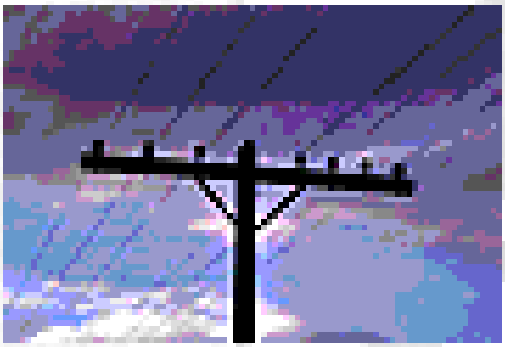
المركـــز العالمـــي للتدريـــب والتطويـــر
International Centre for Training & Development
Tel: (009712) 6330529– Fax: 6342853 – P.O. Box: 6201 Abu Dhabi – U.A.E.
Email: merlyn@ictd.ae Web Site: www.ictd.org

Power System Motors and Transformers Operation and Maintenance

21 – 25 December 2008 – Abu Dhabi



Who should attend:

Plant electricians, new engineers, mechanics (who work with and around electrical equipment) can gain significantly from this course. This course provides fundamental knowledge of how the electrical device functions. This fundamental knowledge is a critical piece of and O&M skills. The course provides practical knowledge associated with how a machine is constructed, defining components the component purpose, and how it may be at risk. This course also provides information on the skills necessary to implement a quality preventive maintenance program, to troubleshoot operational problems and corrective maintenance activities for the more common integrity issues.

This course discusses construction, operation, and routine preventive / corrective maintenance of: AC Motors, DC Motors, Distribution Transformers, Low Voltage Circuit Breakers, and Protective Systems.

Objectives

AC & DC Motors

1. Define related motor terms.
2. Describe the various types of motor enclosures.
3. Describe how the rated motor voltage differs from system voltage.

4. Demonstrate the ability to interpret nameplate data.
5. Describe the basic construction and components of those AC motors typically found in an industrial setting.
6. Explain the relationship between speed, frequency, and the number poles in a 3-phase induction motor.
7. Define percent slip and speed regulation.
8. Explain how a 3-phase motor direction is reversed.
9. Describe the main components and types of DC motors
10. Define torque, starting current, and armature reaction as they apply to a DC motor.
11. Describe dual-voltage motors and their application.
12. Describe the methods for determining various motor connections.
13. List and briefly explain six causes for rotating machinery failure.
14. Describe the various types of rotary machinery maintenance: visual inspections, tightness checks, air gap distance, and bearing lubrication and replacement.
15. Describe the following rotating machinery tests: insulation resistance, continuity, vibration analysis, DC high potential, power factor, and thermography.

Distribution Transformers

1. Describe the operation of a transformer.
2. Describe the magnetic conductivity.
3. Describe how voltage is stepped up and stepped down.
4. Explain the relationship between electric current and magnetic field.
5. Describe conductivity and retentivity.
6. Describe turns ratios.
7. Describe transformer losses.
8. Explain transformers using vectors
9. Classify transformers.
10. Describe instrument transformers.
11. Describe various wiring connections such as wye/wye, wye/delta, and delta/delta.
12. Describe transformer maintenance and safety.

Low Voltage Circuit Breakers

1. Define the following terms: overcurrent, overload, circuit breaker, and inverse time.
2. Describe how inverse time-current characteristic can be applied to a circuit breaker.
3. Describe how a series trip and solid state trip units function and are tested.
4. List the protective devices found in a molded case breaker.

5. Explain how molded case trip devices are tested.
6. Describe the two basic types of low circuit breaker contacts.
7. Describe the five basic types of low circuit breaker operating mechanisms.

Machinery Protection

1. Explain why protective devices are used in electrical equipment.
2. Describe how a fuse works and is typically applied.
3. Describe how a circuit breaker works and is typically applied.
4. Describe what protective relays are and is typically applied.
5. Describe how an overcurrent relay works and is typically applied.
6. Describe how an undervoltage relay works and is typically applied.

Course Outline

AC & DC Motors

I. Terms and Definitions
II. Motor Enclosures: Open Motor, Enclosed Motor
III. Nameplate Data: Rated Voltage, Full-Load Amps (FLA), Rate Full-Load Speed, Rated Horsepower, Frame Sizes, Duty or Time Rating NEMA Design Letter, Insulation Class, Nominal Rated Voltage, Minimum Starting Voltage, Frequency, Service Factor, KVA Code Letter, Bearings, Locked-Rotor Current, Starting Current, Temperature Rise, Power Factor.
IV. Introduction: Single-Phase AC Motors, Single-Phase Induction Motors, Split-Phase Induction Motors, Three Phase Motors, Motor Theory, Rotating Fields, Rotor Behavior in a Rotating Field, Induction.
V. Induction Motors: Construction, Stator, Rotor, Torque, Starting Current, Power Factor, Speed Control Reversing Rotation
VI. Synchronous Motors: Construction, Principle of Operation, Rotor Field Excitation, Synchronous Motor Pullout, Synchronous Motor Torque Angle
VII. Wound Rotor Motors and Control
VIII. Direct Current Motors: Armature Construction, Types of DC Motors, Torque, Starting Current and Counter EMF, Starting Resistance, Armature Reaction, Interpoles, Direction of Rotation of DC Motors
IX. Shunt Motors
X. DC Series Motors: Speed Control and Speed Regulation, Motor Ratings
XI. DC Compound Motors: Torque, Speed, Industrial Applications

Distribution Transformers

I. Transformer Principles: Power Distribution, Increase of Voltage, Reduction of Voltage, Transformers, Electric Current and Magnetic Field

Relationships, Magnetic Flux, Conductivity (Permeability), Retentivity, Induction, Electromotive Force of Induction, Counter Electromotive Force, Calculations, Leakage, Open-Closed Core Transformers, Turns Ratios, Losses, Eddy-Current Loss, Hysteresis Loss, Transformer Types

II. Vector Diagrams: Transformer Operating Principles, Operation with/without Load, Calculating Secondary Voltage, Ideal Transformer, Non-Inductive vs. Inductive Load, Vector Diagrams, Ratio

III. Transformer Classification: Service Classification, Instrument Transformers, Current Transformers (CT), Calculating Operating Ratio, CT Classes, Polarity Markings, CT Precautions, CT Accuracy, Potential (Voltage) Transformers (PT), PT Types, PT Accuracy, Constant-Current Transformers, Constant-Current Regulator Operation, Series Transformers, Small Power Transformers, Control and Signal, Special Purpose, GSU, Substation, Distribution Transformers, Purpose Classification

IV. Transformer Circuit: Magnetic Circuits, Magnetic Flux, Construction, Aging and Annealing, Exciting Current, Iron Loss, Hysteresis Loss, Eddy-Current Loss, Forces on Windings, Copper Loss, Reactive Voltage, Impedance, Calculating Impedance, Regulation, Efficiency

V. Transformer Connections: Voltage Transformations, Single-Phase, Taps, Single-Phase, Polarity Testing, Transformer Connections, Two-Phase Circuits, Three-Phase Circuits, Wye and Delta Connections, Open Delta, T to T, Voltage-Vector Diagram Construction, Voltage-Vector Diagram Test Procedure, Transformer Connections, Parallel Operation, Displacement, Ratio, Calculating Circulating Current, Percent Impedance, Calculating Load

VI. Transformer Maintenance: Transformer Safety Standards, Transformer Circuit Grounding, Clearances, Secondary Circuits, Entering Dangerous Areas, Inspection and Maintenance, Load and Voltage, Ground Connections, Insulation Tests, Insulation Resistance, Detailed External Inspection

Low Voltage Circuit Breakers

I. Definitions
II. Basic Protective Device Requirements
III. Time Current Characteristics
IV. Low Voltage Power Circuit Breaker Trip Devices: Series Trip Unit, Solid State, Trip Devices
V. Protective Device Maintenance and Testing
VI. Low Voltage Power Circuit Breaker Testing
VII. Molded Case Circuit Breakers: Molded Case Overload Devices, Thermal Trip Element, Magnetic Trip Element, Thermal-Magnetic Trip Element
VIII. Testing the Molded Case Circuit Breaker

IX. Circuit Breaker Contacts
X. Operating Mechanisms: Solenoid Operated Mechanisms, Motor Charged Spring, Manual Charged Spring, Manual Operating Mechanisms
XI. Molded Case Circuit Breakers: Molded Case, Operating Mechanism, Arc Extinguishers and Contacts, Contacts, Trip Elements, Modifications and Accessories
XII. Introduction to Air Circuit Breakers
XIII. Low Voltage Power Circuit Breakers
XIV. Introduction to Vacuum Circuit Breaker
XV. Principles of Vacuum Circuit Breakers
XVI. The Vacuum Interrupter
XVII. Introduction to Gas Circuit Breakers
XVIII. Sulphur Hexaflouride Gas Interruption

Machinery Protection

I. Protection Schemes: Protective Devices, Zones Of Protection, Fault Protection
II. Protective Devices: Protective Relays, Overcurrent Relays, Undervoltage Relays, Instrument Transformers, Potential Transformers, Current Transformers
III. Generator Protection: Short Circuit Protection, Ground Fault Protection, Low Field Excitation Or Loss Of Field Excitation Protection, Generator Motoring Protection
IV. Transformer And Bus Protection: Transformer Protection, Unit Differential Protection, Bus Protection
V. Motor Protection: Short Circuit And Overload Protection, Undervoltage Protection, Disconnect Devices, Motor Protection Arrangement, Motor Protection Arrangement, Ground Detection
VI. Auxiliary Power System, System Components, System Protection, Backup Protection, Operator Actions

Course Fees:

3000 US$, this rate includes Participant's Manual, Hand-outs, etc., buffet lunch, coffee/tea on arrival, morning & afternoon of each day.

Course Date and Location:

21 – 25 December 2008 – Abu Dhabi

Timing Schedule:

Daily Course Timings:

07:30 - 08:00	Morning Coffee / Tea
08:00 - 10:00	First Session
10:00 - 10:20	Coffee / Tea / Snacks
10:20 - 12:20	Second Session
12:20 - 13:30	Lunch Break & Prayer Break
13:30 - 15:00	Last Session

Course Coordinator:

Ms. Merlyn Puyaoan
Training Coordinator

INTERNATIONAL CENTER FOR TRAINING & DEVELOPMENT
P.O. Box: 6021, Abu Dhabi, UAE
Tel: +971 2 6330539
Fax: +971 2 6342853
Email: merlyn@ictd.ae
Web-site: **www.ictd.org**

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