Modern Substation Design, Automation, and Control Training Course



16 - 20 Nov 2026

Cape town

4600 € (Per Person)

Ref: #ERE3482_274043

Course Introduction / Overview:

This comprehensive course provides an in-depth exploration of modern electrical substation design, automation, and control systems. In an era of grid modernization and the integration of renewable energy, the substation has evolved from a passive node to an intelligent hub of the power system. This program covers the entire lifecycle, from fundamental design principles to the implementation of sophisticated automation technologies. Participants will gain a robust understanding of both Air-Insulated (AIS) and Gas-Insulated (GIS) substations, primary and secondary equipment selection, and critical safety considerations like earthing and lightning protection. A significant focus is placed on the transition to digital substations, guided by the principles outlined in the IEC 61850 standard. Drawing on authoritative texts like "Electric Power Substations Engineering" by John D. McDonald, the curriculum bridges theoretical knowledge with practical application. BIG BEN Training Center has designed this course to empower professionals with the skills to design, operate, and maintain reliable, efficient, and secure substations that meet the demands of the 21st-century power grid. This training is essential for anyone involved in the engineering and management of critical power infrastructure.

Target Audience / This training course is suitable for:

- Electrical Engineers and Technicians.
- Substation Design and Project Engineers.
- Protection and Control Engineers.
- SCADA and Automation Specialists.
- Power System Planners and Consultants.
- Operations and Maintenance Personnel.
- Project Managers in the energy sector.
- Commissioning Engineers.
- Asset Management Professionals.
- Utility and Industrial Electrical Supervisors.

Target Sectors and Industries:

- Electric Power Generation, Transmission, and Distribution Utilities.
- Renewable Energy Sector (Solar, Wind, and Hydro Power Plants).
- Heavy Industries (Oil and Gas, Mining, Manufacturing, Smelting).
- Railway and Transportation Electrification.
- Large-scale Commercial and Industrial Facilities.
- Data Centers and Critical Infrastructure Facilities.
- Engineering, Procurement, and Construction (EPC) Companies.
- Governmental bodies and energy regulatory agencies.

Target Organizations Departments:

- Engineering and Design Department.
- Operations and Maintenance (O&M) Department.
- Protection, Control, and Automation Department.
- Project Management and Execution Department.
- Asset Management and Planning Department.
- Technical Services and Support Department.
- Grid Operations and Control Center Department.
- Health, Safety, and Environment (HSE) Department.

Course Offerings:

By the end of this course, the participants will have able to:

- Analyze and apply fundamental principles of substation design and layout.
- Differentiate between various switchgear and transformer technologies.
- Develop robust earthing and lightning protection systems for substations.
- Implement modern power system protection schemes using IEDs.
- Understand and apply the IEC 61850 standard for substation automation.
- Design and configure Substation Automation Systems (SAS).
- Integrate SCADA systems for effective remote monitoring and control.
- Evaluate and mitigate cybersecurity risks in substation control systems.
- Manage substation projects from conception through to commissioning.
- Incorporate renewable energy sources into existing substation designs.
- Conduct effective testing and maintenance procedures for substation equipment.

Course Methodology:

The training methodology at BIG BEN Training Center is designed to be highly interactive, engaging, and practical, ensuring that participants can immediately apply their learning in a professional context. This course moves beyond traditional lectures by incorporating a blended learning approach that includes detailed presentations, real-world case studies of substation design projects and operational failures, and collaborative group discussions. Participants will analyze complex engineering problems, debate design choices, and develop solutions in a team-based environment. Interactive sessions will focus on simulating the configuration of Intelligent Electronic Devices (IEDs) and mapping out communication architectures based on the IEC 61850 standard. The instructor will facilitate workshops on developing protection coordination schemes and designing SCADA HMI screens. Throughout the course, emphasis is placed on a continuous feedback loop, where participants receive constructive input on their work. This hands-on, problem-solving approach ensures a deep and lasting understanding of substation systems, empowering attendees with both the theoretical knowledge and the practical confidence to excel in their roles.

Course Agenda (Course Units):

Unit One: Fundamentals of Electrical Substation Engineering

- Introduction to Power Systems and the Role of Substations.
- Classification of Substations (e.g., AIS, GIS, Transmission, Distribution).
- Key Components: Power Transformers, Circuit Breakers, and Switchgear.
- Understanding Instrument Transformers (CTs and VTs).
- Principles of Substation Layout and Electrical Clearances.
- Busbar Arrangements and Switching Schemes.
- Auxiliary Power Systems (AC and DC Supplies).

Unit Two: Substation Design and Safety Systems

- Substation Site Selection and Civil Works Considerations.
- Design of Substation Earthing (Grounding) Grids.
- Lightning Protection and Insulation Coordination Principles.
- Control and Relay Panel Design and Wiring.
- Substation Fire Protection and Safety Protocols.
- Cabling Design and Management within a Substation.
- Interpreting Single-Line Diagrams and Electrical Schematics.

Unit Three: Power System Protection and IEDs

- Fundamentals of Power System Protection.
- Overcurrent, Differential, and Distance Protection Schemes.
- Introduction to Intelligent Electronic Devices (IEDs).
- Configuration and Logic Programming of IEDs.
- Protection Relay Coordination and Setting Calculations.
- Testing and Commissioning of Protection Systems.
- Analysis of Fault Records and Disturbance Events.

Unit Four: Substation Automation and Communication

- Architecture of a Substation Automation System (SAS).
- Communication Protocols: DNP3, Modbus, and IEC 60870.
- The IEC 61850 Standard: Principles and Architecture.
- GOOSE Messaging for High-Speed Inter-Relay Communication.
- SCADA Systems for Remote Monitoring and Control.
- Designing Effective Human-Machine Interfaces (HMI).
- Data Acquisition and Remote Terminal Units (RTUs).

Unit Five: Advanced Topics and Future Trends

- The Concept and Implementation of Digital Substations.
- Cybersecurity for Substation Operational Technology (OT).
- Substation Asset Management and Condition Monitoring.
- Integration of Renewable Energy Sources and Energy Storage.
- Power Quality Issues and Mitigation in Substations.
- Advanced Testing and Diagnostic Techniques.
- Future Trends in Substation Technology and Grid Modernization.

FAQ:

Qualifications required for registering to this course?

There are no requirements.

How long is each daily session, and what is the total number of training hours for the course?

This training course spans five days, with daily sessions ranging between 4 to 5 hours, including breaks and interactive activities, bringing the total duration to 20 - 25 training hours.

Something to think about:

As grid complexity increases with renewable integration, how might the traditional centralized control philosophy for substations evolve towards a more decentralized and intelligent automation model?

What unique qualities does this course offer compared to other courses?

This course distinguishes itself by offering a holistic and forward-looking perspective on substation engineering, seamlessly integrating classical design principles with the cutting-edge demands of modern grid automation. Unlike programs that treat design, protection, and automation as separate disciplines, this curriculum weaves them together, reflecting the interconnected nature of today's digital substations. A core differentiator is the deep dive into the practical application of the IEC 61850 standard, moving beyond mere theory to explore its real-world implementation challenges and benefits, including GOOSE messaging and process bus architecture. Furthermore, the course places a crucial emphasis on the growing importance of cybersecurity within the operational technology (OT) environment of a substation, a topic often overlooked in traditional engineering courses. By bridging the gap between the physical infrastructure (transformers, switchgear) and the digital intelligence layer (IEDs, SCADA, communication networks), participants gain a comprehensive skill set that is immediately relevant and essential for designing and managing the resilient, secure, and intelligent substations required for the future energy landscape.