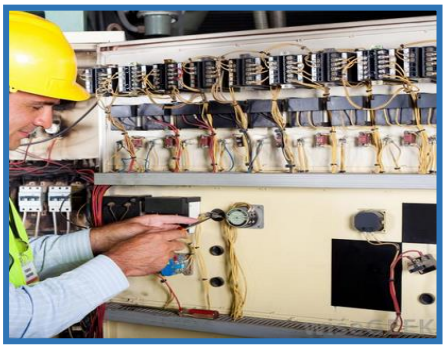
COURSE OVERVIEW EE0036-4D
13.8 KV Switchgear Maintenance

Course Title
13.8 KV Switchgear Maintenance

Course Reference
EE0036-4D

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



Course Date/Venue

Session(s)	Date	Venue
1	July 22-25, 2024	Club B Meeting Room, Ramada Plaza by Wyndham Istanbul City Center, Istanbul, Turkey
2	October 07-10, 2024	Boardroom 1, Elite Byblos Hotel Al Barsha, Sheikh Zayed Road, Dubai, UAE

Course Description

This highly-interactive course includes various practical sessions and exercises. Theory learnt will be applied using our state-of-the-art simulators.

Switchgear represents a significant capital investment in the electric power grid. The reliable performance of the 13.8 KV distribution switchgear within industries is a basic requirement for overall reliability of the plant. The trend now in switchgear maintenance is to move from the conventional approaches such as corrective maintenance and preventive maintenance to advanced strategies as well as risk-based maintenance and condition-based maintenance. This way, the service activity is no longer driven by predefined timeframes, observations and past experiences, but takes the actual condition of the equipment, the required reliability level and the life time extension expectation into account.

This course is designed to provide delegates with a detailed and up-to-date overview of the 13.8 KV switchgear maintenance. It covers the switchgear and the basic concepts of electrical engineering; the industrial switchgear; the CB design specification; the air, oil and modern vacuum circuit breakers and switchgear up to 13.8 KV; the switchgear lifespan practice and assessment; the switchgear diagnostics and maintenance; the switchgear operating tests; the switchgear inspection, maintenance and services; the general inspection technical procedure and the troubleshooting procedure of switchgear.

The course will give delegates the necessary information and skills required to maintain the 13.8 KV switchgear and an appreciation of the safety procedures associated with medium voltage electrical distribution. Also, it will provide participants with the practical and procedural aspects of safe working on electrical equipment and give the necessary guidance to carry out these duties to meet the requirements of the regulations and standards.

The course will describe voltage convention classifications, switchgear components and their function, the protection system for generator, transformer and motor including switchgear construction, ground fault relay system and the safe operation, isolation, deisolation, inspection, maintenance and troubleshooting of the 13.8 KV switchgears.

Course Objectives

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

- Apply systematic techniques on 13.8 KV switchgears maintenance
- Discuss switchgear and the basic concepts of electrical engineering
- Identify the industrial switchgear covering fuses, auto-reclosers, automatic sectionalizes, circuit breakers, isolator switches, load switches, relays, current transformers and voltage transformers
- Recognize the CB design specification based on short circuit current level, arc phenomena and circuit interruption
- Describe air circuit breakers and switchgear up to 13.8KV, oil circuit breakers and switchgear up to 13.8KV and modern vacuum CB and switchgear up to 13.8 KV
- Explain switchgear lifespan covering load effects, number of switching cycles, mechanical lifespan, electrical lifespan and ageing
- Carryout switchgear lifespan practice and assessment that includes electrical lifespan calculation, maintenance costs, spare parts availability, sustainability with existing fault conditions, risk assessment and cost benefit analysis
- Employ switchgear diagnostics and maintenance comprising of switchgear inspection, routing testing of switchgears, dielectric test on the main circuit and tests on auxiliary and control circuits
- Perform switchgear operating tests, tightness tests, condition-based maintenance (CBM), reliability centered maintenance (RCM) and asset register
- Illustrate switchgear inspection, maintenance and services and apply general inspection technical procedure, circuit breaker inspection on a daily, monthly and annual basis, disassembly, cleaning, tightening, testing procedure, direct testing, contact resistance test, insulation resistance test, test report and indirect testing
- Troubleshoot switchgear in a professional manner and identify the low insulation resistance and resistance between terminals of too high

Who Should Attend

This course covers a wide understanding and deeper appreciation of the 13.8 KV switchgears maintenance for electrical engineers and other technical staff.

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.

Accommodation

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

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. Carlos Monterrosa, PE, MSc, BSc, is a **Senior Electrical Engineer** with over **30 years** of extensive experience in the **Oil & Gas**, **Refinery**, **Petrochemical**, **Power** and **Utilities** industries. His expertise widely covers in the areas of **High Voltage Electrical Safety**, **HV/MV Cable Splicing**, **Jointing & Termination**, **High Voltage Circuit Breaker Inspection & Repair**, **High Voltage Power System** Safe Operation, High Voltage Safety, **High Voltage Transformers**, Safe Operation of High Voltage & Low Voltage Power Systems, **Transformer** Operation & Maintenance, **Electrical** Maintenance & Inspection, **Electrical Isolation**, **Circuit Breakers**, **Switchgears & 132 KV Cables**, **Power System** Control & Stability, **Economic Dispatch** of Power Plants, **Electrical Power Systems** Quality & Troubleshooting, **UPS & Battery** Maintenance & Troubleshooting, **Motors & Variable Speed Drives** Troubleshooting & Maintenance, **Generator Excitation Systems & AVR** Commissioning & Troubleshooting, **Power Generation & Transmission**, **Electrical Distribution Systems**, Power System Blackouts Preventive Measures, **Power System Protection & Relaying**, **Electrical Networks & Distribution Cables** Fault Analysis, **Motor Control Circuit** Troubleshooting, Power Factor Correction, **Load Forecasting** & System Upgrade, National Electrical Code (**NEC**), Earthing & Bonding, **Power Distribution Systems**, Overhead Power Line Construction, **Generator** Operation & Maintenance, PdMA Motor Testing Data Analysis, Power System Blackouts & Restoration, Siemens Master Drives, **Substation Automation** Systems, Power Factor Correction, Practical Electrical Wiring, Schematic & Wiring Diagrams Analysis, **Energy** Management, Electrical Equipment & Control Circuits, Practical **Fiber-Optics** Technology, Structured Cabling System (**SCS**), **Industrial Process Control & Instrumentation**, Programmable Logic Controllers (**PLC**) & **SCADA** System, **Renewable Energy**, **Industrial Data Communication**, Root Cause Failure Analysis (**RCFA**) for Control & Instrumentation. Further, he is also well-versed in National Electrical Code (**NEC**), National Electrical Safety Code (**NESC**), **Power System Distribution**, **Electromechanical Maintenance**, **Power Systems** Security, **Power Electronics**, **Custody Measurement**, **Process Control & Instrumentation**, **PLC**, **SCADA**, **DCS**, **Power Generation**, **Industrial Data Communication** and **Telecommunication**.

Mr. Monterrosa has built-up a formidable reputation in his design, inspection, installation and maintenance of High Voltages Distribution, **Transformers**, Substation, AC & DC **Drives**, Power Electronics, **Instrumentation** & **Control Systems** and **Data Communications**. While he has performed significant consultancy projects in these areas, he was also involved in generator **excitation systems**, generator protection, LV/MV Drives, ACS/DCS drives and Electrical AC **motors** and **drives**. He spends most of his time on consultancy projects in which he is **world renowned** for his professionalism and practical problem-solving abilities.

He gained his expertise & thorough practical experience through several positions and dedication as a **Project Manager**, **Technical Services Manager**, **Application & Product Engineer**, **Electrical Engineer**, **Instrumentation Engineer**, **Design Engineer**, **Project Engineer**, **Electrical Designer**, **Laboratory Instructor**, **Chief Technician**, **LAN Technician**, **Project Coordinator** and **Research Assistant** for various international companies and institutions such as the **ABB Inc**., Ecole de Technologie Supériure (ETS), Woods Electronics, Formatronique Ltd. and COCLA just to name a few.

Mr. Monterrosa has a **Bachelor** degree in **Electrical Engineering** & **Power Electronics** from Ecole de Technologie Supérieure, **Canada** and holds various Certification in **Industrial Robotics** & **Automated Systems** from Institut Supérieur d'Electronique, Canada, a Certificate in **Electronic Systems** Technology from Formatronique, Canada and a Certificate in Computer **Applied Digital Technologies** from Formatronique, Canada. Further, he is a **Certified Instructor/Trainer** and has delivered numerous trainings, workshops, courses, seminars and conferences internationally.

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

Istanbul	**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.
Dubai	**US$ 4,500** per Delegate + **VAT**. This rate includes H-STK® (Haward Smart Training Kit), buffet lunch, coffee/tea on arrival, morning & afternoon of each day.

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

0730 – 0800	*Registration & Coffee*
0800 – 0815	*Welcome & Introduction*
0815 – 0830	***PRE-TEST***
0830 – 0930	***Introduction to Switchgear*** *Electrical Engineering Basic Concepts ● Three Phase Review and Per Unit ● Voltage Levels ● One Line and Three Line Diagram ● Generation System Layout ● Transmission System Layout ● Substation System Layout ● Distribution System Layout*
0930 – 0945	*Break*
0945 – 1100	***Industrial Switchgear*** *Fuses ● Auto-reclosers ● Automatic Sectionalizer ● Circuit Breakers ● Isolator Switches ● Load Switches ● Relays ● Current Transformers ● Voltage Transformers*
1100 – 1230	***CB Design Specification Based on Short Circuit Current Level*** *Per Unit System ● Faults on Power Systems ● Typical Protection System for Generator/Transformer/Motor ● Transient Phenomena in Power System ● Symmetrical Component Analysis of Three Phase Network*
1230 – 1245	*Break*

1245 – 1420	***CB Design Specification Based on Short Circuit Current Level (cont'd)*** *Network Connection for Various Fault Types ● Current and Voltage Distribution in System Due to a Fault ● Effect of System on Zero Sequence Quantities ● Computer Programs Based Short Circuit Calculation*
1420 – 1430	***Recap***
1430	*Lunch & End of Day One*

Day 2

0730 – 0930	***CB Design Specification Based on Arc Phenomena and Circuit Interruption*** *Arc Phenomena ● Maintenance of the Arc ● Properties of Arc ● Arc Interruption Theory ● Circuit Breaker Rating ● Circuit Constants and Circuit Conditions ● Conditions of Severity ● Restriking Voltage Transient ● Class A Ultra Fast Transients ● Class B System Transients ● Class C Low Transients ● Transmission Line Transient ● Switching Transients ● Duties of Switchgear*
0930 - 0945	*Break*
0945 – 1100	***Air Circuit Breakers & Switchgear up to 13.8 KV*** *Method of Increasing Arc Resistance ● Plan Break Type ● Magnetic Blow Out Type ● Arc Splitter Type*
1100 - 1230	***Air Circuit Breakers & Switchgear up to 13.8 KV (cont'd)*** *Application ● Construction and Operation ● Axial Air CB ● Blast Air CB*
1230 – 1245	*Break*
1245 – 1420	***Oil Circuit Breakers & Switchgear 13.8 KV*** *Arc Rupture Under Oil ● Advantages of Oil ● Disadvantages of Oil ● Plan Break Oil Circuit Breakers ● Arc Control Circuit Oil Breakers ● Minimum Oil Circuit Breakers ● Construction and Operation*
1420 – 1430	***Recap***
1430	*Lunch & End of Day Two*

Day 3

0730 – 0930	***Modern Vacuum CB and Switchgear 13.8 KV*** *Introduction ● Advantages of Vacuum Interruption ● Vacuum Contactors and Interrupters ● The Vacuum Medium ● The Vacuum Arc ● Vacuum Arc Stability ● Vacuum Break Down ● Vacuum Switch Construction ● Applications of Vacuum Circuit Breakers ● Vacuum Circuit Breakers & Switchgear Safety Aspects ● Vacuum Circuit Breakers & Switchgear Safe Operation*
0930 – 0945	*Break*
0945 – 1100	***Switchgear Lifespan*** *Load Effects ● Number of Switching Cycles ● Mechanical Lifespan ● Electrical Lifespan ● Ageing*
1100 – 1230	***Switchgear Lifespan Practice*** *Electrical Lifespan Calculation Exercise*
1230 – 1245	*Break*
1245 - 1420	***Switchgear Lifespan Assesment*** *Maintenance Costs ● Spare Parts Availability ● Suitability with Existing Fault Conditions ● Risk Assessment ● Cost/Benefit Analysis*
1420 – 1430	***Recap***
1430	*Lunch & End of Day Three*

Day 4

0730 – 0930	***Switchgear Diagnostics & Maintenance*** *Switchgear Defects ● Switchgear Inspection ● Routine Testing of Switchgears ● Dielectric Test on the Main Circuit (Oil, Air, Vacuum & SF6 Type Devices) ● Tests on Auxiliary & Control Circuits ● Mechanical Operating Tests ● Tightness Test ● Condition Based Maintenance (CBM) ● Reliability Centred Maintenance (RCM) ● Asset Register*
0930 – 0945	*Break*
0945 – 1100	***Switchgear Inspection, Maintenance & Services*** *Inspection ● General Inspection Technical Procedure ● Daily Inspection of Circuit Breakers ● Monthly Inspection of Circuit Breakers ● Annual Inspection of Circuit Breakers ● Disassembly ● Cleaning ● Tightening ● Lubrication ● Equipment Used in Testing ● Testing Procedure ● Direct Testing ● Contact Resistance Test ● Insulation Resistance Test ● Test Report ● Indirect Testing*
1100 - 1230	***Switchgear Troubleshooting*** *Low Insulation Resistance (Below 2000 Mega-ohms) between Phase Terminal and Earthed Frame with Breaker Closed & Phase Terminals of a Pole ● Resistance between Terminals of Pole too High (Above 100 Microhms) (15 Micro-ohm per Joint) Contact Unequal Contact Wipe and Travel in 3-pole Measured from Top Surface of Interrupter Flange and the Contact Lip by a Simple Rod with Breaker Open and Breaker Closed*
1230 – 1245	*Break*
1245 - 1345	***Switchgear Troubleshooting (cont'd)*** *One of the Pole Does Not Close ● Breaker Operation too Slow during Opening Timing from Trip Command to Contact Separation Instant too Large (60 ms instead of say 40 ms)*
1345 – 1400	***Course Conclusion***
1400 – 1415	***POST-TEST***
1415 – 1430	*Presentation of Course Certificates*
1430	*Lunch & End of Course*

Simulators (Practical Sessions)

Practical sessions will be organized during the course for delegates to practice the theory learnt. Delegates will be provided with an opportunity to carryout various exercises using our state-of-the-art "GE Multilin Relay 469" and "GE Multilin Relay 750".

GE Multilin Relay 469 Simulator

GE Multilin Relay 750 Simulator

Course Coordinator

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