COURSE OVERVIEW EE0592-4D
Transformer Oil Analysis

Course Title
Transformer Oil Analysis

Course Date/Venue
September 16-19, 2024/Beyoglu Meeting Room, Taksim Square Hotel, Istanbul, Turkey

Course Reference
EE0592-4D

Course Duration/Credits
Four days/2.4 CEUs/24 PDHs

Course Description

This practical and highly-interactive course includes real-life case studies and exercises where participants will be engaged in a series of interactive small groups and class workshops.

This course is designed to provide participants with detailed and up-to-date overview of Transformer Oil Analysis. It covers the importance, types and basic principles of transformer oil analysis; the proper sampling techniques and handling and transporting samples; the importance of dissolved gas analysis (DGA); identifying high, medium, and low-risk levels and interpreting DGA results; the Duval triangle analysis, critical conditions in oil samples and the impact of extreme conditions on transformer performance; the preventative and corrective actions and oil quality testing methods; and the condition monitoring techniques for transformer.

During this interactive course, participants will learn to link test results to transformer conditions and diagnose potential issues; the importance of Furan analysis; the impact of moisture content on transformer oil and performance; the methods for measuring moisture content; developing a maintenance plan and the importance of regular oil testing; the transformer oil reconditioning and replacement; managing oil contamination and risk; the advanced diagnostic tools for transformer analysis and online monitoring system; the data interpretation and trend analysis; the emerging technologies and methods of transformer oil analysis; and the impact of digitalization on oil analysis.

Course Objectives

Upon the successful completion of this course, each participant will be able to: -

- Apply and gain an in-depth knowledge on transformer oil analysis
- Discuss transformer rating, types and configuration as well as cooling method, insulation class and impedance voltage
- Explain vector group, efficiency, tap changer, overload capacity and short-circuit withstand capability
- Recognize temperature rise, noise level, mounting and enclosure, weight and dimensions and other power transformer technical specifications
- Identify transformer oil properties and types and prevent arcing and corona discharge
- Carryout preventive measures, diagnostic methods and steps and risks levels in DGA
- Conduct transformer oil analysis including water content, dielectric strength and acidity or neutralization number (NN) as well as interfacial tension (IFT), IFT-NN relationship and quality index system
- Recognize the colour of transformer oil number and condition, quality index system, dissipation factor and evaluate transformer solid insulation
- Carryout dissolved gas analysis including test vessels, apparatus for measurement of interfacial tension (IFT), sampling and frequency of analysis (IEC 60567, IEC 60475)
- Employ duval triangle method following Dornenburg ratios and fault interpretation, Rogers ratios and Duval triangle and Duval pentagon methods
- Apply furanic analysis in transformers, analytical methods for furanic compounds and transformer condition monitoring
- Address identified risks after DGA and employ immediate actions for the worst case and preventive measures
- Recognize advanced diagnostic tools and future trends like moisture level of transformer insulation, frequency dielectric spectroscopy (FDS) method and sludge identification in transformer insulation
- Identify mechanical fault of windings and diagnose transformer bushings as well as new technologies in oil analysis
- Recognize the benefits of online monitoring, impact of digitalization on oil analysis and data interpretation and trent analysis
- Employ maintenance strategies for power transformers and oil management strategies and implement comprehensive maintenance program
- Carryout techniques of reconditioning transformer oil, criteria for oil replacement and common contaminants and their effects

Who Should Attend

This course provides an overview of all significant aspects and considerations of transformer oil analysis for electrical engineers, maintenance technicians, reliability engineers, substation operators and technicians, asset managers, field service engineers, technical consultants and those who are involved with the operation, maintenance, and management of electrical transformers.

Course Certificate(s)

Internationally recognized certificates will be issued to all participants of the course who completed a minimum of 80% of the total tuition hours.

Certificate Accreditations

Certificates are accredited by the following international accreditation organizations:-

- The International Accreditors for Continuing Education and Training (IACET - USA)

  Haward Technology is an Authorized Training Provider by the International Accreditors for Continuing Education and Training (IACET), 2201 Cooperative Way, Suite 600, Herndon, VA 20171, USA. In obtaining this authority, Haward Technology has demonstrated that it complies with the **ANSI/IACET 2018-1 Standard** which is widely recognized as the standard of good practice internationally. As a result of our Authorized Provider membership status, Haward Technology is authorized to offer IACET CEUs for its programs that qualify under the **ANSI/IACET 2018-1 Standard**.

  Haward Technology's courses meet the professional certification and continuing education requirements for participants seeking **Continuing Education Units** (CEUs) in accordance with the rules & regulations of the International Accreditors for Continuing Education & Training (IACET). IACET is an international authority that evaluates programs according to strict, research-based criteria and guidelines. The CEU is an internationally accepted uniform unit of measurement in qualified courses of continuing education.

  Haward Technology Middle East will award **2.4 CEUs** (Continuing Education Units) or **24 PDHs** (Professional Development Hours) for participants who completed the total tuition hours of this program. One CEU is equivalent to ten Professional Development Hours (PDHs) or ten contact hours of the participation in and completion of Haward Technology programs. A permanent record of a participant's involvement and awarding of CEU will be maintained by Haward Technology. Haward Technology will provide a copy of the participant's CEU and PDH Transcript of Records upon request.

- British Accreditation Council (BAC)

  Haward Technology is accredited by the **British Accreditation Council** for **Independent Further and Higher Education** as an **International Centre**. BAC is the British accrediting body responsible for setting standards within independent further and higher education sector in the UK and overseas. As a BAC-accredited international centre, Haward Technology meets all of the international higher education criteria and standards set by BAC.

Course Instructor(s)

This course will be conducted by the following instructor(s). However, we have the right to change the course instructor(s) prior to the course date and inform participants accordingly:

Mr. Pan Marave, PE, MSc, BEng, is a **Senior Electrical & Instrumentation Engineer** with over **40 years** of extensive experience in **Oil**, **Gas**, **Petrochemical**, **Refinery** & **Power** industries. His expertise includes **Circuit Breakers**, **Switchgears**, **Transformers**, **Electrical Generator & Power Transformers**, **Transformer Oil Sampling Procedures**, **Transformer Oil** Quality Testing Methods, **Transformer Oil Reconditioning & Replacement**, **Electrical Safety**, **Power System Equipment**, **Electrical Drawing**, **Transmission Networks**, **Substation**, **Cable & Over Head Line**, **Substation Automation Systems & Application**, **Distribution Networks**, **Circuit Breaker**, **HV Switchgear Maintenance**, **HV/LV Electrical** Authorisation, Basic **Electricity**, **Electrical & Special Hazards**, **Personnel Protection**, **HV/LV Equipment**, **Motor Controllers**, **Electrical Switching** Practices, Uninterruptible Power Supply (**UPS**), **UPS and Battery System**, Preventive Maintenance of **Battery Charger and UPS System**, **UPS, DC System & Battery Design**, **Operation, Maintenance & Troubleshooting**, **Emergency Planning**, **Safety Management**, Safety Instrumented Systems (**SIS**), Safety Integrity Level (**SIL**), Emergency Shutdown (**ESD**); **Electrical Installation**, Maintenance & Troubleshooting, **Electrical Inspection & Testing**, Electrical Measurements, Power Flow Analysis of **Electrical Power Systems**, Electrical Fundamentals, **Basic Electricity** & Electrical Codes, **DCS**, **SCADA** & **PLC**; **Measurement** (**Flow**, **Temperature**, **Pressure**); **Process Analyzers** & **Analytical Instrumentation**; **Process Control**, **Instrumentation** & **Safeguarding**; **Process Controller**, **Control Loop & Valve Tuning**; Industrial **Distribution Systems**; Industrial **Control & Control Systems**, Power Systems **Protection & Relaying**; **Earthing**, **Bonding**, **Grounding**, **Lightning & Surge Protection**; Electric Power **Substation** & **Systems**; Electrical Engineering Principles; **Motor Control Circuit**; **Electrical Fault Analysis**; Electrical Networks & Distribution **Cables**; **Hazardous Areas Classification** and **Detailed Engineering Drawings**, **Codes** & **Standards**. Furthermore, he is also well-versed in Microprocessors Structure, Lead Auditor (**ISO 9000:2000**), **ISO 9002**, Quality Assurance, and Projects & Contracts Management.

Presently, Mr. Marave is the **Technical Advisor** of **Chamber of Industry & Commerce** in Greece. Prior to this, he gained his thorough practical experience through several positions as the **Technical Instructor**, **Engineering Manager**, **Electronics & Instruments Head**, **Electrical**, **Electronics & Instruments Maintenance Superintendent**, **Assistant General Technical Manager** and **Engineering Supervisor** of various international companies such as the **Alumil** Mylonas, **Athens Papermill**, **Astropol** and the **Science Technical Education**.

Mr. Marave is a **Registered Professional Engineer** and has **Master's** and **Bachelor's** degree in **Electrical Engineering** from the **Polytechnic Institute of New York** and **Pratt Institute of New York** (**USA**) respectively. Further, he is a **Certified Instructor/Trainer**, a **Certified Internal Verifier/Assessor/Trainer** by the **Institute of Leadership & Management** (**ILM**) and an active member of the **Technical Chamber** and the Institute of Electrical and Electronics Engineer (**IEEE**) in Greece. He has presented and delivered **numerous international** courses, conferences, trainings and workshops worldwide.

Training Methodology

All our Courses are including **Hands-on Practical Sessions** using equipment, State-of-the-Art Simulators, Drawings, Case Studies, Videos and Exercises. The courses include the following training methodologies as a percentage of the total tuition hours:-

30% Lectures
20% Practical Workshops & Work Presentations
30% Hands-on Practical Exercises & Case Studies
20% Simulators (Hardware & Software) & Videos

In an unlikely event, the course instructor may modify the above training methodology before or during the course for technical reasons.

Course Fee

US$ 5,000 per Delegate + **VAT**. This rate includes Participants Pack (Folder, Manual, Hand-outs, etc.), buffet lunch, coffee/tea on arrival, morning & afternoon of each day.

Accommodation

Accommodation is not included in the course fees. However, any accommodation required can be arranged at the time of booking.

Course Program

The following program is planned for this course. However, the course instructor(s) may modify this program before or during the course for technical reasons with no prior notice to participants. Nevertheless, the course objectives will always be met:

Day 1: ***Monday, 16th of September 2024***

0730 – 0800	*Registration & Coffee*
0800 – 0815	*Welcome & Introduction*
0815 – 0830	***PRE-TEST***
0830 - 0930	***Power Transformer Technical Specifications*** *Transformer Rating • Transformer Type and Configuration • Notes on Cooling Method • Insulation Class • Impedance Voltage • Vector Group • Efficiency*
0930 - 0945	*Break*
0945 – 1045	***Power Transformer Technical Specifications (cont'd)*** *Tap Changer • Overload Capacity • Short-Circuit Withstand Capability • Temperature Rise • Noise Level • Mounting and Enclosure*
1045 - 1215	***Power Transformer Technical Specifications (cont'd)*** *Weight and Dimensions • Insulation Material • Standards and Compliance • Accessories and Features • Testing and Quality Assurance • Warranty and Service*
1215 - 1230	*Break*
1230 - 1430	***Transformer Oil & Types of Oils*** *Transformer Oil Properties • Transformer Oil Types • Prevention of Arcing • Prevention of Corona Discharge • Preventive Measures • Diagnostic Methods • Practical Steps and Risk Levels in DGA • In-Depth Analysis of DGA Results*
1420 – 1430	***Recap***
1430	*Lunch & End of Day One*

Day 2: ***Tuesday, 17th of September 2024***

0730 – 0930	***A Guide to Transformer Oil Analysis*** *Water Content • Dielectric Strength • Acidity or Neutralization NUMBER(NN) • Interfacial Tension (IFT) • IFT-NN Relationship • Quality Index System*

0930 - 0945	*Break*
0945 - 1045	***A Guide to Transformer Oil Analysis (cont'd)*** *Color of Transformer Oil Number and Condition • Quality Index System • Dissipation Factor • Evaluation of Transformer Solid Insulation*
1045 - 1215	***A Dissolved Gas Analysis*** *Test Vessels • Apparatus for Measurement of Interfacial Tension (IFT) • Sampling and Frequency of Analysis (IEC 60567, IEC 60475) • TOA L1 Limits and Generation Rate Per Month Alarm Limits are based loosely on IEC 60599 • Some Transformer Problems*
1215 – 1230	*Break*
1230 - 1420	***Duval Triangle Method*** *Dornenburg Ratios • Dornenburg Ratios and Fault Interpretation • Rogers Ratios • Duval Triangle & Duval Pentagon Methods • Example Calculation and Interpretation*
1420 – 1430	***Recap***
1430	*Lunch & End of Day Two*

Day 3: ***Wednesday, 18th of September 2024***

0730 – 0900	***Condition Monitoring*** *Furanic Analysis in Transformers • Notes on Hydrolysis • Analytical Methods for Furanic Compounds • Significance in Transformer Condition Monitoring*
0900 - 0915	*Break*
0915 - 1045	***Strategies Addressing Identified Risks After DGA*** *Worst Case Scenario in DGA • Consequences of Worst-Case DGA Results • Immediate Actions for the Worst Case • Preventive Measures to Worst Case*
1045 - 1245	***Strategies Addressing Identified Risks After DGA (cont'd)*** *Strategies • Common Issues • Specific Gases and Their Indicative Faults • Addressing Common Issues • Interpretation of Hydrogen Levels*
1245 - 1300	*Break*
1300 -1420	***Advanced Diagnostic Tools & Future Trends*** *Moisture Level of Transformer Insulation • FDS Method (Frequency Dielectric Spectroscopy) • RVM-PDC Method • Sludge Identification in Transformer Insulation*
1420 – 1430	***Recap***
1430	*Lunch & End of Day Three*

Day 4: ***Wednesday, 19th of September 2024***

0730 – 0930	***Advanced Diagnostic Tools & Future Trends (cont'd)*** *Identification of Mechanical Fault of Windings • Diagnostic of Transformer Bushings • New Technologies in Oil Analysis*
0930 – 0945	*Break*
0945 - 1145	***Advanced Diagnostic Tools & Future Trends (cont'd)*** *Benefits of Online Monitoring • Impact of Digitalization on Oil Analysis • Data Interpretation and Trent Analysis*
1145 - 1245	***Maintenance Strategies & Oil Management*** *Maintenance Strategies for Power Transformers • Oil Management Strategies • Implementing a Comprehensive Maintenance Program • Techniques of Reconditioning Transformer Oil*

1245 - 1300	*Break*
1300 - 1345	***Maintenance Strategies & Oil Management (cont'd)*** *Criteria for Oil Replacement • Practical Steps for Oil Management • Common Contaminants and Their Effects • Strategies for Contamination Control • Maintenance Schedule • Maintenance Schedule – Example*
1345 – 1400	***Course Conclusion***
1400 – 1415	***POST-TEST***
1415 – 1430	*Presentation of Course Certificates*
1430	*Lunch & End of Course*

Practical Sessions

This practical and highly-interactive course includes real-life case studies and exercises:-

Course Coordinator

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