COURSE AUTHOR Jon Giesecke

L2 TRANSFORMER CONDITION ASSESSMENT COURSE

Mr. GIESECKE is one of the world's leading experts in combining technologies used in the in-service inspection of high voltage oil-filled power transformers and substation diagnostics.

He has been training personnel worldwide in these methods for over 20 years with great success.

Prior to forming JLG Associates LLC in 2006, Giesecke was employed by EPRI Solutions as a senior project manager in the Substation Predictive Maintenance business area.

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As a Senior Project Manager, some of his responsibilities included: the development and implementation of the Substation Predictive Maintenance Program (SPdM) at numerous electric utilities in the U.S. and abroad; Developing and Instructing an EPRI Solutions' SPdM course; instructed portions of the EPRI Transformer Performance Monitoring and Diagnostics course and the EPRI Substation/Switchyard Predictive Maintenance course; Providing training, services and consulting to evaluate maintenance responsibility and advanced programs applied to switchyard/substation components.

Along with vast knowledge in transformer and substation diagnostics, Mr. Giesecke is an ITC level III thermographer has instructed at the FLIR ITC training center. He also served on the board of directors of the International Society of Professional Thermographers, Inc. (ISPoT), and chaired the ethics committee. He has over 20 years of experience in transformer/substation predictive maintenance and over 25 years in substation electrical maintenance. He was also responsible for PdM template development for fossil and nuclear applications. He has been instrumental in the data acquisition and analysis of data at many nuclear facilities, aiding the nuclear power industry in creating a timely response to INPO's SOER 99-01 and 2002-03.

TARGET AUDIENCE

BASIC LEVEL

All those interested in a methodology and inspection process for oil filled power transformers.

INTERMEDIATE LEVEL

Geared towards substation managers, engineering staff and substation technicians that desire to learn the latest technologies and methods/diagnostics

MASTER LEVEL

Geared towards the substation technician and engineer that is doing the hands on testing and inspections. In depth learning with virtual hands on will be provided for a full understanding of partial discharge, vibration and sound level testing. This course consists of 13 lessons on three levels, each of which is approximately 45 minutes long. The list of the levels and lessons is the following:

BASIC LEVEL

Lesson 1: Introduction

MAIN TAKEAWAYS:

- 1. Understand the value of benchmarking critical switchyard electrical equipment
- 2. Know what technologies and processes are used to determine transformer condition
- 3. Learn to use data from several technologies to make critical decisions
- 4. How often to test and when to test
- 5. How to apply the severity criteria
- 6. How to make appropriate recommendations for action
- 7. Why do the calculation of a cost benefit analysis (CBA)
- 8. Show and describe the equipment condition status report
- 9. Present the "history" behind this inspection method
- 10. Explain Level I Testing compared to Level II Testing
- 11. An overview of PD detection, vibration & sound level analysis for power transformers will be provided
- 12. A brief preview of the future sessions

INTERMEDIATE LEVEL

Lesson 2: Vibration and Sound Analysis

MAIN TAKEAWAYS:

- 1. Provide an understanding of vibration analysis used to determine clamping pressures (tightness) of an oil-filled power transformer
- 2. Vibration analysis of oil circulation pumps in the cooling system will be provided
- 3. Ultrasonic (acoustic emission) analysis of transformer main windings and pumps / motors
- 4. Sound level analysis of oil-filled power transformers

Lesson 3: Partial Discharge Detection

MAIN TAKEAWAYS:

- 1. Acoustic / ultrasonic noise explanation (airborne and contact)
- 2. High frequency current transducer (HFCT) used for PD / arcing detection
- 3. Combining HFCT and AE data using a PD-TP500A test set
- 4. Data analysis of PD waveforms

Lesson 4: Infrared Thermography

MAIN TAKEAWAYS:

- 1. Provide an understanding of thermography as it applies to switchyard equipment
- 2. Equipment-specific severity criteria will be provided
- 3. Equipment failure modes will be included in this lesson
- 4. Understanding the cooling system operation and critical issues on power transformers will be explained in detail: inlet-to-outlet delta for pumped vs natural cooling

Lesson 5: Oil sampling, DGA, Furan, and oil quality understanding

MAIN TAKEAWAYS:

- 1. Explanation of the correlation between PD/Arcing testing and DGA
- 2. Portable testing vs Lab testing
- 3. How to interpret DGA results for Main tank

Lesson 6: Functional Testing & Visual Inspections

MAIN TAKEAWAYS:

- 1. Performing functional testing of the transformer cooling system
- 2. Functional testing of Load Tap Changers (LTC) and analysis of data
- 3. Functional testing of Lightning/Surge Arresters
- 4. Complete visual inspection tips and tricks

Lesson 7: Report generation and cost benefit analysis

MAIN TAKEAWAYS:

- 1. Learn Level two condition assessment (L2CA) method of reporting using the Excel spread sheet matrix
- 2. Learn the Equipment Condition Status Report (ECSR)
- 3. Learn about the transformer grading tool which assigns a number and letter grade to each transformer.

MASTER'S LEVEL

Lesson 8: Vibration and Sound Analysis

MAIN TAKEAWAYS:

1. Vibration and sound level analysis are used to detect changing or already damaging conditions within a transformer or cooling pumps

- 2. Learn the data acquisition locations (8) on a transformer and the most important readings to take on a pump
- 3. Learn analysis of data to determine looseness of a transformer, especially the energy shift; what frequency is used to determine a loose winding
- 4. Determine the clamping pressures (tightness) of an oil-filled power transformer. Where to collect data, how to mark the transformer shell for future readings?
- 5. Vibration analysis of oil circulation pumps in the cooling system; Analysis of thrust bearings will be covered
- 6. Acoustic emission analysis of the transformer main windings and pumps / motors will be covered in detail
- 7. Sound level analysis of oil filled power transformers location of data collection and weighting will be provided
- 8. How to determine a core form vs shell form transformer and where to place the accelerometer

Lesson 9: Partial Discharge Detection

MAIN TAKEAWAYS:

- 1. Acoustic/Ultrasonic noise explanation (Airborne and Contact) Used in two ways in Switchyards and Substations; Airborne for leak detection; Contact mode for detection of electrical leakage and partial discharge
- 2. Know what signature to expect when high amplitude arcing is occurring in oil filled equipment
- 3. Understand where/why/when to take readings and the frequency ranges to use.
- 4. Learn the operation of the TP500A
- 5. Understanding the High Frequency Current Transducer (HFCT) used for PD/Arcing detection
- 6. Combining HFCT and AE data using the PD-TP500A test set. This test set will be operating live and demo experiments will be done during the lesson
- 7. Testing techniques for oil filled power transformers, LTC's Voltage regulators, PT's, CT's, LA's, SA's, OCB's and SF6 CB's will be provided
- 8. Airborne Ultrasonic testing for N2 leakage and corona will be discussed and a demo of the test set will be provided
- 9. Functional testing of Lightning/Surge Arresters. Explain testing at full operating voltage and compare to power factor testing at 10Kv

Lesson 10: Oil sampling, DGA, Furan, and oil quality understanding

MAIN TAKEAWAYS:

- 1. Provide an understanding of the importance of dissolved gas analysis (DGA) and oil quality testing, and explain the importance of noting changing values and taking appropriate action as required
- 2. Provide an understanding of furan analysis, and why it is done it is a value in the L2CA program
- 3. Explanation of the correlation between PD / arcing testing and DGA
- 4. Portable testing vs lab testing
- 5. How to interpret DGA results for the main tank
- 6. How to interpret DGA results for LTC, voltage regulator, and OCB
- 7. How to perform proper sampling

Lesson 11: Infrared Thermography

MAIN TAKEAWAYS:

- 1. Provide an understanding of Thermography as it applies to switchyard equipment
- 2. Know what technology to apply next when a hot spot is detected
- 3. Learn about emissivity and spot size ratio
- 4. Equipment specific severity criteria
- 5. Techniques to reduce / eliminate sun glare issues
- 6. Substation component identification for IR thermographers will be presented
- 7. Understand cooling system operation and learn inlet / outlet temperature delta
- 8. A full understanding of IR testing of substation components will be provided
- 9. Equipment specific severity criteria will be included
- 10. Equipment failure modes covered in detail

Lesson 12: Functional Testing & Visual Inspections

MAIN TAKEAWAYS:

- 1. Understand what to look for on each piece of equipment listed below and why
- 2. Control cabinets
- 3. Overhead connections
- 4. Disconnects
- 5. Station Batteries
- 6. Transformers
- 7. Cooling systems
- 8. Circuit breakers
- 9. Control house
- 10. Grounding system
- 11. Performing functional testing of the transformer cooling system
- 12. Functional testing of Load Tap Changers (LTC) and analysis of data
- 13. Complete visual inspection tips and tricks
- 14. Using the diagnostic test equipment for:
 - a. Partial Discharge
 - b. Vibration and Sound Level
 - c. Arc Signature analysis
 - d. Infrared Thermography
 - e. Corona Detection
 - f. Surge/Lightning Arrester Testing

Lesson 13: Report generation and cost benefit analysis

MAIN TAKEAWAYS:

- 1. Learn L2CA method of reporting using the Excel spread sheet matrix
- 2. Learn the Equipment Condition Status Report (ECSR)
- 3. Learn about the transformer grading tool which assigns a number and letter grade to each transformer.
- 4. Learn Cost Benefit Analysis (CBA)
 - a. The importance of anomaly tracking and avoided cost documentation
 - b. Understanding the calculation process
 - c. Build an actual case history using the CBA process



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