

**Training Title**

**FAULT ANALYSIS IN TRANSFORMER**

**Training Duration**

5 days

**Training Dates & Venue**

REF					
EE013	Fault Analysis in Transformer	5	13 - 17 May 2023	\$6,500	London, UK

Training will be held at any of the 5-star hotels. The exact venue will be informed once finalized.

**Training Fees**

- \$6,500 per participant for Public Training includes Materials/Handouts, tea/coffee breaks, refreshments & Buffet Lunch

**Training Certificate**

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

**TRAINING OVERVIEW**

**TRAINING DESCRIPTION**

Power and Distribution Transformers are essential devices in electricity supply. The operation of any transformer must fulfill certain requirements to withstand the electric, thermal, and mechanical stresses during its service life. Power transformers are crucial in deciding the power flow in large power systems. Their better performance implies high power system efficiency and enhanced power transfer capability. However, various power transformer failures in the recent past leading to power supply interruption, have acquired much attention from the electrical intellectuals. Different preventive, predictive and spontaneous repair techniques have been designed to eliminate or at least minimize the failures.

This seminar is intended to establish recommended practice as well as to give general advice and guidance in testing and diagnosing failure analysis of power transformers to establish their condition, identify problems, and provide potential remedies.

**TRAINING OBJECTIVES**

Upon completion of this course, the participant should be able to:

- Physical background of power transformer components in relation to the probability and cause of failure of such components
- Typical Practical operation of power transformers and recognizing the threshold of failure
- Power transformer diagnostic flow charts
- Transformer types, applications, components, indicators, nameplate data, and safety procedures
- Understand turn ratios and calculate terminal voltage and current
- Understand how to perform different electrical test on power transformers and how to evaluate and interprets the results of these tests

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- Different protection systems associated with power transformer and their behavior during failure investigations
- Understand the various tests performed on insulating oil and how to recognize the result of dissolved gas analysis to detect the cause of failure of power transformers
- Applicable safety & Precautions procedures
- Understand how to Perform visual and mechanical inspections
- Different maintenance philosophies applied covering Visual and diagnostic inspections with troubleshooting.

### WHO SHOULD ATTEND?

Field and shop technicians, field engineers, supervisors, and others responsible for the testing and maintenance of power and distribution transformers.

### TRAINING METHODOLOGY:

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

Very useful Course Materials will be given.

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

### DAILY OUTLINE

#### **1. Day-1**

#### **1. Power Transformer Main Components and the main causes of Components Failures**

- Introduction
- Core
  - o Core Material
  - o Core Assembly
  - o Types of Transformer Core Construction
  - o Grounding of Core
  - o Causes of core failures
- Coil or Winding Assembly
  - o Core and Coil Assembly Clamping Construction
  - o Causes of failures
- INSULATION SYSTEM
  - o Coordination of Insulation
  - o Types of Insulating Materials
  - o Classification of Solid Insulation
  - o causes of insulation failures

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- o Insulating System and Temperature
- o Insulating Mineral Oil
  - \_ Specification for Transformer Oil
  - \_ Insulation Coordination of Transformer Oil
- **POWER TRANSFORMER ENCLOSURES**
- o Enclosure Types for Power Transformers
  - Cooling Circuits
- o Temperature Gradient
- o Methods Used for Cooling
- o Cooling Classes
  - \_ Self-Cooled
  - \_ Self-Cooled and Forced-Air Cooled (OA/FA)
  - \_ Forced-Oil Circulation Cooling (Pumps)
  - \_ Forced-Oil-Cooled Process
- **TRANSFORMER ACCESSORIES**
- o Pressure Relief Devices
  - \_ Mechanical Relief
  - \_ Diaphragm Relief
- Fault Gas Detector Relays
- o Sudden Pressure Relays
- o Gas in Oil Detector Relay (Buchholz)
  - Indicators
- o Liquid Temperature (Top-Oil) Gauge
- o Hot-Spot Temperature Indicator
- o Liquid-Level Indicator (Dial-type)
- o Pressure/Vacuum Indicator
- o Pressure-Vacuum Bleeder and Regulator
  - Bushings
- o Ratings for Bushings
- o Types of Bushings
- o Causes of failures
  - No-load Tap Changers (NLTC)
- o Operation
- o Major Components
- o Causes of Failures
- **POWER TRANSFORMER NAMEPLATE DATA verifications**
- o Transformer Nameplate with NLTC
- 2. TRANSFORMER INSTALLATION TESTING**
- o Turns-Ratio Tests
- o TTR Testing Indications
- o Expected Test Results
- o Interpretation of Data
- o Review of Sample Data
  - Winding-to-Winding Polarity Test
- o Polarity
- o Three-Phase Polarity and Phase Sequence

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- o Voltmeter Flicks-Method Polarity Test
- Winding Resistance Test
- o Three Phase Transformer (Wye with a Neutral Bushing)
- o Three-Phase Transformer (Wye Without a Neutral Bushing)
- Winding Insulation Testing (Megger Test)
- o Winding Insulation-Resistance Test
- Core-Ground Inspection and Test
- Transformer Tank Ground Test
- Tap Setting Verification
- Applied Voltage (Hi-Pot) Test
- Insulation Power-Factor Test
- o Definition of Power Factor of Insulation per ANSI C57
- o Winding Insulation Test
- o Temperature Correction
- o Instruments and Testing Procedure
- o Power Factor Values
- Insulating Oil Testing
- o Testing Categories
- o Oil Specifications
- o Types of Transformer Oil Test
- o Visual Examination
- o Fluid Sampling Method
- o Comparing Oil-Test Data
- Gas Analysis of Operating Transformers
- o Major Causes of Gases in Oil-Filled Transformers
- o Analysis of Transformer Combustible Gases
- o Methods for Analyzing Combustible Gas
- o Solubility of Gases in Transformer Oil
- o PCB Analysis Test
- 3. TRANSFORMER OPERATIONAL TESTING**
- o Operational Test
- o Complete System Functional Test
- o Types of Transformer Operational Testing
- o Exciting Current Check
- o No-Load Voltage Output (Secondary) Check
- o Voltage Phasing (or Rotation)
- o Synchronizing for Parallel Operation
- o Transformer Noise Level
- 4. TRANSFORMER OPERATIONAL OBSERVATION PERIOD CHECKS AND INSPECTIONS**
- o Transformer and System Temperature Checks
- o Transformer Operational Inspection
- o Transformer Operational Problem Indicators
- o Oil Leaks
- o Pressure (Over/Under)
- o Overheating

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o Load Voltage, Current, and Temperature Relationship Checks

**5. PREVENTIVE MAINTENANCE AND FAILURE MODE ANALYSIS**

o In-Service Inspections for Power Transformers

o Current and Voltage Readings

o Temperature Readings

o Liquid-Level Indicators

o Pressure/Vacuum Gauges

o Gauges and Alarms

o Visual Inspection

o Analyzing Failure Mode

o Transformer Failure

**6. Analyzing Oil Test Data in the Transformer Maintenance Records**

o Dielectric Test

o Oil Power Factor

o Interfacial Tension Test

o Visual (Color) Examination

o Neutralization Number (Acidity)

o Water Content Test

o Gas-in-Oil Analysis

o Range of Combustible Gases (ppm)

o Combustible Gas Test

o Dissolved Combustible Gas Testing

o Dissolved Combustible Gas Analysis

**7. Analyzing Electrical Test Data in the Transformer Maintenance Records**

o Insulation Resistance

o Insulation Power-Factor on Power Transformers

o Transformer Turns-Ratio

**8. ANSI C57 TRANSFORMER FAILURE MODE ANALYSIS METHOD**

o Determination and Investigation of a Failure Occurrence

o Following a Suspected Failure

o Investigation Flow Chart

o Failure Mode Data Collection

o General Approach

o On-Site Investigation

o Electrical Tests

o Sampling and Tests of Gas and Insulating Fluid

o Focused Tests

**9. Power Transformers Typical Work Aides**

o WORK AID 1: PRE-OPERATIONAL FIELD INSTALLATION

o CHECKLIST POWER TRANSFORMERS (OIL-IMMERSED)

o WORK AID 2: FIELD TESTING

o WORK AID 3: TABLE OF FIELD INSPECTION

o WORK AID 10: TRANSFORMER TEST METHOD DATA

o Work Aid 10A: Turns Ratio Test (TTR)

o Work Aid 10B: Polarity Test (3 Methods)

o Work Aid 10C: Winding Resistance

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- o Work Aid 10D: Winding Insulation Resistance (Four Types of Tests)
- o Work Aid 10E: Core Ground Test
- o Work Aid 10F: Transformer Tank Ground Test
- o Work Aid 10G: Insulation Power-Factor Test
- o Work Aid 10J: Oil Test Results Comparison

**NOTE:**

**Pre & Post Tests will be conducted**

**Case Studies, Group Exercises, Group Discussions, Last Day Reviews and assessments will be carried out.**

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