COURSE OVERVIEW EE1128
Advanced Circuit Breaker Operation & Maintenance

Course Title
Advanced Circuit Breaker Operation & Maintenance

Course Date/Venue
June 01-05, 2025/Sahra Meeting Room, Al Bandar Rotana – Creek, Dubai, UAE

Course Reference
EE1128

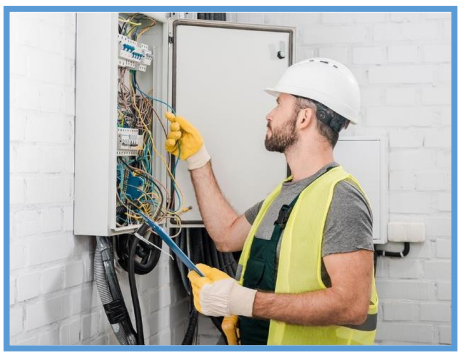
Course Duration/Credits
Five days/3.0 CEUs/30 PDHs

Course Description

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

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, SF_6, 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, SF_6, 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:

(1) Dr. Ahmed El-Sayed, PhD, MSc, BSc, is a **Senior Electrical & Instrumentation Engineer** with over **30 years** of extensive experience in the **Power**, **Petroleum**, **Petrochemical** and **Utilities**. He specializes in **Circuit Breaker**, **Breaker** Replacement Strategy, Digitalization & **Smart Breakers**, Advanced Arc Quenching Technology, **Circuit Breaker** in Petroleum Facilities, **Breaker** Failures & Protection,Electrical Testing of **Circuit Breaker, HV/LV Equipment**, **High Voltage Electrical Safety**, **LV & HV Electrical System**, **HV Equipments Inspection & Maintenance**, **HV Switchgear Operation & Maintenance**, **LV Distribution Switchgear & Equipment**, **HV Switchgear Maintenance**, **HV/LV Electrical** Authorisation, **Hazardous Area Classification, Power Quality**, **Disturbance Analysis**, **Blackout**, **Power Network**, **Power Distribution**, **Power Systems Control**, **Power Systems Security**, Power **Electronics**, **ETAP**, Electrical **Substations**, Tariff Design & Structure Analysis, **Engineering Drawings, Codes & Standards**, **P&ID Reading, Interpretation & Developing**, **PLC**, **SCADA**, **DCS**, **Process Control**, **Instrumentation**, **Automation**, Power **Generation**, **Process Control Instrumentation**, **SIS**, **SIL**, **ESD**, **Alarm Management Systems**, **Fieldbus Systems** and **Fiber Optics** as well as the service pricing of these. He is currently the **Systems Control Manager** of **Siemens** where he is in-charge of Security & Control of Power **Transmission Distribution** & **High Voltage** Systems and he further takes part in the Load Records Evaluation & Transmission Services Pricing.

During his career life, Dr. Ahmed has been actively involved in different Power System Activities including Roles in Power System Planning, Analysis, Engineering, **HV Substation** Design, Electrical Service Pricing, Evaluations & Tariffs, Project Management and also in Teaching and Consulting. His vast industrial experience was honed greatly when he joined many International and National Companies such as **Siemens**, **Electricity Authority** and **ACETO** industries where he focused more on dealing with Technology Transfer, System Integration Process and Improving Localization. He was further greatly involved in manufacturing some of **Power System** and **Control & Instrumentation Components** such as Series of Digital Protection **Relays**, MV **VFD**, **PLC** and **SCADA** System with intelligent features.

Dr. Ahmed is well-versed in different electrical and instrumentation fields like Load Management Concepts, **PLC** Programming, Installation, Operation and Troubleshooting, **AC Drives** Theory, Application and Troubleshooting, Industrial Power Systems Analysis, AC & DC **Motors**, Electric Motor **Protection**, **DCS SCADA**, **Control** and Maintenance Techniques, Industrial Intelligent Control System, **Power Quality** Standards, Power Generators and Voltage Regulators, Circuit Breaker and Switchgear Application and Testing Techniques, **Transformer** and **Switchgear** Application, Grounding for Industrial and Commercial Assets, Power Quality and **Harmonics**, **Protective Relays** (O/C Protection, Line Differential, Bus Bar Protection and **Breaker Failure Relay**) and Project Management Basics (PMB).

Dr. Ahmed has **PhD**, **Master's** & **Bachelor's** degree in **Electrical** and **Instrumentation Engineering** from the **University of Wisconsin Madison**, **USA**. Further, he has numerous papers published internationally in the areas of Power Quality, Superconductive Magnetic Energy Storage, SMES role in Power Systems, Power System **Blackout** Analysis, and Intelligent Load Shedding Techniques for preventing Power System Blackouts, HV **Substation Automation** and Power System Stability.

AND,

(2) Mr. Herman Eksten, PE, PgDiP, is a **Senior Electrical Engineer** with over **30 years** of extensive experience **Oil**, **Gas**, **Petrochemical**, **Refinery** & **Power** industries and **Water & Utilities** specializing in **Electrical Safety**, Certified **HV Electrical Safety**, **Low Voltage Electrical Safety**, **Electrical Circuits**: Series and Parallel Connection, **Electrical Faults & Protective Devices**, **Renewable Energy Integration**, **Smart Grid** & **Renewable Integration**, **Renewable Energy** Storage Systems, **Renewable Energy** Economics & Finance, Risk Control Methods, **LOTO – Breakers** Operation in Electricity Substation, **LOTO** Principles and Procedures, **Arc Flash Risk Assessment**, Safety in **Power Electronic Equipment & Lasers**, **Circuit Breakers & Switchgears**, **Switchgear Assets Management**, **Circuit Breakers Control Circuits**, **Substation Maintenance** Techniques, **High Voltage Operation, Electrical Protection**, **Overhead Lines & Substation**, **Power Supply**, **High Voltage Substation**, **Electrical Protection Design**, **Earthing & Lightning Protection Design, Underground Equipment**, **Distribution Network Maintenance & Construction**, **Transformers Operation & Maintenance**, **Electric Power System, Power Plant Management**, **Substation Commissioning & Troubleshooting**, **Cable Splicing & Termination, Electrical Installation & Maintenance**, **Power Generation Operation & Control, Switchgear Life Assessment**, **Structured Cabling, Electric Power System, Power System Stability, Power System Planning & Economics**, **Power Flow** Analysis, **Combined Cycle Power Plant**, **UPS & Battery System, Variable Speed Drives,** and **HV Motors & Transformers**. He is currently the **Lead Electrical Engineer** of **SNC-LAVALIN** wherein he is responsible for basic designs and successful implementation of electrical engineering to plant overhead lines and substations.

During his career life, Mr. Eksten held various positions such as the **Lead Electrical Engineer**, **Operations Manager**, **Project Engineer**, **Technical Specialist**, **Customer Executive**, **District Manager**, **Electrical Protection Specialist**, **High-Voltage Operator** and **Apprentice Electrician** for FOX Consulting, UHDE (ThyssenKrupp Engineering), TWP Projects/Consulting (EPMC-Mining), ISKHUS Power, Rural Maintenance (PTY) Energia de Mocambique Lda., Vigeo (PTY) Ltd and ESKOM.

Mr. Eksten is a **Registered Professional Engineering Technologist** and has a Postgraduate Diploma in Management Development Programme and a National Higher Diploma (NHD) in Electrical Power Engineering. Further, he is a **Certified Instructor/Trainer**, a Senior member of the South African Institute Electrical Engineers (**SAIEE**) and holds a Certificate of Registration Membership Scheme from the Engineering Council of South Africa (**ESCA**). He has further delivered numerous trainings, courses, seminars, workshops and conferences internationally.

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.

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

Day 1 ***Sunday, 01st of June 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, 02nd of June 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, 03rd of June 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, 04th of June 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*

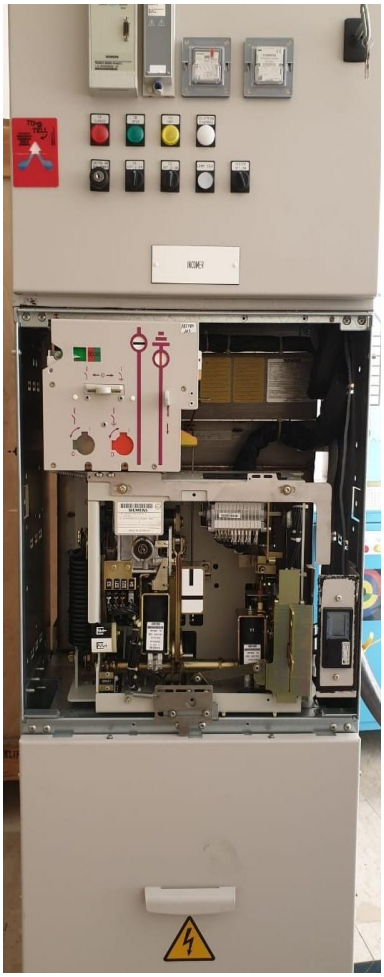
Day 5 Thursday, 05th of June 2025

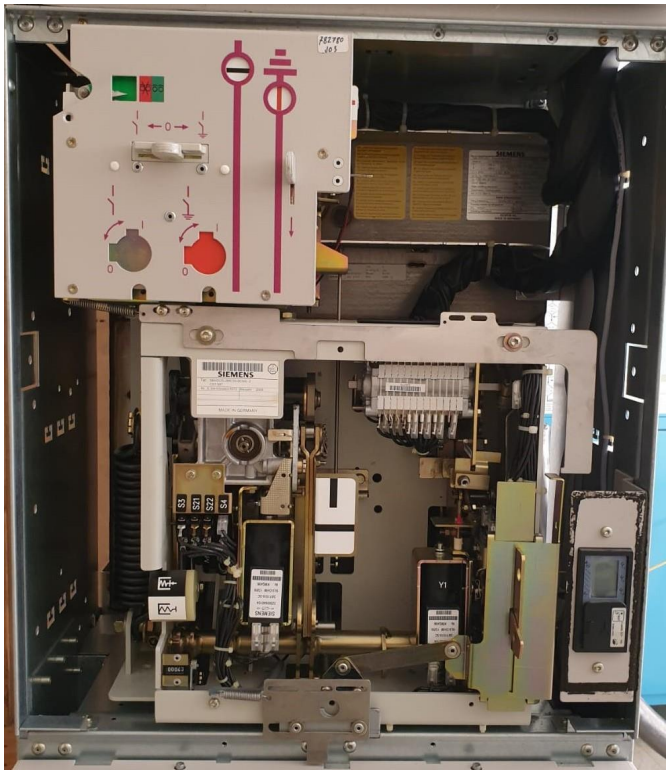
0730 – 0830	***Breaker Performance Evaluation*** *CBM vs. TBM Strategies • Analyzing Trip Logs • Load and Fault Current Trends • Performance Benchmarking*
0830 – 0930	***Digitalization & Smart Breakers*** *IoT-Enabled Breakers • Condition Monitoring and Diagnostics • Cloud-Based CB Data Analysis • Integration 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 t Topics that were Covered During the Course*
1400 – 1415	***POST-TEST***
1415 – 1430	*Presentation of Course Certificates*
1430	*Lunch & End of Course*

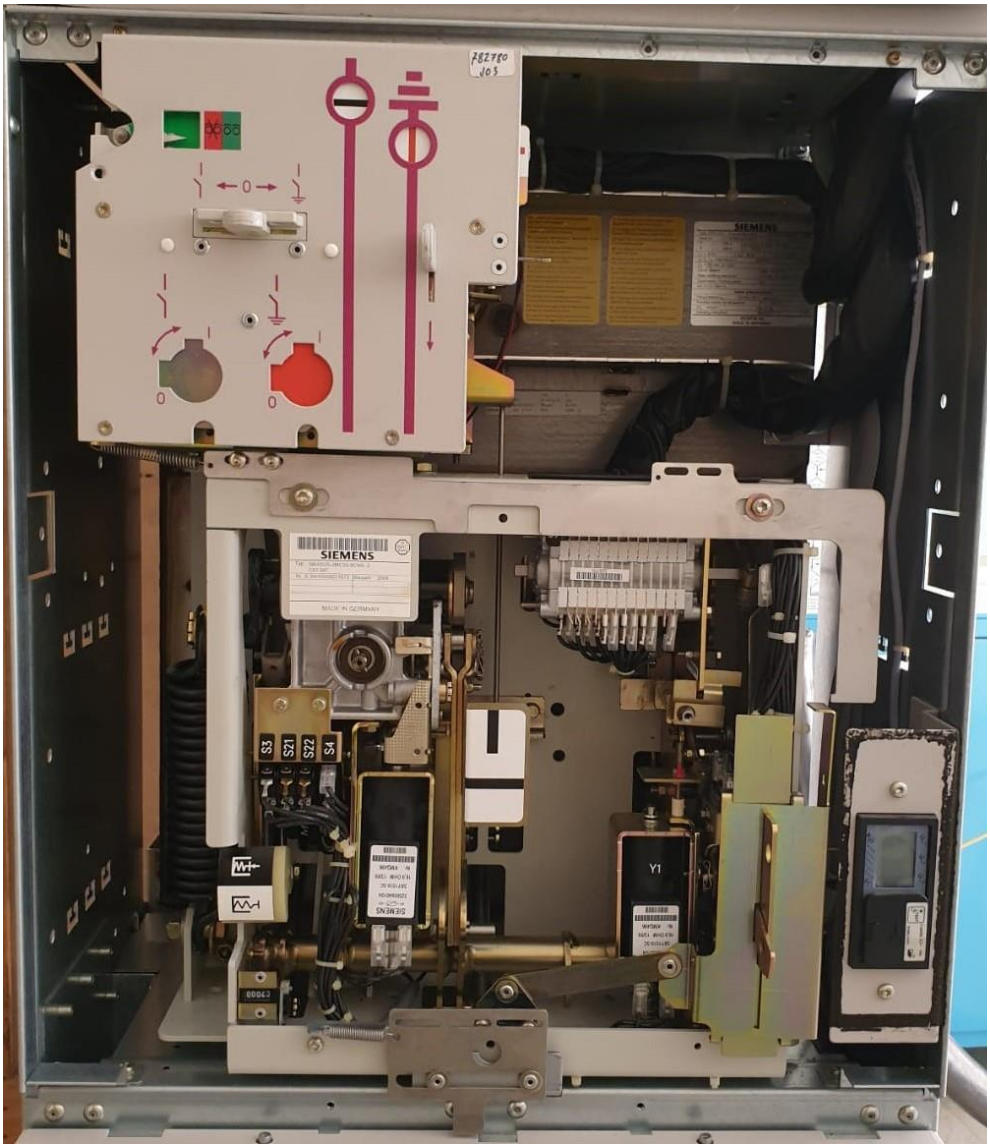
Simulators (Hands-on Practical Sessions)

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 "Switchgear Simulator", "GE Multilin Relay 469" and "GE Multilin Relay 750".





Switchgear Simulator



Switchgear Simulator

GE Multilin Relay 469 Simulator

GE Multilin Relay 750 Simulator

Course Coordinator

Mari Nakintu, Tel: +971 2 30 91 714, Email: mari1@haward.org