



Transformer Diagnostics

Training Course

Industry Need

This course addresses major topics related to the aging infrastructure of power transmission and distribution systems, particularly of power transformers, providing attendees with valuable and state of the art concepts on the specification, design review, application, testing and continuous assessment of these costly and essential assets through a broad range of diagnostic techniques. It also covers new industry challenges such as the introduction of on-line monitoring systems, the appearance of new synthetic and vegetable oils and also the recurrence of corrosive sulfur in oil as a potential cause of major transformer failures.

Objectives

The successful course attendee will be able to perform the following tasks:

- Understand major power transformers constructive types and characteristics as well as their applicability to power generation, transmission and distribution
- Comprehend the importance and functionality of essential power transformers accessories, particularly LTC (Load Tap Changer) and Bushings
- Describe essential protective devices and their modus operandi (relays, surge arresters, pressure relief, etc)
- View the transformer as a “thermal machine” and as such, fully understand the importance of winding “hot-spot” temperature, from design to day-to-day operation
- Understand scope of major industry standards such as IEEE/ANSI and Cigre/IEC
- Be able to maintain a well structured and organized data bank containing operational and non-operational power transformers data
- Perform diagnostic analysis of power transformers using conventional industry accepted practices and testing techniques as for electrical (insulation quality, winding resistance, etc) and non-electrical tests (oil quality, gases, etc)
- Distinguish the fundamental aspects of corrective, preventative and condition based maintenance as

well as apply useful concepts of reliability centered maintenance (RCM)

- Apply adequate oil treatment/oil reclamation procedures when necessary
- Assess the applicability of on-line monitoring and diagnostics systems as well as review available sensors technology for transformers continuous monitoring
- Develop a transformer condition assessment program for a transformer fleet using state of the art knowledge on maintenance strategies

Prerequisites

The course participant should have bachelor or associated electrical engineering degree or equivalent and basic understanding of transformer functionality and its equivalent circuits and applicability. Although not a theoretical course on power transformers, it is expected that the participant understands basic principles of Electromagnetism and its fundamental laws applied to energy conversion. Knowledge of phase diagrams, power factor, lagging vs. leading currents, magnetic Hysteresis and core saturation are also welcome.

Course Structure

The course duration is three days with three-hour morning and afternoon sessions each day.

Documentation

Course participants will receive a bound set of course notes that include copies of class visuals that complement the lectures.

Instructors

The course will be taught by Siemens staff member who has extensive experience in the area of transformer diagnostics.

Location

The course is conducted on a regular basis at Siemens PTI offices in Schenectady, NY and at other major cities throughout the United States. It is also available for presentation at a client's location by special arrangement.

PTI – Power Academy TD

Power Transmission & Distribution
www.siemens.com/power-technologies

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Course Outline

Day 1

- Power transformers
 - Fundamentals (magnetic/electric)
 - Constructive types
 - Accessories
 - Major application differences
- Understanding standards and guides
 - ANSI/IEEE Standards/Guides
 - IEEE Transformer Committee
 - Cigre Study Committee A2
- Essential specification
 - Introductory remarks
 - Voltage/Power
 - Short-circuit impedance
 - Losses
 - Protection
 - Cooling system
 - Oil preservation system
 - Weight/Size (limitations)
 - Design review
 - Transportation issues
 - Testing/Installation/Commissioning
- Transformer as a “Thermal Machine”
 - Origin of heat
 - Effect of heat
 - Core contribution
 - Temperature gradients
 - Natural cooling (ON)
 - Forced cooling (AF/OF)
 - Direct cooling (OD)
- IEEE Loading Guide
- Factory virtual tour

Day 2

- Transformer aging
 - Paper aging
 - Oil aging
 - Aging byproducts
 - Importance of O₂ and H₂O
 - Sources of H₂O
 - Moisture in paper x oil
 - Furan compounds
 - Degree of polymerization
 - Estimating aging
 - Failure rate x Probability of failure
- Diagnostic techniques
- Dissolved Gas Analysis (DGA)
 - IEEE Reference gas levels
 - Rate of gas formation
 - DGA periodicity
 - DGA accuracy and lab deviations

- Oil quality analysis
 - Reference levels
 - Moisture content
 - Dielectric strength
 - Interfacial tension
 - Power factor
 - Neutralization index
- Bushing tests
 - Factory reference and deviations
 - Bushing capacitance
 - Bushing power factor
 - Core insulation (Megger)
 - Turns ratio
 - Winding resistance
 - Short-circuit impedance
 - Frequency Response Analysis (FRA)
 - Mechanical integrity (Visual)

Day 3

- Maintenance criteria
 - Corrective maintenance
 - Preventative maintenance
 - Reliability centered maintenance
 - Condition based maintenance
 - Over-maintenance
 - Oil treatment (filtering)
 - Oil reclamation
- On-line monitoring system
 - What is
 - Sensor technology
 - Integrated systems
 - Cost x Benefit analysis
 - Demo
- The Repair x Replace dilemma
 - End of life
 - Cost of repair x Cost of new
 - Repair strategies
- New challenges
 - New oils (ester, vegetable)
 - Corrosive sulfur (copper sulfide)
- Comprehensive assessment program

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Siemens PTI has local offices in many countries throughout the world. For further information and contact to our worldwide business locations and local experts, please visit the Siemens PTI website and complete a contact form.

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