



COURSE OVERVIEW EE0007-4D
Transformer Operation, Maintenance, Diagnosis,
Testing & Lifetime Extension

Course Title

Transformer Operation, Maintenance, Diagnosis, Testing & Lifetime Extension

Course Date/Venue

October 07-10, 2024/Club B Meeting Room, Ramada Plaza by Wyndham Istanbul City Center, Istanbul, Turkey

Course Reference

EE0007-4D



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.



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 extension. 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: -

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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.

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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. Ahmed Hayajneh is a **Senior Electrical Engineer** with **20 years** of experience in **Oil, Gas, Petrochemical, Refinery & Power** industries. His expertise widely covers in the areas of **HV/MV Cable Splicing, Jointing, Inspection & Termination, HV/LV Equipment, High Voltage Electrical Safety, LV & HV Electrical System, HV Equipment Inspection & Maintenance, HV Switchgear Operation & Maintenance, LV Distribution Switchgear & Equipment, LV/MV Electrical Safety (11 KV, 415 & 220 Voltage), Power System Equipment, Power Cable Standard and Testing, Cables & Wiring, Overhead Transmission Lines, Transmission Network Maintenance, Electrical Forecasting Techniques, Inspection Reporting Techniques, Electrical Substation Design & Planning, Electrical Drawings & Schematics, Fault Detection Analysis, Distribution Networks & Load Forecasting, Power Generation, Electrical Power System, Electrical Installations & Utilities, Electrical Distribution Systems & Control Circuits, Electrical Drawings, Relay Logic Circuits, Troubleshooting Transformers, System Grounding, Circuit Breakers, Protection Devices & Technology, Protection Relay, Transformers, Generators, Power Transformers, Motors, Substations, Switchgears & Distribution, Power System Analysis, Electrical Equipment Control Systems, Transformer Maintenance & Testing, Electrical Substation & Design, Power Quality Studies & Load Criteria, Substation Earthing System, Electrical Equipment Maintenance, Electrical Safety, Electrical Protection, Batteries, Chargers & UPS, Electrical Submersible Pumps (ESP), Power Supply Substations, Area Classification, Safety Management System, Permit to Work & Issuing Authority, Emergency Diesel Generator, Variable Frequency Drives (VFD), PLC & SCADA for Automation & Process Control, Automation Solutions & Techniques, Automating Process Equipment, DCS Automated Process Control Systems, High & Low Voltage Electrical Safety, Electrical Inspection & Testing, Electrical Control & Monitoring System, Electric Power System, Intensive Overhead Transmission Line (OHTL), Generator Maintenance & Troubleshooting, Transmission Line Networks, Distribution Engineering, HVDC Transmission & Control, Substation Maintenance Techniques and Overhead Power Line Construction & Patrolling.**

Mr. Ahmed gained his expertise and experience through several positions as a **Senior Electrical Project Engineer, Senior Electrical Engineer, Site Electrical Engineer** and **Senior Instructor/Trainer** for various companies such as United Electro-Mechanical International Company, AL OSAIS Contracting Co., ASTRACO, Saudi Service for Electro Mechanic Work Co. (S.S.E.M), Dubai Electricity & Water Authority (DEWA) and Saudi Electricity Company (SEC).

Mr. Ahmed has a **Bachelor's degree in Electrical Engineering**. Further, he is a **Certified Instructor/Trainer** and has delivered various trainings, seminars, conferences, workshops and courses globally.

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, 07th of October 2024

0730 – 0800	<i>Registration & Coffee</i>
0800 – 0815	<i>Welcome & Introduction</i>
0815 – 0830	PRE-TEST
0830 – 0930	Power Transformer Fundamentals <i>Main Electric Parameters & Laws • Magnetism & Electromagnetism • Lenz & Faraday's Laws •</i>
0930 – 0945	<i>Break</i>
0945 -1115	Power Transformer Fundamentals (cont'd) <i>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</i>
1115 - 1230	Types & Construction of Transformers <i>Oil-filled Transformers with Expansion Tanks • Oil-filled Sealed Transformers • Dry Transformers • Gas Insulated Transformers (GIT) • Two & Three Windings Transformers • Applications</i>
1230 - 1245	<i>Break</i>
1245 – 1420	Special Transformers <i>Single Phase Transformers • Autotransformers • Arc Furnace Transformers • Rectifier Transformers • Zig-Zag & Grounding Transformers • Instrument Transformers</i>
1420 – 1430	Recap
1430	<i>Lunch & End of Day One</i>



Day 2: Tuesday, 08th of October 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: Wednesday, 09th of October 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: Thursday, 10th of October 2024

0730 – 0830	Transformer Installation, Testing & Commissioning General Layout • Floor Mounted Transformers • Pad Mounted Transformers • Pole Mounted Transformers • Oil Retention Basin • Neutral Grounding • Earthing & Bonding • Transportation & Handling • Site Acceptance Tests (SAT)
0830 - 0930	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 • Windings • Tank & Conservator • On-load Tap Changer • Bushings • Cooling System • Accessories & Auxiliary Equipments • Infrared Thermography • Schedule of Preventive Maintenance Actions & Inspections • Procedures

0930 – 0945	<i>Break</i>
0945 – 1100	Transformer Life Expectancy <i>Mean Time Between Failures (MTBF) • Insulation System Aging Factors • Oil • Paper • Bushings</i>
1100 - 1230	Transformer Diagnostic: Methods of Insulating System & Lifetime Extension <i>Insulation System Composition • Transformer Oil Types • Thermal Effects • Energy Losses • Modes of Heat Transfer • Oxidation & Degradation of Insulation Systems • Corrosive Sulphur Effect • Insulation System Aging Factors</i>
1230 – 1245	<i>Break</i>
1315 - 1345	Transformer Diagnostic: Methods of Insulating System & Lifetime Extension (cont'd) <i>Aging Measurement • Electrical Diagnosis of Insulation System • Gas Diagnostic Analysis • Chemical Diagnostic Analysis • Physical Diagnostics Analysis • Estimation Diagnostic Analysis • Transformer Lifetime Extension • Remaining Life Assessment (RLA)</i>
1345 – 1400	Course Conclusion
1400 – 1415	POST-TEST
1415 – 1430	<i>Presentation of Course Certificates</i>
1430	<i>Lunch & End of Course</i>

Practical Sessions

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



Course Coordinator

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