Training Title

TRANSFORMER OPERATIONAL PRINCIPLES, SELECTION & TROUBLESHOOTING

Training Duration

5 days

Training Date

Ref EE120	Transformer Operational Principles, Selection & Troubleshooting	5	30 Sept – 4 Oct '18	$4,250	Dubai, UAE

In any of the 5 star hotels. The exact venue will be informed once finalized.

Training Fees

- **4,250 US$ per participant for Public Training includes Materials/Handouts, tea/coffee breaks, refreshments & Buffet Lunch**

Training Certificate

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

Language: English

TRAINING OVERVIEW

Introduction & Description

Installation of high voltage distribution and transmission equipment has increased significantly over the years due to ongoing global demand for power. As a result, the need to ensure the reliability of operation of power systems is paramount. Power transformers are among the most important and most expensive components of power systems, their failure can impose extraordinarily high costs on plants, factories and utilities of all descriptions. It is critical that all personnel operating and working with such equipment have a sound knowledge of their operational requirements and maintenance. This practical workshop provides knowledge on both the theory and operation of Power Transformers. The course will develop and enhance an understanding of what is involved in the maintenance of these essential components of the power systems, through the tips and tricks learnt and developed by some of the World's pre-eminent electrical engineers.

TRAINING OBJECTIVES:

At the end of the course participants will gain:

- **An understanding of the fundamental theory and principles of the operation of power transformers**

- **An insight into the identification and application of transformers' types**
- **An understanding of the power transformers components and their construction**
- **Knowledge of power transformer protection**
- **An understanding of power transformers oil and oil tests and interpretation of results**
- **Knowledge of the most effective power transformer electrical tests**
- **Skills in how to manage power transformer breakdowns to ensure minimum disruption**

TRAINING METHODOLOGY

The course is designed to maximise delegate benefit from the outset. The goals of each participant are discussed to ensure their needs are fulfilled as far as possible. Questions are encouraged throughout particularly at the daily wrap up sessions. This provides opportunities for participants to discuss specific issues and if possible find appropriate solutions. Case studies are employed to highlight particular points and appropriate video material used to illustrate particular conditions.

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

WHO SHOULD ATTEND?

The course is suggested for Electrical Engineers

- **Power System Engineers**
- **Electrical Engineers**
- **Consulting Engineers**
- **Project Engineers**
- **Power System Technicians**
- **Electrical Contractors**
- **Electrical Technicians**
- **Tradesman Electricians**
- **Electrical Inspectors**
- **Utility Engineers**

Course Outlines

I. Basic Transformer Theory

1. **Definition of a Transformer**
2. **Magnetic Units and Conversion Factors**
3. **Currents and Magnetic Fields**
4. **Magnetic Induction**

5. Constructing a Simple Transformer
6. The Magnetic Circuit
7. The B-H Curve
8. The B-H Curve and Hysteresis
9. Magnetizing Currents and Harmonics
10. Transformer Core Design and Construction
11. Magnetostriction
12. Completing the Transformer by Adding a Second Winding
13. Transformer tap Changers
14. Reading and Applying Nameplate Information

II. Two-Winding Transformer Connections

1. The Y-Y Connection in Three-Phase Systems
2. Advantages of the Y-Y Connection
3. Disadvantages of the Y-Y Connection
4. The Y-Δ Connection and the Δ-Y Connection
5. Phase Angle Displacement and Phase Rotation
6. The Y-Δ Grounding Bank
7. The Zigzag Connection
8. Comparisons of Economy of the Different Winding Configurations
9. Trade-Off Between Steel and Copper in the Design of a Transformer
10. Connecting Three-Phase Banks Using Single-Phase Transformers
11. Transforming Three-Phase Voltages into Two-Phase Voltages
12. The Scott Transformer Connection
13. Three-Phase Transformer Designs
14. Standard Terminal Markings for Transformers

III. Transformer Impedance and Losses

1. Leakage Flux and Leakage Reactance
2. Conductor Losses
3. No-Load Losses
4. Magnetizing Reactance
5. Equivalent Circuit of a Two-Winding Transformer
6. A Brief Tutorial on Symmetrical Components
7. Transformer Equivalent Circuits Modeled in Zero Phase Sequence Networks
8. Series Impedance and Regulation
9. Matching Transformers for Parallel and Bank Operations

IV. Transformer Types

1. Power Transformers

2. Distribution Transformers
3. Phase-Shifting Transformers
4. Rectifier Transformers
5. Dry-Type Transformers
6. Instrument Transformers
7. Step-Voltage Regulators
8. Constant-Voltage Transformer

Autotransformers and Three-Winding Transformers

9. Autotransformer Connections
10. Impedance of an Autotransformer
11. Limitations of the Autotransformer Connection
12. Autotransformer Voltages with Short Circuits Applied
13. Impulse Voltages Applied to Autotransformers
14. Autotransformer Core and Coil Designs and Terminal Configurations
15. Advantages and Disadvantages of the Autotransformer Connection
16. Three-Winding Transformers
17. Modification of Transformer Laws with Three Windings
18. Equivalent Circuit of a Three-Winding Transformer
19. Core and Coil Construction of Three-Winding Transformers
20. Thermal Capability of Three-Winding Transformers
21. The Stabilizing Effect of a Δ Tertiary Winding

V. Short Circuits, Inrush Currents, and Other Phenomena

1. Effects of Short Circuits on Transformers
2. Comparisons of Short-Circuit Currents for Various Faults
3. Mechanical Forces in Transformers
4. Forces between Transformer Windings
5. Short-Circuit Forces in Three-Winding Transformers
6. Exciting Current Inrush
7. Tank Overheating from Zero-Sequence Currents
8. Primary Fuse Misoperations
9. Ferroresonance
10. Voltage Surge

VI. Basic Concepts of Power System Faults and Transformer Protection

1. The Reasons For Protection
2. Principles of protection
3. Disconnection Devices
4. Protection and system design
5. Nature of short circuit currents

6. Sources Of Short Circuits
7. Transformer Protection

VII. Condition Monitoring And Diagnostics

1. Partial Discharge
2. Insulation Resistance Monitoring
    - Insulation Resistance Test (IR)
    - Megger Test
    - Polarization Index Test
    - Correction for Winding Temperature
    - Insulation Contamination
    - IR Test Connections
    - Typical IR Testing Program
3. DC HI-POT TEST
    - Maximum Allowable Test Voltage
4. Measuring Insulation Degradation
    - Capacitive Charging Current
    - Resistive Leakage Current
    - Energy Dissipated
5. Insulation Power Factor
    - Insulation Power Factor Standards
    - Power Factor Test Sets
    - Outage for Scheduled Maintenance
6. On Line Measuring Partial Discharge Activity For Insulation
7. On-Line Monitoring Of Transformers
    - Local Indications
    - Thermography
    - PDA - Partial Discharge Analysis
    - Insulating Oil Properties
    - Test for Dielectric Strength
    - Water Content in Oil
    - Acidity Test (Neutralization Number
    - Oxidation Inhibitor
    - Interfacial Tension Test (IFT)
    - Oil Color
    - Oil Power Factor Test
8. Insulating Oil Dissolved Gas Analysis (DGA)
    - Release of CO2)
    - Release of Acetylene
    - DGA Test Report
    - DGA Trends

- **Continuous Gas Monitoring**

VIII. Maintenance, Testing, Troubleshooting, and Reliability

1.Good Utility Practices
2.Preventative Maintenance versus Predictive Maintenance
3.Factory Tests
4. Ratio Test
5.Other Factory Tests
6.Field Tests
7.Gas-in-Oil Analysis
8.Water-in-Oil Analysis
9. Drying Transformers
10. Oil Dielectric Test
11. Reliability Calculations
12. The Chi-Squared Distribution
13. The Poisson Distribution

- *Typical case studies.*

NOTE:
Case Studies, Last Day Review, Discussions & Pre & Post Assessments will be carried out.