COURSE OVERVIEW EE0406
ABB Generator-Session 1
(E-Learning Module)

Course Title
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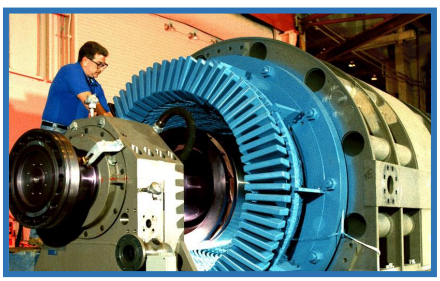
Course Reference
EE0406

Course Format & Compatibility
SCORM 1.2. Compatible with IE11, MS-Edge, Google Chrome, Windows, Linux, Unix, Android, IOS, iPadOS, macOS, iPhone, iPad & HarmonyOS (Huawei)

Course Duration
30 online contact hours
(3.0 CEUs/30 PDHs)

Course Description



This E-learning course is designed to provide participants with a detailed and up-to-date overview of ABB generators. It covers the electrical generators, electromagnetism, basic principle of a generator, electromagnetic effect, commutator and brushes; the DC generator components, basic DC generator, alternators and the three phase alternators; the typical alternator assembly, alternator coil (winding) connection and rotor assembly; the two types of rotors comprising of the salient-pole rotor and the cylindrical rotor; the winding temperature and winding insulation ratings; and the neutral earthing resistor and insulated bearings.

During this course, participants will learn the excitation of generators, conventional excitation, static excitation and brushless excitation; the three phase's synchronous generator and the advantage of 3-phase generator; the electromotive force for each stator winding and generator protection in accordance with ANSI Codes for protection; the typical one line diagram generator protection and the details for generator protections; the regulation of voltage, paralleling and synchronizing of generators; and the coupling operations with a synchronoscope and parallel control operation; and the startup and stopping of generator sets and machine protection.

Course Objectives

Upon the successful completion of this course, participants will be able to:-s

- Apply and gain an in-depth knowledge on ABB generators
- Describe electrical generators, electromagnetism, basic principle of a generator, electromagnetic effect, commutator and brushes
- Identify DC generator components, basic DC generator, alternators and the three phase alternators
- Perform typical alternator assembly, alternator coil (winding) connection and rotor assembly
- Recognize the two types of rotors comprising of the salient-pole rotor and the cylindrical rotor
- Determine winding temperature and review winding insulation ratings
- Describe neutral earthing resistor and insulated bearings as well as employ excitation of generators, conventional excitation, static excitation and brushless excitation
- Recognize the three phase's synchronous generator and explain the advantage of 3-phase generator
- Apply electromotive force for each stator winding and carryout generator protection in accordance with ANSI codes for protection
- Employ typical one line diagram generator protection and discuss the details for generator protections
- Regulate voltage as well as parallel and synchronize generators
- Carryout coupling operations with a synchronoscope and parallel control operation
- Start and stop generator sets and apply machine protection

Who Should Attend

This course provides an overview of all significant aspects and considerations of ABB generators for engineers, supervisors, foremen and other technical maintenance and operational staff.

Training Methodology

This Trainee-centered course includes the following training methodologies:-

- Talking presentation Slides (ppt with audio)
- Simulation & Animation
- Exercises
- Videos
- Case Studies
- Gamification (learning through games)
- Quizzes, Pre-test & Post-test

Every section/module of the course ends up with a Quiz which must be passed by the trainee in order to move to the next section/module. A Post-test at the end of the course must be passed in order to get the online accredited certificate.

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, VA 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 **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.

- 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 Fee

As per proposal

Course Contents

- Electrical Generators
- Generators
- Electromagnetism
- Basic Principle of a Generator
- Electromagnetic Effect
- Commutator & Brushes
- DC generator
- DC Generator components
- Basic DC Generator
- Alternators
- Three Phase Alternators
- Basic Three Phase Alternator
- Alternator Components
- Typical Alternator Assembly
- Why Three Phase
- Alternator Coil (Winding) Connection
- Prime Movers
- Typical Examples of Prime Movers
- Turbo-generators 2 x 10 MW (gas turbine) onsite
- Diesel generator set 1 MW for a site
- The Rotor
- The Alternator Rotor
- A Rotor Assembly
- Photograph of an actual rotor
- The Two Types of Rotors
- The Salient-pole Rotor
- The Cylindrical Rotor
- The Stator
- Winding Temperature

- Winding Insulation Ratings
- Cooling
- Neutral Earthing Resistor
- Insulated Bearings
- Excitation of Generators
- Conventional Excitation
- Static Excitation
- Brushless Excitation
- Brushless Exciter (Without Pilot Exciter)
- Brushless excitation (with pilot exciter)
- The three phase's synchronous generator
- Generator with three stator windings: U-X, V-Y and W-Z
- Advantage of 3-Phase Generator
- Electromotive force for each stator winding
- Generator Protection
- ANSI Codes for Protection
- Typical one line diagram generator protection
- Details for generator protections
- Functional Description of a typical Generator
- Voltage Regulation
- Automatic Voltage Regulator (AVR)
- AVR set-point
- Generators Paralleling And Synchronising
- Conditions For Paralleling
- Distribution with several generators in parallel
- Procedure to Synchronize a Generator
- Coupling operations with a Synchronoscope
- Parallel Control Operation
- Taking the Load
- Load Sharing
- Operation Of Generator Sets
- Starting and stopping of generator sets

- Starting Means of Generators
- Machine Protection
- Information Interface – Generator to Switchgear
- Warnings and Cautions
- Conclusion
- Abbreviations
- AMG Synchronous Generator Marine Application Series
- Introduction
- General information
- European directives
- Site conditions
- Important note
- Limitation of liability
- General safety
- Safety Instructions
- Disposal and recycling instructions
- Transport and storage
- Transport and unpacking
- Storage
- Installation and alignment
- Preparations for installation
- Installation and alignment
- Final inspection of installation
- Electrical connections
- General
- Automatic Voltage Regulator
- Electrical connections
- Commissioning
- General
- Check of mechanical installation
- Check of electrical installation
- Insulation resistance measurements

- Automatic Voltage Regulator (AVR)
- Starting
- Running the machine the first time
- Shut down
- Operation
- General
- Normal operating conditions
- Protection of synchronous generators
- Start-up procedure
- Continuous supervision
- Shut down procedures
- Maintenance
- Preventive maintenance
- Safety precautions
- Maintenance program
- Maintenance of general construction
- Maintenance of bearings
- Maintenance of stator and rotor winding
- Maintenance related to electrical performance, excitation, control and protection
- Maintenance related to thermal performance and cooling system
- Troubleshooting
- Mechanical performance
- Lubrication system and rolling bearings
- Thermal performance, open air cooling system
- Electrical performance and excitation system of generators
- After sales and spare parts
- After sales
- Spare parts
- Damage Curves
- Insulated Power Cable Damage Curves
- Ampacity
- Intermediate Overload Limit Curve (10 seconds to 1-6 hours)

- Short Circuit Damage Curve (0.01 to 10 seconds)
- Full Load Amps (FLA)
- Short-Time Thermal (Overload) Capability Curve
- Short Circuit Withstand Capability Point
- Decrement Curve
- Generator Thermal Limit Curves
- Overcurrent Coordination Setting Guidelines Generators
- MV Generator Switchgear Feeder Unit with Voltage Controlled 51V
- LV Generator Molded Case Circuit Breaker or Power Circuit Breaker Feeder Unit
- Transformer Overcurrent Protection
- Overcurrent Coordination Setting Guidelines Transformers
- MV Transformer Switchgear Feeder Unit
- LV Transformer CB Feeder Unit
- MV Motor Overcurrent Protection
- Overcurrent Coordination Setting Guidelines Motors
- MV Motor Switchgear Feeder Unit
- MV Motor Fused Starter Feeder Unit
- LV Motor Circuit Breaker Feeder Unit
- LV Motor MCP Starter Feeder Unit
- LV Motor Fused Starter Feeder Unit
- Basic Fault Calculations
- Sympathetic trip protection
- Single line diagram
- Need for Protection
- Need for Protective Apparatus
- Basic Requirements of Protection
- Summary
- Speed Is Vital Otherwise
- Faults, Types and Effects
- The Development of Simple Distribution Systems
- Active Faults
- Passive Faults

- Types of Faults on a Three Phase System
- Transient & Permanent Faults
- Symmetrical & Asymmetrical Faults
- Transient & Permanent Faults
- Simple Calculations of Short Circuits
- Introduction
- Calculation of Short Circuit using %X
- Short Circuit Calculation PU Method
- Generator Protection
- Differential Protection (87)
- Stator Ground Fault Protection (64 or 59n)
- Rotor Ground Fault Protection (64)
- Phase Unbalance or Negative Phase Sequence Protection (46)
- Interturn Protection (60)
- Underfrequency and Overfrequency Protection (81)
- Out-of-Step Protection (21-78)
- Loss of Excitation Protection (40)
- Overexcitation Protection (59)
- Reverse Power Protection (32)
- Supplementary Start Protection (50)
- Phase Back-up Protection (21B)
- Generator Overcurrent Protection Voltage Controlled & Voltage Restrained
- Generator Short-Circuit Current
- Course Recap
- Generator Testing
- Standard Tests
- Standard Test Sheet
- Voltage Transient Test Sheets
- Special Tests
- Application Specific Special Tests
- Generator Efficiency Test
- Voltage Transients

- Reactances
- Inspection And Testing Of Emergency Generators
- Certification requirements
- State licensure requirements
- Maintenance and testing – Applicable standards
- Maintenance and testing – General
- Weekly inspections
- Monthly testing
- 3-year testing
- Automatic transfer switches (ATS)
- Some words of caution on testing
- Document your inspections and tests
- Test Equipment
- General Principles
- Ammeters, Voltmeters and Ohmmeters
- Clamp Meters
- Multimeters
- Phase Meters
- Oscilloscopes
- Phasing Sticks
- Voltage Testers
- Cable Fault Locators
- Instrument Transformers Test Equipment
- Relay and Meter Test Equipment
- Insulation Testers (Megger)
- Earthing Test Equipment
- Course Recap
- Automatic Voltage Regulator User's Manual
- General Information
- Adjustments
- Connection
- Trouble Shooting

- Permanent Magnet Generator (PMG) User's Manual
- General Information
- Connection
- Technical Characteristics
- Lead Competence Center Electrical Control Systems
- Industrial^{IT} PMS for Industrial Plants
- Business Drivers for PMS
- Operational Drivers for PMS
- Architecture
- Typical Electrical Network of Industries
- Electrical Distribution Equipment
- Industrial^{IT} System 800xA Architecture for PMS
- PMS Functionality
- Power Management Functionality
- Load Shedding: The types
- Load Shedding: Keywords
- ABB's Starting-point for Load Shedding
- Contingency Load Shedding
- Technical Data Load Shedding
- Power Management Functionality
- Display Generator Capability Diagram
- Active and Reactive Power Control
- Power Control Example Displays
- Generator Dialogue Faceplates
- Power Management Functionality
- Mode Control
- Supervision, Control and Data Acquisition
- Integration with Supervisory Systems
- Integrated Protection & Control Units
- Power Management Functionality
- Re-Acceleration / Re-Starting
- Power Management Functionality

- Synchronisation
- Power Management Functionality: Summary
- Tertiary Control
- PMS Benefits
- ABB Industrial IT PMS
- Why ABB Industrial^{IT} PMS?
- References
- Industrial^{IT} PMS Application Areas
- PMS Global References
- Named References
- References Overview (1)
- Hellenic Aspropyrgos Refinery (HAR)
- References Overview (2): Thailand
- Thai Oil Company Ltd.
- References Overview (3): Brazil
- References Overview (4): India
- Offshore References with Industrial^{IT}
- Completion of BP Valhall Project – Norway
- Statoil - Norway
- PMS – System Configuration: Gulftaks A&C
- Pemex - Mexico
- EnCana - UK
- ABB delivers Industrial IT solution to the Statoil Hammerfest, Norway LNG Plant
- Maersk Olie og Gas - Denmark
- ABB supplies Industrial^{IT} solutions for DONG platforms in the North Sea
- ONGC India chooses ABB Industrial^{IT} for offshore Fire and Gas System
- Power Management System for Hammerfest LNG Plant
- PMS Configuration – Sakhalin LNG
- Switchgear Survival Guide: Ten Tips to Optimize Switchgear Life and Enhance Reliability
- Introduction
- Ten Tips to Optimize the Life of Electrical Switchgear
- Conclusion

- System Earthing
- What will happened in case of short circuits ?
- Zero Sequence Current
- Types of Faults:
- Consequences
- Solutions
- Benefits
- Earthing Methods
- Ungrounded System
- Solid earthing
- Resistance earthing
- Petersen Coil earthing (arc suppression)
- NEC earthing (with and without resistance)
- Extract from a Code of Practice on Neutral Earthing of MV Power Systems
- Extract From Code of Practice
- Touch Potentials (Reb =1 Ω)
- Touch Potentials (Reb = 10 Ω)+ R)
- Effects of electricity on humans
- Dangerous Current Flows
- Effects of a Current Flow through the Body
- Normal Electrocardiogram
- Resistance of the Human Body
- Principles of Core-balance Protection
- Protection on Direct Contact
- Connection of Core Balance CT in a three phase system
- Protection Against Unsafe Voltage Rise
- Course Recap
- Substation Grounding and Bonding
- Design of a Substation Grounding System
- Buried Grounding Electrode Conductors
- Typical Ground Resistance Requirements - Which one to follow!
- Design of a Substation Grounding System

- Grid Connections
- Material Selection
- Soil Characteristics
- Protective Surface Material
- Soil Resistivity Measurements
- Wenner's Four-Pin Method
- Ground Resistance
- Design Modifications
- Construction of a Grounding System
- Computer Aided Design
- Special Danger Points
- The Mathematical Model
- Design and Optimize Substation Grounding Grid Based on IEEE STD. 80 - 2000 using Market Software
- Bonding
- The Key? –Just Bond It Together!
- Preparations – Crimping & Exothermic Welding
- Preparations – Busbar Lug Connection
- Bonding see video #8
- Hazardous Area Classification And The Selection of Equipment
- European System
- Introduction
- Definitions
- ATEX Directive 94/9/EC
- What is ATEX?
- Directive 137
- Who Needs to Comply with the ATEX Directive?
- ATEX Directive Scope
- ATEX Groups and Categories
- Continued
- Group II
- ATEX Zones
- ATEX 137

- Hazard - Gas, Mists or Vapors
- Temperature Codes
- Gases/Vapors
- Hazard – Dusts
- ATEX 137
- Requirements
- Coverage
- Groups and categories of apparatus
- Equipment selection (ATEX)
- CE Marking of Equipment
- ATEX Markings
- ATEX Product Markings
- Marking
- Hazardous Area Classification (HAC) Standards
- Sect Hazardous Area Classification (HAC) Standards
- Equipment Enclosures NEMA vs IP Ratings
- Conversion of Nema Enclosure Type Numbers To IP Classification
- Shell Deluge Test
- ATEX - The New European Approval Process
- The CE Mark
- ATEX Concept Categories
- ATEX Approvals for OEM(original equipment manefature)
- ATEX Approvals for OEM
- The IEC Ex Scheme
- HAC - Relevant International Standards
- Standards for Equipment
- (Gases and vapours)
- Standards for Various Protection Techniques
- Hazardous Area Standards EC
- Harmonized Standards
- CENELEC (Comité Européen de Normalisation ELECtrotechnique)
- Relationship Between CENELEC and IEC Standards

- Examples of Hazardous Area Classification - *Example no. 1-9*
- COURESE RECAP
- De-Energized Work
- Introduction
- Policies and Procedures
- Main policies and procedures
- Voltage Detection Equipment
- Lock and Tag Out
- Sources of energy at HV Switchgears
- Relevant american standards for LOTO procedures
- LOTO local control
- LOTO remote control
- Improper use or failure of LOTO procedures
- Electrical control and service restoring procedures
- Padlock with key
- Hasps
- Warning tag
- Characteristics of LOTO devices
- Group lock devices
- Permit to Work (PTW) and Work Assignment
- Requirements of PTW
- Form of PTW
- Main objetives of PTW
- Principles of PTW
- Work assignment
- Personnel Protection
- Introduction
- Personal Protective Equipment (PPE)
- Basic PPE
- Harness
- Sit Harness
- Respirators

- Labeling chart for insulated gloves according to ANSI/ASTM D120 standard
- Insulated gloves.
- Dielectric shoes
- Fire blanket
- PPE for Arc Flash
- Arc flash protective clothing
- Arc flash protective hood
- Arc flash blanket
- COURSE RECAP
- Emergency Planning
- Technological hazards
- Natural hazards
- Required actions
- Resources needed
- Items of emergency plan
- Scale map
- Communications and Phone Numbers
- Emergency phone numbers
- Panic Button
- Electrical Fires and Fire Fighting
- Classes of fires
- Electrical fire
- Carbon dioxide portable extinguisher
- Course Recap