COURSE OVERVIEW EE0320-3D
Fault Analysis in Electrical Networks & Distribution Cables
Power Systems Troubleshooting

Course Title

Fault Analysis in Electrical Networks & Distribution Cables: *Power Systems Troubleshooting*

Course Date/Venue

September 20-22, 2020/Boardroom 3, Elite Byblos Hotel Al Barsha, Sheikh Zayed Road, Dubai, UAE

Course Reference

EE0320-3D

Course Duration/Credits

Three days/1.8 CEUs/18 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.

The detection of faults on electrical distribution systems has been one of the most persistent and difficult problems facing the electric utility industry. The performance and characteristics of electrical system configurations are vital factor in reducing or increasing the effect of faults on the system as earthing system, switch gear, protective relays, active and reactive power generation, etc. Protective systems are designed to sense faults and initiate fault clearing in a timely manner while minimizing the affected area. Protective relays are used to sense the faults and initiate circuit breakers tripping. Alternatively, fuses are used on the distribution system to sense and clear faults.

Electrical faults can cause severe damage when not interrupted promptly. In some cases, high-impedance fault currents may be insufficient to operate protective relays or blow fuses. Standard overcurrent protection schemes utilized on secondary distribution at some industrial, commercial and large residential buildings may not detect high-impedance faults, commonly called arcing faults.

In these cases, more careful design techniques, such as the use of ground fault circuit interruption, are required to detect arcing faults and prevent burndown. When a short-circuit fault occurs, the fault path explodes in an intense arc. Local customers endure an interruption and customers farther away, a voltage sag; faults cause most reliability and power quality problems. Faults kill and injure line operators. Crew operating practices, equipment and training must account for where fault arc are likely to occur and must minimize crew exposure. When faults occur, we have ways to reduce their impacts. This course focuses on the general characteristics of faults and specific analysis of common fault types with suggestions on how to reduce them.

This course is designed to present methods of Electrical Fault analysis, causes, detection and remedies in Electrical Networks and Distribution Cables, particularly with the aid of a personal computer and Power System Simulator. The approach is designed to develop participant's thinking process, enabling them to reach a sound understanding of a broad range of topics related to electrical faults, while motivating their interest in the electrical power industry. The course includes many case studies describing present day, practical applications. Those case studies and exercises will be solved in the class.

Course Objectives

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

- Apply and gain an in-depth knowledge on fault analysis in electrical networks and distribution cables covering power systems troubleshooting
- Discuss the basic concepts covering main electric parameters and laws, standards, regulations and voltages
- Identify the types of faults and their effects as well as differentiate symmetrical faults, unsymmetrical faults, arc characteristics and symmetrical components
- Explain limiting fault currents and identify the various faults and types of transformers and equipments
- Determine system grounding covering generation, transformers, transmission, distribution and power system
- Illustrate protection and switching equipment tripping devices for circuit breakers, protection devices, technology and instrument transformers
- Employ grading and protection co-ordination, distance and differential protections, transformer protection, generator protection, overhead lines protection, cable protection, motor protection and miscellaneous protections
- Carryout protection relay management, reclosing practices and single-phase protective devices
- Perform electrical system restoration and electrical maintenance program

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 covers systematic techniques of fault analysis in electrical networks and distribution cables for engineers, supervisors and other technical staff who work in transmission, distribution, maintenance, operation, control and analysis of utilities and industrial electrical networks.

Course Certificate(s)

Internationally recognized certificates will be issued to all participants of the course.

Certificate Accreditations

Certificates are accredited by the following international accreditation organizations:-

- USA International Association for Continuing Education and Training (IACET)

  Haward Technology is an Authorized Training Provider by the International Association for Continuing Education and Training (IACET), 2201 Cooperative Way, Suite 600, Herndon, Virginia 20171, USA. In obtaining this authority, Haward Technology has demonstrated that it complies with the **ANSI/IACET 1-2013 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 1-2013 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 Association 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 **1.8 CEUs** (Continuing Education Units) or **18 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. Herman Eksten, PE, PgDiP, is a **Senior Electrical Engineer** with over **40 years** of extensive experience within the **Petrochemical**, **Oil & Gas** and **Power** industries specializing in **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.

Course Fee

US$ 3,750 per Delegate + **5% VAT**. 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.

Training Methodology

This interactive training course includes the following training methodologies as a percentage of the total tuition hours:-

30% Lectures
20% Workshops & Work Presentations
20% Case Studies & Practical Exercises
30% Videos, Software & Simulators

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

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Day 1: Sunday, 20th of September 2020

0730 – 0800	*Registration & Coffee*
0800 – 0815	*Welcome & Introduction*
0815 – 0830	***PRE-TEST***
0830 – 0845	***Basic Concepts*** *Introduction to Troubleshooting & Fault Analysis in Electrical Networks & Distribution Cables●Main Electric Parameters & Laws● Standards & Regulations ● Standard Voltages*
0845– 0900	***Faults & Their Effects*** *Types of Faults ● Causes of Faults(Internal and External) ● High-Impedance Faults●Lightning, Switching Overvoltage and Use of Surge Arresters ● Short-circuit Faults (Phase and Earth Faults) ● The Effect of Faults On Equipment (Thermal and Electromechanical Stress) ●Short-circuit Calculations*
0900– 0930	***Symmetrical and Unsymmetrical Faults*** *Series R-L Circuit Transients ● System Representation ●Sequence Bus Impedance Matrices*
0930 – 0945	*Break*
0945 – 1030	***Arc Characteristics***
1030 – 1130	***Symmetrical Components*** *Definition of Symmetrical Components ● Sequence Networks of Impedance Loads ● Sequence Networks of Series Impedances ● Sequence Networks of Three-Phase Lines ●Sequence Networks of Rotating Machines ●Per-Unit sequence Models of Three-Phase Two-Winding Transformers ● Per-Unit Sequences Models of Three-Phase Three-Winding Transformers ● Power in Sequence Networks*
1130 – 1230	***Limiting Fault Currents***
1230 – 1245	*Break*

1245 – 1300	***Faults on Transformers*** *Types of Transformers ● Transformers Parameters ● Transformer Connections Fault Profiles ● Internal Faults &Protections ● Secondary Faults ● Primary-to-Secondary Faults*
1300 – 1320	***Equipment Faults*** *Generators ● Switchgears ● Motors ●Overhead Lines ● Underground Cables ● Fault Location*
1320 – 1420	***System Grounding*** *Solid, Impedance & Ungrounded Systems ● Generation Units ● Power Transformers ● Transmission Lines ● Distribution System ● Arrangement of Grounding in Power System● Touch & Step Potentials●Earth Grid & Calculations*
1420 – 1430	***Recap***
1430	*Lunch & End of Day One*

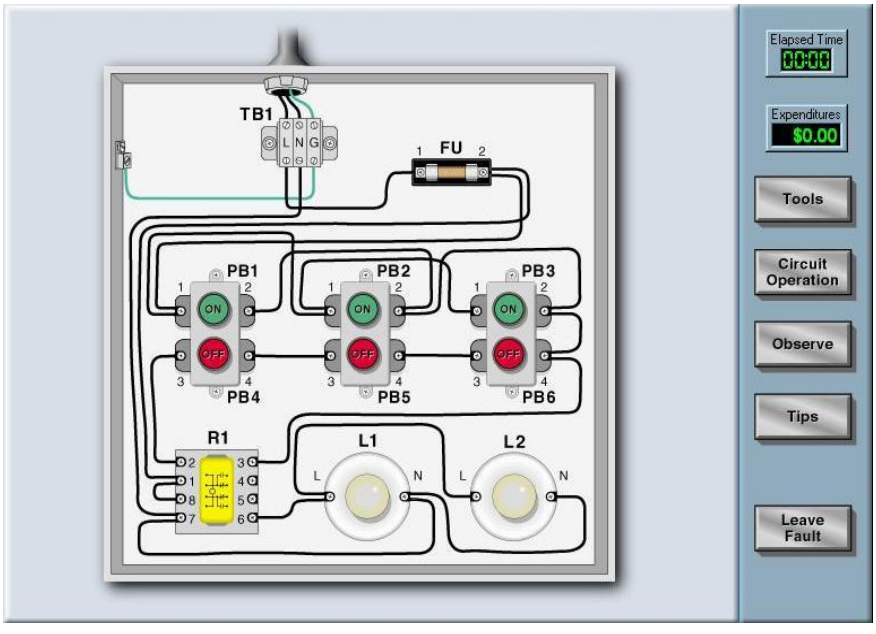
Day 2: ***Monday, 21st of September 2020***

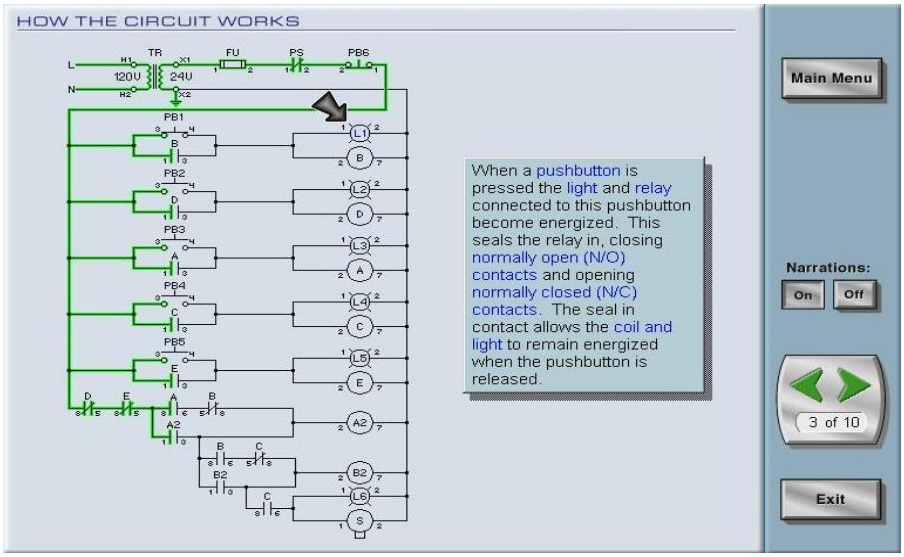
0730 – 0830	***Protection & Switching Equipment*** *Switches ●Isolators ● Fuses*
0830– 0900	***Tripping Devices – Circuit Breakers*** *The Mechanism of Electric Arc Breakdown ● Types of Circuit Breakers & Applications (LV, MV & HV) ● Main Characteristics ● Operating Mechanism, Tripping Circuits & Control Systems ● Reclosers*
0900 – 0930	***Protection Devices & Technology*** *Introduction to Protection● Protection Relays (History; Construction & Principles of Operation; Modern Technology) ● Classification of Protection Relays & Codes ● Main Protection & Back-up Protection ● Intelligent Electronic Devices (IED's) ● Fuses (Characteristics, Applications & Special Cares) ● Examples & Exercises*
0930 – 0945	*Break*
0945 – 1045	***Instrument Transformers*** *Current & Voltage Transformers● Types, Construction, Performance, Specification & Applications● Magnetisation Curve & Characteristics (Ratio, Accuracy & Burden Power) ●Testing ● Examples*
1045 – 1130	***Grading & Protection Co-ordination*** *Principles● Analysis in HV, MV & LV Networks (Transmission & Distribution Networks; Users' Networks) ● Calculation of Settings ● LV Approach (Typical Time-Current Curves & Selectivity of LV Circuit Breakers) ● Recloser-Recloser Coordination ● Coordinating Instantaneous & Timed Elements ● Practical Examples*
1130 – 1230	***Distance & Differential Protections***
1230 – 1245	*Break*
1245 – 1320	***Transformer Protection***
1320 – 1420	***Generator Protection***
1420 – 1430	***Recap***
1430	*Lunch & End of Day Two*

Day 3:	Wednesday, 22nd of September 2020
0730 – 0830	***Overhead Lines Protection***
0830– 0900	***Cable Protection***
0900– 0930	***Motor Protection***
0930 – 0945	*Break*
0945 – 1100	***Miscellaneous Protections***
1100 – 1130	***Protection Relay Management*** *Scheme Design ● SCADA Control of the Protection Scheme ● Adaptive Control by Phases ● Maintenance & Testing*
1130 – 1215	***Reclosing Practices*** *Reclose Attempts & Dead Times ● Immediate Reclose ● Reclosing with Live Works*
1215 – 1230	*Break*
1230 – 1300	***Single-Phase Protective Devices*** *Single-Phase Reclosers with Three-Phase Lockout*
1300 – 1320	***System Restoration*** *Brown-out●Black-out*
1320 – 1345	***Electrical Maintenance Program*** *Maintenance Actions ● Testing Intervals ● International Electrical Testing Association (NETA) Specifications*
1345 – 1400	***Course Conclusion***
1400 – 1415	***POST-TEST***
1415 – 1430	*Presentation of Course Certificates*
1430	*Lunch & End of Course*

Simulator (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 simulator "Simutech Troubleshooting Electrical Circuits V4.1".





Simutech Troubleshooting Electrical Circuits V4.1

Course Coordinator
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