COURSE OVERVIEW EE0007
Transformer Maintenance & Testing

Course Title
Transformer Maintenance & Testing

Course Date/Venue
November 03-07, 2024/Club B Meeting Room, Ramada Plaza by Wyndham Istanbul City Center, Istanbul, Turkey

Course Reference
EE0007

Course Duration/Credits
Five days/3.0 CEUs/30 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.

The high efficiency and reliability of power transformers have contributed to the domination of power networks since the beginning of the last century. Transformers play also a key role in the interconnection of power systems at different voltage levels. Without transformers, it would simply not be possible to use electric power in many of the ways it is used today. Consequently, transformers occupy prominent positions in the electric power system, being the vital links between power generating stations and points of electric power utilization.

This course is designed to provide delegates a detailed and up-to-date overview of transformer operation, maintenance, diagnosis, testing and lifetime extention. It covers the power transformer fundamentals including the main electric parameters and laws, magnetism and electromagnetism, Lenz and Faradays Laws, circuits, star and delta connections, theory, the role of transformers in power systems, standards, regulations and voltages as well as the various types and construction of transformers.

Further, the course will also discuss the special transformers, transformer components, materials, cooling of transformers, transformer performance, electrical parameters and transformer faults; the power transformer failure and faults; the proper power transformer protection, operation and factory acceptance test (FAT); the transformer installation, testing and commissioning; and the transformer maintenance, routine inspections, diagnostic analysis, life expectancy and extension.

During this interactive course, participants will learn the methods of insulating system and lifetime extension in transformer diagnostic; the insulation system composition, transformer oil types, thermal effects and energy losses; the heat transformer modes, insulation systems oxidation and degradation, corrosive sulphur effect and insulation system aging factors; the aging measurement, electrical diagnosis of insulation system, gas diagnostic analysis and chemical diagnostic analysis; and the physical diagnostics analysis, estimation diagnostic analysis, transformer lifetime extension and remaining life assessment (RLA).

Course Objectives

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

- Apply and gain systematic techniques and methodologies of transformer operation, maintenance, diagnosis, testing and lifetime extension
- Operate, maintain, troubleshoot and test power transformers in a professional manner
- Discuss the power transformer fundamentals covering the main electric parameters and laws, magnetism and electromagnetism, Lenz and Faradays Laws, circuits, star and delta connections, theory, the role of transformers in power systems, standards, regulations and voltages
- Identify the various types and construction of transformers
- Describe special transformers as well as enumerate transformer components and materials
- Determine cooling of transformers, transformer performance and electrical parameters
- Recognize power transformer failure and faults as well as employ proper power transformer protection, operation and factory acceptance test (FAT)
- Install, test and commission transformer efficiently
- Carryout transformer maintenance, routine inspections, diagnostic analysis, life expectancy and extension
- Apply the methods of insulating system and lifetime extension in transformer diagnostic
- Discuss the insulation system composition, transformer oil types, thermal effects and energy losses
- Identify the heat transformer modes, insulation systems oxidation and degradation, corrosive sulphur effect and insulation system aging factors
- Carryout aging measurement, electrical diagnosis of insulation system, gas diagnostic analysis and chemical diagnostic analysis
- Perform physical diagnostics analysis, estimation diagnostic analysis, transformer lifetime extension and remaining life assessment (RLA)

Who Should Attend

This course provides an overview of all significant aspects and considerations of transformer operation, maintenance, diagnosis, testing and lifetime extension for engineers and other technical staff who need a sound understanding of power transformer operation, maintenance, troubleshooting or testing.

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 **3.0 CEUs** (Continuing Education Units) or **30 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 **Electrical Generator** & **Power Transformers**, **Transformer** Operation Principles, Selection & Troubleshooting, **Current** & **Voltage Transformers**, **Power Transformer Protection**, **Basic Electronics** & **Transformers**, **Circuit Breakers**, **Switchgears**, **Transformers**, **Circuit Breaker**, **HV Switchgear Maintenance**, **HV/LV Electrical** Authorisation, Basic **Electricity**, **Electrical & Special Hazards**, **Personnel Protection**, **HV/LV Equipment**, **Motor Controllers**, **Electrical Switching** Practices, **Emergency Planning**, **Safety Management**, Safety Instrumented Systems (**SIS**), Safety Integrity Level (**SIL**), Emergency Shutdown (**ESD**), **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 Generation & Transmission**, Power Systems **Protection & Relaying**, **Earthing**, **Power System Protective Relay**, **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** degrees 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.

Course Fee

US$ 6,000 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.

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 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: ***Sunday, 03rd of November 2024***

0730 – 0800	*Registration & Coffee*
0800 – 0815	*Welcome & Introduction*
0815 – 0830	***PRE-TEST***
0830 – 0930	***Power Transformer Fundamentals*** *Main Electric Parameters & Laws ● Magnetism & Electromagnetism ● Lenz & Faraday's Laws*
0930 – 0945	*Break*
0945 -1115	***Power Transformer Fundamentals (cont'd)*** *Single & Three-phase Circuits (3 & 4 Wires) ● Star (Y) & Delta (Δ) Connections ● Basic Transformer's Theory ● The Role of Transformers in Power Systems ● Standards & Regulations ● Standard Voltages*
1115 - 1230	***Types & Construction of Transformers*** *Oil-filled Transformers with Expansion Tanks ● Oil-filled Sealed Transformers ● Dry Transformers ● Gas Insulated Transformers (GIT) ● Two & Three Windings Transformers ● Applications*
1230 - 1245	*Break*
1245 – 1420	***Special Transformers*** *Single Phase Transformers ● Autotransformers ● Arc Furnace Transformers ● Rectifier Transformers ● Zig-Zag & Grounding Transformers ● Instrument Transformers*
1420 – 1430	***Recap***
1430	*Lunch & End of Day One*

Day 2: Monday, 04th of November 2024

0730 – 0930	***Transformer Components & Materials*** *Steel Core ● Copper & Aluminium Windings ● Insulation Materials ● Expansion Tank & Radiators ● Expansion Tank & Radiators ● Bushings ● Cooling System ● Tap Changers ● Built-on Protections ● Accessories*
0930 – 0945	*Break*
0945 – 1100	***Cooling of Transformers*** *Heat Dissipation & Load ● Environment & Cooling of Transformers ● Cooling Fluids ● Types of Cooling Systems & Notations (ONAN; ONAF; OFAF; OFWF; AN; GIT) ● Types of Cooling Systems & Notations (ONAN; ONAF; OFAF; OFWF; AN; GIT) (cont'd) ● Rated Power & Cooling System*
1100 - 1230	***Transformer Performance & Electrical Parameters*** *Rated Power ● Rated Voltages & Ratio ● Rated Frequency Losses & Efficiency ● Impedance Voltage Drop*
1230 - 1245	*Break*
1245 - 1420	***Transformer Performance & Electrical Parameters (cont'd)*** *Vector Group ● Voltage Regulation (On-load Tap Changers & Off-load Tap Changers)*
1420 – 1430	***Recap***
1430	*Lunch & End of Day Two*

Day 3: Tuesday, 05th of November 2024

0730 – 0930	***Power Transformer Failure & Faults*** *Causes of Failure ● Oil & Insulation Faults ● Windings Faults ● Overloads & Overheating ● Assessing Risk Failure ● Preparing a Risk Based Transformer Management Program*
0930 – 0945	*Break*
0945 – 1100	***Power Transformer Protection*** *Built-on Protections ● Differential Protection ● Overcurrent Protection ● Restricted Earth Fault Protection ● Overload Protection*
1100 – 1230	***Transformer Operation*** *Inrush Currents & Harmonics ● Parallel of Transformers ● Power Factor ● Power Factor (cont'd) ● Lightning & Switching Overvoltages ● Surge Arresters ● Fire Protection*
1230 – 1245	*Break*
1245 - 1420	***Factory Acceptance Tests (FAT)*** *Type Tests ● Routine Tests ● Routine Tests ● Special Tests ● Oil Testing*
1420 – 1430	***Recap***
1430	*Lunch & End of Day Three*

Day 4: Wednesday, 06th of November 2024

0730 - 0930	***Transformer Installation, Testing & Commissioning*** *General Layout ● Floor Mounted Transformers ● Pad Mounted Transformers ● Pole Mounted Transformers ● Oil Retention Basin*
0930 – 0945	*Break*
0945 – 1100	***Transformer Installation, Testing & Commissioning (cont'd)*** *Neutral Grounding ● Earthing & Bonding ● Transportation & Handling ● Site Acceptance Tests (SAT)*
1100 - 1230	***Transformer Maintenance, Routine Inspections & Diagnostic Analysis*** *Establishing a Preventive Maintenance & Inspection Program ● Safety ● Visual Inspection ● Insulation Resistance (Oil & Solid) ● Insulation Power Factor (PF) ● Oil Analysis & Samples ● Windings*

1230 - 1245	*Break*
1245 – 1420	***Transformer Maintenance, Routine Inspections & Diagnostic Analysis (cont'd)*** *Windings ● Tank & Conservator ● On-load Tap Changer ● Bushings ● Cooling System ● Accessories & Auxiliary Equipments ● Infrared Thermography ● Schedule of Preventive Maintenance Actions & Inspections ● Procedures*
1420 – 1430	***Recap***
1430	*Lunch & End of Day Four*

Day 5: Thursday, 07th of November 2024

0730 – 0830	***Transformer Life Expectancy*** *Mean Time Between Failures (MTBF) ● Insulation System Aging Factors*
0830 - 0930	***Transformer Life Expectancy (cont'd)*** *Oil ● Paper ● Bushings*
0930 – 0945	*Break*
0945 – 1100	***Transformer Diagnostic: Methods of Insulating System & Lifetime Extension*** *Insulation System Composition ● Transformer Oil Types ● Thermal Effects ● Energy Losses*
1100 - 1230	***Transformer Diagnostic: Methods of Insulating System & Lifetime Extension (cont'd)*** *Modes of Heat Transfer ● Oxidation & Degradation of Insulation Systems ● Corrosive Sulphur Effect ● Insulation System Aging Factors*
1230 – 1245	*Break*
1245 – 1315	***Transformer Diagnostic: Methods of Insulating System & Lifetime Extension (cont'd)*** *Aging Measurement ● Electrical Diagnosis of Insulation System ● Gas Diagnostic Analysis ● Chemical Diagnostic Analysis*
1315 - 1345	***Transformer Diagnostic: Methods of Insulating System & Lifetime Extension (cont'd)*** *Physical Diagnostics Analysis ● Estimation Diagnostic Analysis ● Transformer Lifetime Extension ● Remaining Life Assessment (RLA)*
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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