintenance and operating principles in detail in both practical laboratory exercises and classroom lecture sessions. It also includes case studies and interactive discussions to reinforce learning potential.

Course Contents:

1. Relay Operation and Fundamentals

- Electromagnetic Attraction, Induction
- Thermal
- Solid State

2. Relay Application

- Auxiliary
- Thermal
- Overcurrent
- Voltage
- Percent
- Current Balance

3. Manufacturers Literature

- Familiarization
- Schematic Usage
- Curve Interpretation

4. Relay Function

- Standards
- Interpretation

5. Safety

- Relay Installation and Removal
- Current Transformer Hazards
- Voltage Transformer Hazards
- Test Plug Usage

6. Record Keeping

- Relay Test Form
- Maintenance Requirements

7. Maintenance / Acceptance Testing

- Visual Inspection
- Mechanical Inspection
- Electrical Tests and Adjustments

- **Case studies, exercises and discussions**
- **Course Evaluation & Summary**

SCADA Systems in the Electrical Supply Industry – Operation & Maintenance

Introduction:

In 1882 Sir Thomas Edison built the world's first electricity generating station in New York. The supply of Electricity spread rapidly across the globe in the ensuing years. Today, over a century later, the use of electrical energy has become commonplace. Generating stations of varying types and size are installed and High Voltage and Extra High Voltage Interconnected Transmission networks are evident in most parts of the world.

Global economics is rapidly changing methodology in Generation and Transmission Network Utilities throughout the world. Many Electricity Utilities have changed from State Ownership to Private Ownership and the trend is increasing worldwide.

Regulatory and shareholder pressures are now driving Electricity Utilities to deliver an improved supply performance and demonstrate a more commercial approach to their activities. At the same time equipment manufacturers, particularly those involved in energy management systems are also being driven by this trend.

A first step for all concerned is to ensure that decision-making personnel possess sufficient up-to-date knowledge of interconnected power system behaviour together with the latest in SCADA/EMS/DMS Technology.

Who Should Attend:

The Seminar is designed for Utility Managers, Engineers and Technicians who are responsible for the:-

- Design, Specification and Project Management
- Operation and Maintenance
- System Operation
- Overall Enterprise Management

of Interconnected Power Generation and Transmission Networks, who may require to refresh their knowledge and acquaint themselves with latest developments.

It is also of benefit to non-utility personnel who require a good understanding of power systems due to employment in related activities, e.g. government agencies, loan agencies etc. Design, Marketing and Project Management Personnel from manufacturers of Power System Equipment including SCADA should also benefit greatly from the seminar.

Seminar Objectives:

To ensure delegates develop their existing knowledge and are acquainted with latest developments in Generation and Transmission System Management. In addition that the principles can be appropriately applied in every day work to improve their personal effectiveness and efficiency throughout the whole enterprise.

Training Methodology:

The latest educational methods and strategies are employed. The course is designed to maximise delegate participation. From the outset, the goals of each participant are discussed to ensure needs are fulfilled as far as possible. Questions and Answers are encouraged throughout and at the daily wrap-up sessions. This gives participants the opportunity to discuss with other delegates and the presenter their specific problems and appropriate solutions. All delegates take away a manual of all the material presented. Only minimum note taking is encouraged to ensure maximum delegate attention during the seminars

Seminar Duration: 9 Days

Seminar Contents:

Session 1

Introductions and Brief History of Electricity Supply since Edison.

Session 2
Essential Revision on the Fundamentals of Electricity

- Ohms Law, Power and Energy
- AC Voltage Generation
- AC Power in Resistive Circuits
- Effects of Inductance and Capacitance
- Power Factor
- Introduction to the P.U. system
- Generation Synchronism and Frequency
- Three-Phase AC Circuits
- The Impedance Triangle
- Voltage Drop Calculations

Questions and Answers

Session 3
Essential Revision on the Elements of a Power System
(A Practical Understanding for the SCADA Operator).

- Power Generation
- Transmission Lines and Cables
- Substations
- Transformers
- Other Terminal Equipment (Breakers, Switches, Earthing Devices, Surge Arrestors, VT's, CT's, Shunt Reactors, Shunt Capacitors, Series Reactors, Series Capacitors, Protective Relaying

Questions and Answers

Session 4

Overview of the Components of a SCADA/Energy Management System(EMS)

- Remote Terminal Units (Network Terminal Units - NTU's)
- Communications
- The Master Station (Control Room) - Hardware and Software - Redundancy Concepts

Questions and Answers

Session 5

Remote Terminal Units - Hardware and Software

- RTU Basic Hardware Structure
- RTU Software and Firmware Structure
  - Input/ Output Requirements from Power System Elements and how derived.
    1. Status (Switching Device Status and Alarms)
    2. Analog Values, MW, Mvar, KV, KA, Frequency etc
    3. Counters (Accumulators)
    4. Control Outputs (Command to Switching Devices)
- RTU Operation and Maintenance
  - Commissioning
  - Periodic Maintenance
  - Reducing Failures
  - Fault Finding

Questions, Answers, Case Studies

Session 6
An Overview of Communications and the effect on SCADA Operators

Types of Power System Communications
- Radio and Microwave
- Power-Line Carrier
- Fibre Optics
- Telephone Circuits and pilot cables
- Satellite

Signalling Protocols
- Proprietary versus Non Proprietary

Examples, Questions and Answers

Session 7

Operating Systems, UNIX
Windows NT
Industrial SCADA Standards

Remote Data Acquisition Software (Part 1)

- Databases
- Database Editor tools
- Graphical User Interface
    - Substation Single Line Diagrams
    - Network Overview Diagrams
    - Selection of Pictures for Operations
    - Treatment of Analogue Values
    - Treatment of Status Values
    - Operation of Switching Devices and Transformer Taps
    - Manual Setting of Status and Analogue Values
    - Tagging

Questions ,Answers, Case Studies, Examples

Session 8

Remote Data Acquisition Software (Part 2)

- Data Trending
- Report Writing and Generation
- Historical Data Collection
- Calculations/ Interpreters
- Disturbance Data Analysis
- Load Estimation
- Expert Alarm Handling

Questions ,Answers, Case Studies, Examples

Session 9
Understanding Power Network Problems for the SCADA Operator

The Power Network Constraints

- Power Flows
- Fault-Levels (Switchgear Fault Clearance Capability
- Voltage Constraints (Reactive Power Control)
- Network Stability (Transient and Dynamic)
- System Frequency

Questions ,Answers, Case Studies, Examples

Session 10
The Control of Generation Output

- Plant Limitations and Introduction (1)
- Merit Orders (The theory of Economic Generation Dispatching)

Questions ,Answers, Case Studies, Examples

Session 11
SCADA/EMS Software for the Control of Generation Output

- Unit Commitment (UC)
- Economic Dispatch Calculation (EDC)
- Automatic Generation Control (AGC)
  Features e.g. Frequency-biased tie-line Control
- Interchange Transaction Scheduling

Questions ,Answers, Case Studies, Examples

Session 12

Advanced EMS Software Applications for the solution of Network Problems/Constraints

- State Estimation
- Operator Load Flow
- Contingency Analysis
- Short-Circuit Analysis (Fault Levels)
- Optimal Power Flow (OPF)

How these are carried out by the SCADA/EMS Operator - Interpretation of Results at the MMI (GUI)
Questions ,Answers, Case Studies, Examples

Session 13

Advanced DMS Software Applications for the solution of Network Problems/Constraints in mainly passive networks (Distribution)

- Network Topology
- Balanced and Unbalanced Load Flow
- Short-Circuit analysis
- Voltage Control
- Nodal Load Estimation
- Automatic Mapping and Facilities Management
- Integration of GIS
- Integration of Enterprise Systems with SCADA (for example)
    - Trouble Call Analysis
    - Remote Metering
    - Customer Billing

Session 14
Normal Operating Hazards with Case Studies - A Practical Session

- Generating Plant Limitations (2)
- Line Switching
- Overvoltages and Transformers

Session 15
Emergency Conditions with Case Studies
Recognising an Emergency Condition with SCADA/EMS/DMS Tools

- Frequency Variations and other indications of System abnormality
- Interchange Variation During Emergencies
- SCADA Operator actions During Emergencies

Session 16
Recovery from Major Disasters with SCADA/EMS/DMS
A Practical Session with Case Studies

- Restoration Procedures including Black-Start
- Cold Load Pick-up
- Generator Loading and Frequency Control
- Voltage Control during Restoration
- Role of SCADA/DMS

Session 17

Questions & Answers

Course Summary

SCADA SYSTEMS APPLICABLE TO THE ELECTRICAL SUPPLY INDUSTRY

Course Objectives:

On completion of the course the trainee/s will be competent in:

- Operating High Voltage Power Systems (Generation and Transmission) with the aid of Modern SCADA Energy Management Systems (EMS)
- SCADA/EMS Hardware and Software Components and their interaction with the Power System

Course Duration: Five Days

Course Contents:

Day 1 - Session 1 (0.5 hours)
Introductions and Brief History of Electricity Supply since Edison.

Day 1 - Session 2 (2 hours)
Essential Revision on the Fundamentals of Electricity

- Ohms Law, Power and Energy
- AC Voltage Generation
- AC Power in Resistive Circuits
- Effects of Inductance and Capacitance
- Power Factor
- Introduction to the P.U. system
- Generation Synchronism and Frequency
- Three-Phase AC Circuits
- The Impedance Triangle
- Voltage Drop Calculations

Questions and Answers
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Day 1 - Session 3 (Three hours)
Essential Revision on the Elements of a Power System
(A Practical Understanding for the SCADA Operator).

- Power Generation
- Transmission Lines and Cables
- Substations
- Transformers
- Other Terminal Equipment (Breakers, Switches, Earthing Devices, Surge Arrestors, VT's, CT's, Shunt Reactors, Shunt Capacitors, Series Reactors, Series Capacitors, Protective Relaying

Questions and Answers

Day 2 Session 4 (0.5 hour)

Overview of the Components of a SCADA/Energy Management System(EMS)

- Remote Terminal Units (Network Terminal Units - NTU's)
- Communications
- The Master Station (Control Room) - Hardware and Software - Redundancy Concepts

Questions and Answers

Day 2 Session 5 (2 hours)

Remote Terminal Units - Hardware and Software

- RTU Basic Hardware Structure
- RTU Software and Firmware Structure
  - Input/ Output Requirements from Power System Elements and how derived.
    1. Status (Switching Device Status and Alarms)
    2. Analog Values, MW, Mvar, KV, KA, Frequency etc
    3. Counters (Accumulators)
    4. Control Outputs (Command to Switching Devices)

Questions and Answers

Day 2 - Session 6 (1 Hour)
An Overview of Communications and the effect on SCADA Operators

Types of Power System Communications
Radio and Microwave
Power-Line Carrier
Fibre Optics
Telephone Circuits and pilot cables
Satellite

Questions and Answers

Day 2 - Session 7 (2.5 Hours)

Operating Systems, UNIX

Remote Data Acquisition Software (Part 1)

- Databases
- Database Editor tools
- Graphical User Interface
    - Substation Single Line Diagrams
    - Network Overview Diagrams
    - Selection of Pictures for Operations
    - Treatment of Analogue Values
    - Treatment of Status Values
    - Operation of Switching Devices and Transformer Taps
    - Manual Setting of Status and Analogue Values
    - Tagging

Questions and Answers

Day 3 - Session 8 (3 hours)

Remote Data Acquisition Software (Part 2)

- Data Trending
- Report Writing and Generation
- Historical Data Collection
- Calculations/ Interpreters
- Disturbance Data Analysis
- Load Estimation
- Expert Alarm Handling

Case Studies with Questions and Answers

Day 3 - Session 9 (3 hours)
Understanding Power Network Problems for the SCADA Operator

The Power Network Constraints

- Power Flows
- Fault-Levels (Switchgear Fault Clearance Capability
- Voltage Constraints (Reactive Power Control)
- Network Stability (Transient and Dynamic)
- System Frequency

Questions and Answers - Case Studies

Day 4 - Session 10 (1 hour)
The Control of Generation Output

- Plant Limitations and Introduction (1)
- Merit Orders (The theory of Economic Generation Dispatching)

Questions and Answers

Day 4 - Session 11 (2 hours)
SCADA/EMS Software for the Control of Generation Output

- Unit Commitment (UC)
- Economic Dispatch Calculation (EDC)
- Automatic Generation Control (AGC)
  Features e.g. Frequency-biased tie-line Control
- Interchange Transaction Scheduling

Questions and Answers

Day 4 - Session 12 (3 hours)

Advanced EMS Software Applications for the solution of Network Problems/Constraints - Introduced in Session 9

- State Estimation
- Operator Load Flow
- Contingency Analysis
- Short-Circuit Analysis (Fault Levels)
- Optimal Power Flow (OPF)

How these are carried out by the SCADA/EMS Operator - Interpretation of Results at the MMI (GUI)
Questions and Answers

Day 5 Session 13 (1 hour)
Normal Operating Hazards with Case Studies - A Practical Session

- Generating Plant Limitations (2)
- Line Switching
- Overvoltages and Transformers

Day 5 Session 14 (2 hours)
Emergency Conditions with Case Studies
Recognising an Emergency Condition with SCADA/EMS Tools

- Frequency Variations and other indications of System abnormality
- Interchange Variation During Emergencies
- SCADA Operator actions During Emergencies

Day 5 Session 15 (2 hours)
Recovery from Major Disasters with SCADA/EMS
A Practical Session with Case Studies

- Restoration Procedures including Black-Start
- Cold Load Pick-up
- Generator Loading and Frequency Control
- Voltage Control during Restoration

Day 5 Session 16 (1 hour)

Questions and Answers and Wrap-up

Who Should Attend:

Electrical Engineers and Technicians involved in the Operation and Control of Generation/Transmission Systems

SCADA Systems Operations & Maintenance

Course Objectives:

On completion of the course the trainee/s will be competent in:

- Operating High Voltage Power Systems (Generation and Transmission) with the aid of Modern SCADA Energy Management Systems (EMS)
- SCADA/EMS Hardware and Software Components and their interaction with the Power System

Course Duration: Five Days

Course Contents:

- Introductions and Brief History of Electricity Supply since Edison.
- Essential Revision on the Fundamentals of Electricity
- Ohms Law, Power and Energy
- AC Voltage Generation
- AC Power in Resistive Circuits
- Effects of Inductance and Capacitance
- Power Factor
- Introduction to the P.U. system
- Generation Synchronism and Frequency
- Three-Phase AC Circuits
- The Impedance Triangle
- Voltage Drop Calculations
- Essential Revision on the Elements of a Power System
- (A Practical Understanding for the SCADA Operator).
- Power Generation
- Transmission Lines and Cables
- Substations
- Transformers
- Other Terminal Equipment (Breakers, Switches, Earthing Devices, Surge Arrestors, VT's, CT's, Shunt Reactors, Shunt Capacitors, Series Reactors, Series Capacitors, Protective Relaying
- Overview of the Components of a SCADA/Energy Management System (EMS)
- Remote Terminal Units (Network Terminal Units - NTU's)
- Communications
- The Master Station (Control Room) - Hardware and Software - Redundancy Concepts
- RTU Basic Hardware Structure

- RTU Software and Firmware Structure
  - Input/ Output Requirements from Power System Elements and how derived.

    1. Status (Switching Device Status and Alarms)
    2. Analog Values, MW, Mvar, KV, KA, Frequency etc
    3. Counters (Accumulators)
    4. Control Outputs (Command to Switching Devices)

An Overview of Communications and the effect on SCADA Operators

Types of Power System Communications

Radio and Microwave
Power-Line Carrier
Fibre Optics
Telephone Circuits and pilot cables
Satellite

Operating Systems, UNIX

Remote Data Acquisition Software (Part 1)

- Databases
- Database Editor tools
- Graphical User Interface
  - Substation Single Line Diagrams
  - Network Overview Diagrams
  - Selection of Pictures for Operations
  - Treatment of Analogue Values
  - Treatment of Status Values
  - Operation of Switching Devices and Transformer Taps
  - Manual Setting of Status and Analogue Values
  - Tagging

Remote Data Acquisition Software (Part 2)

- Data Trending
- Report Writing and Generation
- Historical Data Collection
- Calculations/ Interpreters
- Disturbance Data Analysis
- Load Estimation
- Expert Alarm Handling

Understanding Power Network Problems for the SCADA Operator

The Power Network Constraints

- Power Flows
- Fault-Levels (Switchgear Fault Clearance Capability
- Voltage Constraints (Reactive Power Control)
- Network Stability (Transient and Dynamic)
- System Frequency

The Control of Generation Output

- Plant Limitations and Introduction (1)
- Merit Orders (The theory of Economic Generation Dispatching)

SCADA/EMS Software for the Control of Generation Output

- Unit Commitment (UC)
- Economic Dispatch Calculation (EDC)
- Automatic Generation Control (AGC)
  Features e.g. Frequency-biased tie line Control
- Interchange Transaction Scheduling

Advanced EMS Software Applications for the solution of Network Problems/Constraints - Introduced in Session 9

- State Estimation
- Operator Load Flow
- Contingency Analysis
- Short-Circuit Analysis (Fault Levels)
- Optimal Power Flow (OPF)

How the SCADA/EMS Operator - Interpretation of Results at the MMI (GUI), carries these out

Normal Operating Hazards with Case Studies - A Practical Session

- Generating Plant Limitations (2)
- Line Switching
- Overvoltages and Transformers

Emergency Conditions with Case Studies

A Practical Session - Recognising an Emergency Condition with SCADA/EMS Tools

- Frequency Variations and other indications of System abnormality
- Interchange Variation During Emergencies
- SCADA Operator actions During Emergencies

Recovery from Major Disasters with SCADA/EMS

A Practical Session with Case Studies

- Restoration Procedures including Black-Start
- Cold Load Pick-up
- Generator Loading and Frequency Control
- Voltage Control during Restoration

Questions and Answers and Summary

Who Should Attend:

Electrical Engineers and Technicians involved in the Operation and Control of Generation/Transmission Systems

HV Switchgear Design, Operations and Maintenance

Course Introduction:

Electric Power Systems are designed to serve loads in a safe and reliable manner. One of the major considerations in the design of any power network is adequate control of short-circuits or “faults” as they are generally referred to. If faults are not controlled they can cause unnecessary loss of electricity service with all of its many ramifications.

Electric Power Systems are designed to be as fault free as possible through appropriate network design, equipment design, proper installation and on-going maintenance. The Circuit breaker and its associated fault detection equipment, protective relaying, is an extremely important device, through its role of clearing short-circuit currents, disconnecting faulty elements from the power network, and thus maintaining the overall integrity of the power network.

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Course Learning Objectives:

On completion of the course the trainees will understand

- The Role and basic principles of the Circuit Breaker
- Types of circuit breakers and selection including those specifically employed by the client
- Testing and Maintenance policies
- Safe working practices

Course Duration: Five Days

Training Methodology

The latest educational methods and strategies are employed. The course is designed to maximise delegate participation. From the outset, the goals of each participant are discussed to ensure needs are fulfilled as far as possible. Questions and Answers are encouraged throughout, during the case studies, practical demonstrations and at the daily wrap-up sessions

Course Contents

- Introduction - Reasons for Faults - and Classification of Faults
  - Distinction between Load and Fault Current
  - Sources of Short-Circuit Current
  - Rotating Machine Reactance Changes
- Introduction to Fault Calculations

- Overview of Power System Protection
  - Measurement - Voltage and Current Transformers
  - Protective Device Characteristics
  - Principles of Co-ordination
  - Types of Protection Systems
- The Role and importance of the Circuit Breaker in Power Systems
- General Principles of Operation of Circuit Breakers
- Introduction to types of Circuit Breaker and Selection Principles
  - Oil
  - Vacuum
  - Air Break
  - Gas-Insulated Breakers

- **Design, Construction and Operation of Circuit Breakers employed by "GEC BVP17, VMX and Brush VSI"**
  - Testing Procedures and Test Equipment
  - Maintenance Procedures
  - Troubleshooting

- Refurbishing a low oil and maintenance of vacuum type circuit breakers
  - ⇒ Problems of refurbishment
  - ⇒ Economics of refurbishment versus replacement

- Other Related Switching Devices employed

- Motor Starting Systems employed.
  - Testing Procedures and Test Equipment
  - Maintenance Procedures
  - Troubleshooting

- Introduction to Safe Working
  - Worked Examples on the client's site
- Alternative Circuit Breaker Maintenance Strategies and Selection
- Discussion on maintenance practices at ADMA
  - Existing Practices
  - Improvements

- **Case studies, Exercises and Discussions**

Course Evaluation & Summary

Who Should Attend:

Engineers and Technicians who are involved in the design, specification, purchasing, maintenance or day to day Operation of Switchgears.

Switchgears and Relays

Course Introduction:

Efficient and Safe Power Protection systems are vital to ensure no overload may occur and a smooth current is maintained at the level determined for the demand required. Safety systems also demand the highest standards of operations and maintenance and therefore Relay Protection Systems play a large part in the Electrical Power Process.

This course is designed to inform participants how Power systems operate and safely maintain Protection Systems.

Course Objectives:

This course is designed to the participants:

-
- An Increased level of knowledge of the theoretical aspects and calculations on Protective Relays
- Familiarity with the application, basic connections and internal schematics
- Ability to test several Relays (Electromagnetic & Solid State), including type 50 / 51, type 27 / 51 type 60 and type 81
- The Safety rules applicable
- Relays Testing and Compliance

Course Duration: Five Days

Who Should Attend:

Electrical personnel involved in the day to day running of day to day operation / maintenance of power switchgear and relays systems & protection.

Course Contents:

1. Relay Operation and Fundamentals

- Electromagnetic Attraction, Induction
- Thermal
- Solid State

2. Relay Application

- Auxiliary
- Thermal
- Overcurrent
- Voltage
- Percent
- Current Balance

3. Manufacturers Literature

- Familiarization
- Schematic Usage
- Curve Interpretation

4. Relay Function

- Standards
- Interpretation

5. Safety

- Relay Installation and Removal
- Current Transformer Hazards
- Voltage Transformer Hazards
- Test Plug Usage

6. Record Keeping

- Relay Test Form
- Maintenance Requirements

7. Maintenance / Acceptance Testing

- Visual Inspection
- Mechanical Inspection
- Electrical Tests and Adjustments

- **Case studies, exercises and discussions**

- **Course Evaluation & Summary**

Transformers & HV Motors
Construction, Operation, Maintenance and Testing

Introduction

The transfer of electricity from generating sources is carried out using many components and sub-systems. When the components are connected together to supply various types and levels of electrical load, the result is usually referred to as a NETWORK. This course addresses the testing and maintenance of one of the principle components in Electrical Networks i.e. Power Transformers. Voltage levels from mains (220 or 415V phase-to-phase) up to 400kV will be considered.

Electricity is high grade energy. In industry one of its principal uses is the supply of motive power using motors. The seminar also addresses large induction and synchronous motors, supplied at voltages from 3.3 kV upwards.

Who Should Attend

The Seminar is designed for Engineers and Technicians who are responsible for the:-

- Operation and Maintenance

Of Power Transformers and HV Motors who may require to refresh their knowledge and acquaint themselves with latest developments in the technology.

Seminar Objectives

To ensure delegates develop their existing knowledge and are acquainted with latest developments.

Training Methodology

The latest educational methods and strategies are employed. The course is designed to maximise delegate participation. From the outset, the goals of each participant are discussed to ensure needs are fulfilled as far as possible. Questions and Answers are encouraged throughout and at the daily wrap-up sessions. This gives participants the opportunity to discuss with other delegates and the presenter their specific problems and appropriate solutions. All delegates take away a manual of all the material presented. Only minimum note taking is encouraged to ensure maximum delegate attention during the seminars

Course Duration: Five Days

Seminar Contents

- **Revision of Power Transformer Fundamentals**
- **Revision of Motor Fundamentals**
- **Types of Transformers**
  - Core Types
  - Single-phase
  - Three-phase
  - Phase Relationships – Phasor Circuits
    - Delta/Star and Star/Delta
    - Star/Star
    - Interconnected-Star Connection
    - The Autotransformer
    - Volts per Turn and Flux Density
    - Tappings
    - Impedance
    - Multi-Winding Transformers including Tertiary Windings
  - Dielectrics
  - Core Steel
  - Winding Conductors
  - Insulation
  - Transformer Oil and other dielectric liquids

- **Large HV Induction Motors (3.3kV to 11 kV)**
  - Construction
  - Vertical High Thrust and Submersible
  - Ratings
    - Rated Voltage
    - Rated Starting Current
    - Effective Reactance, X_m
    - Continuous Current, Measurements and Calculations
    - Horsepower
    - Rated Frequency and “slip” (AC only)
    - Rotational Speed (RPM)
  - Transformer and Other types of Starters
  - Variable Speed Drives
  - Testing and Diagnostic Software
  - Fault Finding
  - Maintenance
  - Mechanical Considerations and Balancing

- **Large Synchronous Motors**
  - The reasons for employment.
  - Utilisation
  - Construction – an Overview
  - Field Control Systems – AVR’s
  - Testing and Diagnostic Software
  - Special maintenance requirements

- ❖ **Transformer Manufacturer's Testing**
- ❖ **Transformer Commissioning Testing**
- ❖ **Transformer Outages for Testing and Maintenance**

- Network Security Considerations
- Safety Considerations
  - Isolation Principles
  - Switching Co-ordination
  - Planned and Unplanned Switching
  - The Permit to Work System – Why is it necessary? – How to work safely
  - Work Before the Outage
  - Work During the Outage

Case Studies and Exercises

❖

❖ **Protection and Alarm Supervision**

- Motors
- Transformers

❖ **In Service Transformer Testing and Maintenance**

- Core Insulation Resistance and Inadvertent Core Ground Test
- Winding Resistances
  - Resistance Across Windings
  - Turns Ratio/Polarity/Phase
  - Excitation Current at All Tap Positions
  - Short Circuit Impedance
  - Insulation Resistance to Ground
  - Capacitance
  - Power Factor/Dissipation Factor
  - Induced Voltage/Partial Discharge
- Bushings
  - Capacitance
  - Dielectric Loss
  - Power Factor/Dissipation Factor
  - Partial Discharge
  - Temperature (Infrared)
  - Oil Level (Sight Glass)
  - Visual Inspection (Cracks and Cleanliness)
- Insulating Oil
  - Dissolved Gas Analysis
  - Dielectric Strength & Interfacial Tension
  - Acid Number
  - Visual Inspection
  - Color & Water Content
  - Oxygen Inhibitor

- On-Load Tap-Changers
  - Contact Pressure and Continuity
  - Temperature (Infrared)
  - Turns Ratio at All Positions
  - Timing
  - Motor Load Current
  - Limit Switch Operation and Continuity
- Tap Changers - No Load
  - Contact Pressure and Continuity Centering
  - Turns Ratio at All Positions
  - Visual Inspection
- Tanks and Associated Devices

❖ **Motor Testing Requirements**

- Torque
- Speed
- Power. Mechanical and Electrical
- Dynamometer
  - Eddy Current
  - Hysteresis
- Dynamometer Controller
- Power Analyser
- Software

Case Studies and Exercises

❖ **Transformer Diagnostic Software**
❖ **External Sources of Transformer and Motor Failure – Power Supply Electrical Disturbances**
❖ **Internal Transformer and Motor Failures**

❖ **Management Issues - Treating Equipment Outages as a Project**

- Project Typology
- Environmental Constraints
- The Deeming Cycle
- Work Breakdown Structure
- The Project Life-Cycle
- Planning Methodology
  - Planning Accuracy versus Precision
  - Information versus Data
  - Balancing Costs and Benefits
  - Planning with Activity Models
  - The Planning Sequence
  - Network diagrams – dealing with complexity
- Critical Path Analysis and Resource Allocation

Case Studies and Exercises
Review and Course Evaluation

Underground Power Cables

Introduction

In 1882 Sir Thomas Edison built the world's first electricity generating station in New York. The supply of Electricity spread rapidly across the globe in the ensuing years. Today, over a century later, the use of electrical energy has become commonplace.

The transfer of electricity from generating sources is carried out using many components and sub-systems. When the components are connected together to supply various types and levels of electrical load, the result is usually referred to as a NETWORK. This course addresses one of the principle components in Electrical Networks the Cables. Voltage levels from mains (220 or 415V phase-to-phase) up to 400kV will be considered. In addition cables for other than power delivery, instrumentation and control are also considered.

Who Should Attend

The Seminar is designed for Engineers and Technicians who are responsible for the:-

- Design, Specification and Project Management
- Operation and Maintenance

of Industrial Networks who may require to refresh their knowledge and acquaint themselves with latest developments in cable technology.

Seminar Objectives

To ensure delegates develop their existing knowledge and are acquainted with latest developments..

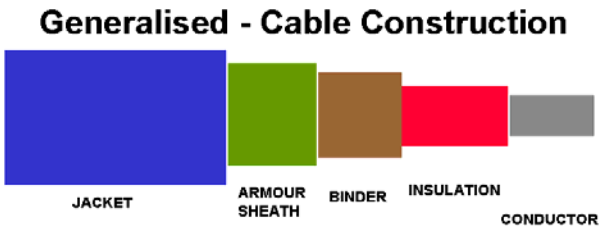
Training Methodology

The latest educational methods and strategies are employed. The course is designed to maximise delegate participation. From the outset, the goals of each participant are discussed to ensure needs are fulfilled as far as possible. Questions and Answers are encouraged throughout and at the daily wrap-up sessions. This gives participants the opportunity to discuss with other delegates and the presenter their specific problems and appropriate solutions. All delegates take away a manual of all the material presented. Only minimum note taking is encouraged to ensure maximum delegate attention during the seminars

Seminar Contents

- **Introducing Industrial Network Layouts – The Single Line Diagram**
- **Cable Types and Classification**

  - Conductors
  - Insulation
  - Binding
  - Armour
  - Jacket



- **Cable Selection for Environmental Conditions (Hazardous Areas)**
  - Flame Retardant EPR Insulation
  - Chlorosulfonated Polethylene Jacket
  - Thermoplastic Low Smoke, Zero Halogen Jacket
  - Flame Retardant Chlorinated Jacket
  - Flame Retardant Chlorosulfonated Polethylene Jacket
  - Flame Retardant Low Temperature Arctic-Flex Jacket
  - Flame Retardant XLPO Insulation
  - Flame Retardant PVC Jacket
  - Flame Retardant PVC Insulation
- **Extruded Clear Polyamide Jacket**
- **Insulation Composite with Jacket**
- **EPR Insulation with LEAD sheath**
- **Metallic Shielding using Annealed Copper Tape**
- **Cross-Linked Polyethylene Insulation (XLPE)**

- **Cable Selection for Industrial Plants**
  - Trends in Cable Selection
  - Cable Grouping – Purchasing Systems
  - Fire Hazard Issues

- **Economic Aspects LV Cable Selection**
  - Environment
  - Buildings
  - Conductor Size

- **Current Ratings**
  - Network Considerations
  - Load Current
  - Load Characteristics
  - Inductive Loads
  - The Power Triangle
  - Continuous Ratings
  - Cable Ratings for Short-Circuit Ratings
  - Introducing Per-Unit Values
  - Calculations for Current Rating, Losses and Volt Drop

- **Installation Underground**
- **Buried Cables in Steel, Concrete or PVC Pipes**
- **Troughs and Trenches**
- **Installation in Buildings and Basements**
- **Cable Terminations**
  - Cable Gland Standards
  - Cable Seals and New Materials
  - Ingress Protection
  - Termination of Polymeric Cables
- **Making a 3-Core LV Epoxy Resin Filled Joint**
- **Cable Laying**
  - Cable Fault Location Techniques
  - Indication and diagnosis of faults
  - New Methods for locating faults

Case Studies and Discussions
Review and Course Evaluation

UPS & BATTERIES

INTRODUCTION

As businesses become increasingly dependent on technology for their fundamental operation, the need for system availability is of paramount importance. At the same time the protection of electronic equipment from power failures, power sags, power surges, under-voltage, electrical line noise, over-voltage, frequency variations, switching transients and harmonic distortion is a major issue in industry today. Such protection is provided by the employment of various types of Uninterruptible Power Systems (UPS).

WHO SHOULD ATTEND

Electrical Engineers, Supervisors and Technicians who need to refresh and expand on their existing knowledge of Batteries, UPS and associated systems.

SEMINAR OBJECTIVES

The attendees will

1. Obtain a reasonable understanding of batteries, how they work and what can go wrong, thus promoting their efficient use.

2. Gain an understanding of the basics of different types of modern UP Systems and how they work.

3. Know the basics of on site fault finding and how to adequately maintain UPS equipment.

TRAINING METHODOLOGY

The latest educational methods and strategies are employed. The course is designed to maximise delegate participation. From the outset, the goals of each participant are discussed to ensure needs are fulfilled as far as possible. Questions and Answers are encouraged throughout and at the daily wrap-up sessions. This gives participants the opportunity to discuss with other delegates and the presenter their specific problems and appropriate solutions. All delegates take away a manual of all the material presented. Only minimum note taking is encouraged to ensure maximum delegate attention during the seminars. Exercises and Case Studies in both classroom and on location are specifically designed to enable attendees to develop the required skills.

OUTLINE

DAY 1

Lead Acid Batteries

- Basic Chemistry - Electrolysis
- Valve Regulated
- Performance Characteristics
- Capacity and Peukert's Equation
- Discharge Temperature Coefficient
- Discharge Voltage
- Specific Power and Internal Resistance
- Cycle Life Performance
- Battery String Management
- Installation Procedures
  - ⇒ Receiving and Unpacking
  - ⇒ Inspections
  - ⇒ Storage
  - ⇒ Preparations for Installation
  - ⇒ Required Charge
  - ⇒ Installing strings
  - ⇒ Series Connections
  - ⇒ Parallel Connections
  - ⇒ Operating Limits
    - – Temperature
    - – Charge
    - – Discharge
- Identifying Bad Batteries
- External Corrosion
- Use of Test Equipment, Fault Finding & Maintenance
- Safety Considerations

- **Summary, Exercises and Case Studies**

DAY 2

Nickel Cadmium Batteries

- Introduction
  This section covers the history, basic chemistry and the present applications
- General Operational
  Cylindrical Cells

DAY 2 (Cont)

- Contact Material
- Potting
- Electrical Characteristics and Capacities
- Impedance and Internal Resistance
- Cell Paralleling
- General Characteristics
- Voltage Characteristics
- High Current Pulse Discharge
- Self-Discharge
- Continuous Overcharge
- Memory Effect
- Storage
- Temperature Characteristics
- Effect of high and low temperatures on storage, discharging and charging
- Cycle Life
- Recommended Charging
- Use of Test Equipment, Fault Finding & Maintenance
- Safety Considerations

Summary, Exercises and Case Studies

DAY 3

<u>Diodes</u>

- History of the Diode
  - ⇒ Thermionic Emission – Fleming's Valve
  - ⇒ The Mercury Arc Diode or Rectifier
- The Semiconductor Revolution
- P and N Type Materials
- P-N Junction Diodes
- Rectifier Circuits

⇒ The Half Wave Rectifier
⇒ A Full Wave Rectifier employing 2 Diodes
⇒ A Bridge Rectifier

Summary, Exercises and Case Studies

DAY 4

Battery Charger Requirements

- Controlling Charging Voltage and Current
- Charging Lead Acid type Batteries and Battery Strings
- Charging Nickel Cadmium Batteries and Battery Strings
- Charging Nickel Metal Hydride Batteries and Battery Strings
- Charging Lithium Batteries and Battery Strings
- Dual Rectifier Power and Charging Systems
- Use of Test Equipment, Fault Finding & Maintenance
- Safety Considerations

Uninterruptible Power Systems
(Part 1)

- Introduction
- History - The Rotary Converter
- Solid State UPS
- Introduction
- General - UPS Components
  - ⇒ Rectifiers
  - ⇒ Invertors
  - ⇒ By-Pass Switches
- Layouts and Circuit Diagrams

Summary, Exercises and Case Studies

DAY 5

Uninterruptible Power Systems
(Part 2)

- Types of UPS
  - ⇒ Offline UPS
  - ⇒ Line interactive UPS
  - ⇒ Online double conversion UPS
  - ⇒ Digital online UPS
- Understanding UPS Jargon
- Incoming Power Supply Problems
  - ⇒ Introduction
  - ⇒ Voltage Spikes and surges
  - ⇒ Micro - cuts
  - ⇒ Brown-outs
  - ⇒ Black-Outs
  - ⇒ Noise and Harmonics
- Temperature and other Environmental Issues
- Handling Electronic Equipment
- Board Level Fault Finding
- Troubleshooting
- Routine Maintenance Requirements
- Auxiliary Equipment
  - ⇒ Contactors
  - ⇒ Circuit Breakers
  - ⇒ Fans
- Using Test Equipment Correctly

Summary, Exercises and Case Studies