

**COURSE OVERVIEW EE0036-4D**  
**13.8 KV Switchgear Maintenance**

**Course Title**

13.8 KV Switchgear Maintenance

**Course Date/Venue**

October 07-10, 2024/Boardroom 1, Elite Byblos Hotel  
 Al Barsha, Sheikh Zayed Road, Dubai, UAE

**Course Reference**

EE0036-4D

**Course Duration/Credits**

Four days/2.4 CEUs/24 PDHs



**Course Description**



***This highly-interactive course includes various practical sessions sand 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 sectionalizers, 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.

### Exclusive Smart Training Kit - H-STK®




Participants of this course will receive the exclusive “Haward Smart Training Kit” (H-STK®). The H-STK® consists of a comprehensive set of technical content which includes **electronic version** of the course materials, sample video clips of the instructor’s actual lectures & practical sessions during the course conveniently saved in a **Tablet PC**.

### 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.

### 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 Supérieure (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

**US\$ 4,500** per Delegate + **VAT**. This rate includes H-STK® (Howard 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: Monday, 07<sup>th</sup> of October 2024**

0730 – 0800	Registration & Coffee
0800 – 0815	Welcome & Introduction
0815 – 0830	<b>PRE-TEST</b>
0830 – 0930	<b>Introduction to Switchgear</b> 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	<b>Industrial Switchgear</b> Fuses • Auto-reclosers • Automatic Sectionalizer • Circuit Breakers • Isolator Switches • Load Switches • Relays • Current Transformers • Voltage Transformers
1100 – 1230	<b>CB Design Specification Based on Short Circuit Current Level</b> 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	<b>CB Design Specification Based on Short Circuit Current Level (cont'd)</b> 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	<b>Recap</b>
1430	Lunch & End of Day One

**Day 2: Tuesday, 08<sup>th</sup> of October 2024**

0730 – 0930	<b>CB Design Specification Based on Arc Phenomena and Circuit Interruption</b> 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	<b>Air Circuit Breakers &amp; Switchgear up to 13.8 KV</b> Method of Increasing Arc Resistance • Plan Break Type • Magnetic Blow Out Type • Arc Splitter Type
1100 - 1230	<b>Air Circuit Breakers &amp; Switchgear up to 13.8 KV (cont'd)</b> Application • Construction and Operation • Axial Air CB • Blast Air CB
1230 – 1245	Break
1245 – 1420	<b>Oil Circuit Breakers &amp; Switchgear 13.8 KV</b> 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	<b>Recap</b>
1430	Lunch & End of Day Two

**Day 3: Wednesday, 09<sup>th</sup> of October 2024**

0730 – 0930	<b>Modern Vacuum CB and Switchgear 13.8 KV</b> 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	<b>Switchgear Lifespan</b> Load Effects • Number of Switching Cycles • Mechanical Lifespan • Electrical Lifespan • Ageing
1100 – 1230	<b>Switchgear Lifespan Practice</b> Electrical Lifespan Calculation Exercise
1230 – 1245	Break
1245 - 1420	<b>Switchgear Lifespan Assesment</b> Maintenance Costs • Spare Parts Availability • Suitability with Existing Fault Conditions • Risk Assessment • Cost/Benefit Analysis
1420 – 1430	<b>Recap</b>
1430	Lunch & End of Day Three

**Day 4: Thursday, 10<sup>th</sup> of October 2024**

0730 – 0930	<b>Switchgear Diagnostics &amp; Maintenance</b> 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	<b>Switchgear Inspection, Maintenance &amp; Services</b> 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	<b>Switchgear Troubleshooting</b> 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	<b>Switchgear Troubleshooting (cont'd)</b> 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	<b>Course Conclusion</b>
1400 – 1415	<b>POST-TEST</b>
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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