COURSE OVERVIEW EE0800-4D

Generator Operation, Maintenance, Control, Testing & Troubleshooting

Course Title

Generator Operation, Maintenance, Control, Testing & Troubleshooting

Course Reference

EE0800-4D

Course Duration/Credits

Four days/2.4 CEUs/24 PDHs

Course Date/Venue

Session(s)	Date	Venue
1	August 12-15, 2024	Boardroom 1, Elite Byblos Hotel Al Barsha, Sheikh Zayed Road, Dubai, UAE
2	November 04-07, 2024	Oryx Meeting Room, Doubletree By Hilton Doha-Al Sadd, Doha, Qatar

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.

This course is designed for those who have a need to understand most aspects of power plant GENERATORS. The course addresses Theory of Generator Operation, Design Considerations, Construction, Relationships to the System, Excitation Systems, Auxiliaries, Normal/Abnormal Operations, Protective Relaying associated with the Generator, Outage Planning, Disassembly, Inspection/Repair, and Reassembly.

There are NO SMALL PROBLEMS when it comes to the GENERATOR!! The Design, Construction, Operations, Safety, Testing, Inspection/Repair as well as disassembly/reassembly shall be fully understood. Register for this course today and get the answers to the all questions including:

- How does a generator function?
- Why is it designed as it is?
- What happens if the generator is synchronized out-of-phase?
- What happened in the control room such that one would make such a large error when synchronizing?
- How can we avoid such an error?
- Just how bad (and what is) negative phase sequence currents?
- Corona discharge what does that mean?
- How do you repair fused stator punchings?

- What components should be high-potential tested?
- How can we avoid accidental injury when testing the generator?
- What are the probable causes of grounded fields?
- Why have we (recently) heard of hydrogen explosions? How do we avoid?
- And the list of answered questions goes on!!!

Course Objectives

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

- Apply systematic techniques in operation, maintenance, control, testing and troubleshooting of power generators
- Determine how a generator functions and how an active and reactive power is generated and how these loads are shared from one generator to another
- Identify the major components used in the construction of an AC generator and discuss how these components are at risk during mis- or abnormal operations
- Explain operation and maintenance of the most common excitation systems and how a speed governor alters generator output in response to a frequency deviation
- Discuss how the voltage regulator alters generator output in response to a voltage deviation
- Identify the causes and effects of both voltage and frequency oscillations and the impact on power system dynamics
- Describe generator normal/safe startup and shutdown procedures and generator synchronizing process
- Discuss abnormal generator operation, recommend actions for generator protection during an unfortunate abnormal condition and describe possible results to equipment and/or system
- Describe the major activities associated with generator maintenance, proper generator disassembly and reassembly sequences, procedures for cleaning generator components, procedures for inspection of generator components and describe the different types and causes of damage
- Identify the various repair methods for defective component condition and list all those electrical tests commonly performed on large AC generators
- Describe the procedures for the various generator tests and describe safety precautions for the conducting of these electrical tests

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**.*

Who Should Attend

This course provides an overview of all significant aspects and considerations of generator for those who are involved in the operation, maintenance, control, testing and troubleshooting of power plant generators including electrical, plant maintenance, utility, mechanical and control 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.

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. Salah Zuriekat, BSc, PMP, is a **Senior Electrical Engineer** with extensive years of experience within the **Power & Water Utilities** and other **Energy** sectors. His expertise widely covers **Cyber Security of Distributed Control System (DCS)**, **SCADA Cyber Security**, **Cyber Security** Fundamentals, **Variable Frequency Drives** (VFD), **PLC & SCADA** for Automation & Process Control, **DCS** Automated Process Control Systems, **PLC** for Process Control & Automation, **Process Control** Techniques & Troubleshooting, **Control Valves & Actuators**, Safety Integrity Level (**SIL**), **Transformer Maintenance & Testing**, **Electrical Substation & Design**, **Power Quality** Studies & Load Criteria, LV/MV Electrical Safety (**11 KV, 415 & 220 Voltage**), **Substation Earthing System**, **Electrical Equipment** Maintenance, **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, **Cables & Wiring**, **Cable & Overhead Line** Quality Control & Inspection, **Overhead Transmission Lines**, **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**, High & Low Voltage **Electrical Safety**, **Electrical Inspection** & Testing, **Electrical Control** & Monitoring System, **Electric Power System**, Intensive Overhead **Transmission** Line (OHTL), **Transmission** Line Networks, **Distribution** Engineering, HVDC **Transmission** & Control, **Substation** Maintenance Techniques, **Electrical Drawings** & **Schematics**, **Distribution Networks** & **Load Forecasting**, **Power Generation**, **Overhead Power Line** Construction & Patrolling, and **Generator** Maintenance & Troubleshooting. He is currently the **Electrical Construction Manager** of Hiba Engineering Construction wherein he is involved in managing and supervising electrical engineers, electricians and other electrical personnel to ensure proper staffing levels and effective teamwork.

Mr. Salah gained his expertise and experience through several positions as an **MEP Manager**, **Project Manager**, **Senior Electrical Project Engineer**, **Electromechanical Project Engineer**, **Site Engineer**, **Sales Engineer**, **Maintenance Engineer**, **MEP Coordinator** and **Senior Instructor/Trainer** for various companies such as the Al Menthar of Medical investment, Drake & Scull International Company (DSI), Axal Arabia Contracting Company (SBG), Alsamah Contracting Company, Control & Communication Company (CCC) and Spectrum Company.

Mr. Salah has a **Bachelor's** degree in **Electrical Engineering**. Further, he is a **Certified Instructor/Trainer**, a **Certified Project Manager Professional** (**PMI-PMP**) 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

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.
Doha	**US$ 5,500** per Delegate. This rate includes H-STK® (Haward Smart Training Kit), 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

0730 – 0800	*Registration & Coffee*
0800 – 0815	*Welcome and Introduction*
0815 – 0830	***PRE-TEST***
0830 – 0930	***Generator Theory*** *Armature Reaction ● Resistive Loads ● Inductive Loads ● Capacitive Loads ● Power Transfer and Load Angle ● Reactive Power ● Net Air Gap ● Developed Torque ● Watt and VAR Control ● Generator Capability ● Stator Winding Heating ● Field Heating ● Core End Iron Heating ● Power System ● Power Transfer Between Generator Rotor and Stator ● Short Circuit Ratio*
0930 – 0945	*Break*
0945 – 1100	***Generator Theory (Lite)*** *Fundamentals of Generator Design ● Review of AC Power ● Armature Reaction ● Development of Torque ● Net Air Gap Magnetic Fields ● Effects of VARs on Current ● Effect of VARs on Voltage ● Active and Reactive Power Flow ● Generators Operating Under Load ● Changing MW Load ● Changing MVAR load*
1100 – 1230	***System Operations*** *Structure of the Power System ● Interconnections ● Power Balance ● Operation of the System ● State of the Power System*

1230 – 1245	*Break*
1245 – 1420	***Generator Construction*** *Stator Frame ● Core, Windings ● End Shield ● Rotor Body ● Field Windings ● Retaining Rings ● Collector Rings ● Hydroelectric Differences*
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

0730 – 0930	***Excitation Systems, Voltage & Frequency Control*** *Speed Governor Response to Frequency Deviations ● Automatic Voltage Regulator Response to Voltage Deviations ● Manual Regulator ● URAL ● Impedance Compensator ● Volts/Hertz ● Maximum Excitation Limit ● Transfer & Tracking ● PSS ● De-Excitation ● Steady State Operation ● Transient Conditions ● Earlier Excitation Systems ● Rotating AC Exciters ● Alterrex ● Brushless Excitation Systems ● Static Excitation Systems*
0930 – 0945	*Break*
0945 – 1100	***Generator Auxiliary Systems*** *Purpose and Operations of the Generator Hydrogen Control System ● Generator Seal Oil System ● Stator Liquid Cooling System (as required)*
1100 – 1230	***Normal Operations*** *Preparation for Start-Up ● Synchronizing ● Load Changes ● Use of Reactive Capability Curve ● Shut-down*
1230 – 1245	*Break*
1245 – 1420	***Abnormal Operations: Relationships Between Operations, Protection and Alarms; Alarms, Protection when Off-Line, Tripping Methods, Protective Actions for Generator Faults and Abnormal Operations & Protection Recommendations*** *System Steady & Dynamic Conditions ● Frequency Deviations ● Voltage Deviations ● Instabilities ● Loss of Synchronism ● Stator Overcurrent ● Field Ground ● Stator Ground Fault ● Stator Phase-to-Phase Fault*
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

0730 – 0930	***Abnormal Operations: Relationships Between Operations, Protection and Alarms; Alarms, Protection when Off-Line, Tripping Methods, Protective Actions for Generator Faults and Abnormal Operations & Protection Recommendations: (cont'd)*** *Over Voltage ● Over Volts-per-Hertz ● Field Overheating ● Loss of Excitation ● Bearing Vibration ● Synchronizing Errors ● Motoring ● Seal Oil System Pressure ● Stator Coolant System ● Local Overheating ● Unbalanced Armature Currents ● Breaker Failures ● System Back Up ● Voltage Surges ● Transmission Line Planned Switching ● High Speed Reclosing ● Accidental Energization*
0930 – 0945	*Break*

0945 – 1100	***Outage Planning & Scheduling*** *Why Maintenance ● Preparation ● Tooling ● Documentation ● Pre-Shutdown Maintenance ● Decision Making*
1100 – 1230	***Generator Mechanical Maintenance Activities*** *Why Generators Fail ● Special Tools ● Spare Parts ● Safety Precautions ● Disassembly/Reassembly Procedure ● Cleaning and Checklists*
1230– 1245	*Break*
1345 – 1420	***Stator Visual Inspection*** *Loose Slot Wedges ● Discoloration ● Loose Punchings ● Bar Vibration ● Girth Cracks ● Corona ● Loose/Broken Ties ● Liquid Connections ● Air Baffles ● Oil Deflectors ● Hydrogen Seals*
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

0730 – 0930	***Rotor Visual Inspection*** *Collector Rings ● Rotor Journal Surface ● Terminal Studs ● Hydrogen Seal Areas ● Axial Flow Fans ● End Turns ● Field Slot Wedges ● Retaining Rings*
0930 - 0945	*Break*
0945 - 1100	***Purpose of Generator Electrical Tests*** *Safety Considerations*
1100 - 1230	***STATOR*** *Winding Resistance ● Insulation Resistance ● Dielectric Absorption ● Direct Current Leakage ● Dissipation Factor Test ● Radio Noise (Corona) ● High Potential Test ● Ring Test*
1230 - 1245	*Break*
1245- 1345	***ROTOR*** *Resistance Test ● PI ● Impedance Testing ● Flux Pattern Test ● Pole Drop ● High Potential Testing ● Air Gap Flux Probe Testing*
1345 - 1400	***Course Conclusion*** *Using this Course Overview, the Instructor(s) will Brief Participants about the Course 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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