



COURSE OVERVIEW EE1128 **Advanced Circuit Breaker Operation & Maintenance**

Course Title

Advanced Circuit Breaker Operation & Maintenance

Course Date/Venue

November 30-December 04, 2025/Boardroom 2,
Elite Byblos Hotel, Al Barsha, Sheikh Zayed
Road, Dubai, UAE

Course Reference

EE1128

Course Duration/Credits

Five days/3.0 CEUs/30 PDHs



Course Description



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

This course is designed to provide participants with a detailed and advanced overview of circuit breakers operation and maintenance. It covers the importance of circuit breakers in oil and gas electrical systems and its applications in substations, motors and generators; the classification and operating principles of air, SF₆, vacuum, and oil circuit breakers, arc interruption methods, current breaking capacity and tripping mechanisms; the electrical design, rating parameters and construction and components of circuit breakers; and interrupting medium and dielectric strength standards and applications.



Further, the course will also discuss the control circuits and interlocks covering typical AC/DC control schemes, interlocking mechanisms, control wiring schematics and testing control circuits; the protection schemes in petroleum plants; the breaker operating sequences and breaker failures and protection; the coordination with relays and fuses and breaker communication and remote operation; the preventive maintenance philosophy and visual and mechanical inspection; the electrical testing of circuit breakers, diagnostic techniques and testing equipment and setup; and maintaining different breaker types and the common operational issues.



During this interactive course, participants will learn the root cause analysis (RCA) for failures, corrective and predictive actions and breaker replacement and retrofit strategy; the safety practices during troubleshooting covering lockout-tagout (LOTO), arc flash risk assessment, PPE requirements and isolation procedures; the breaker performance, digitalization and smart breakers and environmental and regulatory compliance; the advanced arc quenching technologies; and the field application in petroleum operations.

Course Objectives

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

- Apply and gain an advanced knowledge on circuit breakers operation and maintenance
- Discuss the importance of circuit breakers in oil and gas electrical systems and its applications in substations, motors and generators
- Explain the classification and operating principles of air, SF₆, vacuum, and oil circuit breakers, arc interruption methods, current breaking capacity and tripping mechanisms
- Identify electrical design, rating parameters and construction and components of circuit breakers as well as interrupting medium and dielectric strength standards and applications
- Recognize control circuits and interlocks covering typical AC/DC control schemes, interlocking mechanisms, control wiring schematics and testing control circuits
- Apply protection schemes in petroleum plants including breaker operating sequences and breaker failures and protection
- Describe coordination with relays and fuses and breaker communication and remote operation
- Carryout preventive maintenance philosophy and visual and mechanical inspection
- Apply electrical testing of circuit breakers, diagnostic techniques and testing equipment and setup
- Maintain different breaker types and identify the common operational issues
- Employ root cause analysis (RCA) for failures, corrective and predictive actions and breaker replacement and retrofit strategy
- Apply safety practices during troubleshooting covering lockout-tagout (LOTO), arc flash risk assessment, PPE requirements and isolation procedures
- Evaluate breaker performance and discuss digitalization and smart breakers and environmental and regulatory compliance
- Carryout advanced arc quenching technologies and implement field application in petroleum operations

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 conveniently saved in a **Tablet PC**.*



Who Should Attend

This course provides an overview of all significant aspects and considerations of advanced circuit breaker operation and maintenance for senior electrical engineers, maintenance technicians and electricians, plant engineers and facility managers, utility technicians, supervisors and team lead in electrical departments, technical trainers and safety officers, third-party service contractors, renewable energy technicians 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

Haward's certificates are accredited by the following international accreditation organizations:

-  British Accreditation Council (BAC)

Haward Technology is accredited by the **British Accreditation Council** for **Independent Further and Higher Education** as an **International Centre**. Haward's certificates are internationally recognized and accredited by the British Accreditation Council (BAC). 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.

-  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.



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 **30 years** of extensive experience in **Circuit Breakers in Petroleum Facilities, Construction & Components of Circuit Breakers, Control Circuits & Interlocks, Oil, Gas, Petrochemical, Refinery & Power** industries. His expertise includes **CEMS Operations and Maintenance, ABB 11KV Distribution Switchgear, Operation & Maintenance of Rotork make MOVs, Maintaining Instrument Air Compressors, 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 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; Circuit Breakers, Switchgears, Transformers, 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.



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.

Accommodation

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

Course Fee

US\$ 5,500 per Delegate + **VAT**. This rate includes H-STK® (Haward Smart Training Kit), buffet lunch, coffee/tea on arrival, morning & afternoon of each day.

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 workshop for technical reasons with no prior notice to participants. Nevertheless, the course objectives will always be met:

Day 1: Sunday, 30th of November 2025

0730 – 0800	Registration & Coffee
0800 – 0815	Welcome & Introduction
0815 – 0830	PRE-TEST
0830 – 0930	Introduction to Circuit Breakers in Petroleum Facilities Importance of Circuit Breakers in Oil & Gas Electrical Systems • Applications in Substations, Motors, and Generators • Types of Faults Managed by Circuit Breakers • Integration with Protective Relays
0930 – 0945	Break
0945 – 1030	Classification & Operating Principles Air, SF ₆ , Vacuum, and Oil Circuit Breakers • Arc Interruption Methods • Current Breaking Capacity • Tripping Mechanisms Overview
1030 – 1130	Electrical Design & Rating Parameters Rated Voltage and Current • Short Circuit Breaking Capacity • Making and Breaking Time Characteristics • Duty Cycle and Operating Sequence (O-3min-CO-3min-CO)
1130 – 1215	Construction & Components of Circuit Breakers Main Contacts, Arcing Contacts, Arc Chutes • Operating Mechanism: Spring vs. Pneumatic vs. Hydraulic • Insulation Components • Auxiliary Contacts and Trip Coils
1215 – 1230	Break



1230 – 1330	Interrupting Medium & Dielectric Strength Comparative Study: Air, Vacuum, SF ₆ , Oil • Dielectric Recovery Characteristics • Environmental Concerns of SF ₆ • Safe Handling and Alternatives
1330 – 1420	Standards & Specifications IEC and ANSI Standards for Circuit Breakers • Compliance with IEEE C37 Series • Testing and Certification Protocols • Nameplate Data Interpretation
1420 – 1430	Recap Using this Course Overview, the Instructor(s) will Brief Participants about the Topics that were Discussed Today and Advise Them of the Topics to be Discussed Tomorrow
1430	Lunch & End of Day One

Day 2: Monday, 01st of December 2025

0730 – 0830	Control Circuits & Interlocks Typical AC/DC Control Schemes • Interlocking Mechanisms (Electrical and Mechanical) • Control Wiring Schematics • Testing Control Circuits
0830 – 0930	Protection Schemes in Petroleum Plants Overcurrent and Short Circuit Protection • Earth Fault Detection and Isolation • Differential Protection • Integration with SCADA and DCS
0930 – 0945	Break
0945 – 1100	Breaker Operating Sequences Open/Close Cycle Behavior • Spring Charging and Energy Storage Mechanisms • Trip-Free Operation • Safety Interlocks During Operation
1100 – 1215	Breaker Failures & Protection Breaker Failure Detection Relays (BF) • Trip Circuit Supervision • Circuit Breaker Health Monitoring • Fail-Safe Designs
1215 – 1230	Break
1230 – 1330	Coordination with Relays & Fuses Time-Current Characteristics (TCC) • Relay Grading and Selectivity • Protection Zones and Discrimination • Fuse and Breaker Coordination
1330 – 1420	Breaker Communication & Remote Operation Remote Switching Schemes • Communication Protocols (IEC 61850, Modbus, DNP3) • Integration with Protective Relay IEDs • Cybersecurity Considerations
1420 – 1430	Recap Using this Course Overview, the Instructor(s) will Brief Participants about the Topics that were Discussed Today and Advise Them of the Topics to be Discussed Tomorrow
1430	Lunch & End of Day Two

Day 3: Tuesday, 02nd of December 2025

0730 – 0830	Preventive Maintenance Philosophy Maintenance Intervals Based on Duty Cycle • Risk-Based Maintenance for CBs • OEM Recommendations vs. Field Practice • Maintenance Documentation
0830 – 0930	Visual & Mechanical Inspection Contact Wear Analysis • Inspection of Arc Chutes and Insulation • Mechanical Alignment and Tension Check • Lubrication and Cleaning
0930 – 0945	Break



0945 – 1100	Electrical Testing of Circuit Breakers Insulation Resistance Test • Contact Resistance Measurement (DLRO) • Timing Tests (Opening/Closing/Travel) • Static and Dynamic Tests
1100 – 1215	Diagnostic Techniques SF ₆ Moisture and Gas Analysis • Partial Discharge Detection • Thermal Imaging and Infrared Scanning • Condition Monitoring Systems
1215 – 1230	Break
1230 – 1330	Testing Equipment & Setup Primary Injection Testing • Secondary Injection Testing for Protection Relays • Motion Analyzer and Contact Travel Test • Test Set Connections and Safety Precautions
1330 – 1420	Maintenance of Different Breaker Types Oil Circuit Breaker Oil Sampling & Filtration • Vacuum Interrupter Testing • SF ₆ Gas Topping and Evacuation • Medium Voltage vs. High Voltage Practices
1420 – 1430	Recap Using this Course Overview, the Instructor(s) will Brief Participants about the Topics that were Discussed Today and Advise Them of the Topics to be Discussed Tomorrow
1430	Lunch & End of Day Three

Day 4: Wednesday, 03rd of December 2025

0730 – 0830	Common Operational Issues Slow Tripping or Non-Operation • Spurious Tripping or Reclosing • Mechanical Jamming or Latch Failure • Control Supply Failure
0830 – 0930	Root Cause Analysis (RCA) for Failures Step-by-Step RCA Methodology • Electrical Signature Analysis • Failure Logs and SCADA Review • Case-Based Discussions
0930 – 0945	Break
0945 – 1100	Corrective & Predictive Actions Contact Tip Replacement • Retrofitting with Digital Relays • Life Extension Strategies • Implementing Predictive Analytics
1100 – 1215	Breaker Replacement & Retrofit Strategy Obsolescence Issues • Upgrading to Vacuum/SF ₆ Breakers • Retrofitting in Legacy Panels • Cost-Benefit Evaluation
1215 – 1230	Break
1230 – 1330	Safety Practices During Troubleshooting Lockout-Tagout (LOTO) • Arc Flash Risk Assessment • PPE Requirements • Isolation Procedures
1330 – 1420	Troubleshooting Simulation & Exercises Interpreting Breaker Behavior • Hands-On Simulated Fault Finding • Interactive Fault Scenarios • Team-Based Troubleshooting Task
1420 – 1430	Recap Using this Course Overview, the Instructor(s) will Brief Participants about the Topics that were Discussed Today and Advise Them of the Topics to be Discussed Tomorrow
1430	Lunch & End of Day Four



Day 5: Thursday, 04th of December 2025

0730 – 0830	Breaker Performance Evaluation CBM vs. TBM Strategies • Analyzing Trip Logs • Load and Fault Current Trends • Performance Benchmarking
0830 – 0930	Digitalization & Smart Breakers IoT-Enabled Breakers • Condition Monitoring and Diagnostics • Cloud-Based CB Data Analysis • Integration with Energy Management Systems
0930 – 0945	Break
0945 – 1115	Environmental & Regulatory Compliance SF ₆ Management Guidelines • EPA Reporting and Monitoring • Recycling and Leak Detection • Environmental Footprint Reduction
1115 – 1245	Advanced Arc Quenching Technologies Magnetic Arc Blowout • Hybrid Interruption Methods • Vacuum Interrupter Improvements • Next-Gen Arc Control Devices
1245 – 1300	Break
1300 – 1345	Field Application in Petroleum Operations Offshore/Onshore Installation Considerations • Corrosion and Humidity Effects • Maintenance Challenges in Hazardous Areas • ATEX/IECEx Compliance
1345 – 1400	Course Conclusion Using this Course Overview, the Instructor(s) will Brief Participants about Topics that were Covered During the Course
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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