A Training Course on High Voltage Direct Current Transmission (HVDC)

12 – 16 April 2027
Addis Ababa

AGILE LEADERS
Training Center

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Ref: 36325_225027 **Date:** 12 – 16 April 2027 **Location:** Addis Ababa **Fees:** 6000 Euro

Overview

Integrating large-scale renewable generation and bulk power transmission over long distances requires robust direct current infrastructure. This course examines the engineering, configuration, and operational principles governing high voltage direct current transmission systems. Participants explore converter configurations, line dynamics, station equipment specifications, and protective schemes essential for maintaining grid stability. Practical models, design calculations, and fault management methods equip professionals to deliver high-capacity transmission infrastructure. This course is delivered by Agile Leaders Training Center.

Who Should Attend

- Transmission design engineers responsible for substation layout, converter sizing, and line specifications.
- Grid planning engineers responsible for interconnecting utility networks and evaluating power flow stability.
- Substation maintenance managers responsible for converter station reliability and high-voltage asset integrity.
- Renewable project engineers responsible for integrating offshore wind generation into mainland grids.
- Power systems protection analysts responsible for fault detection schemes, arresters, and switchgear coordination.

Departments and Industries

This programme serves infrastructure, engineering, and utility specialists involved in long-distance electrical interconnection.

- Grid Planning and Substation Engineering Units in Power Transmission Utilities
- Renewable Energy Systems Divisions in Offshore Wind Development
- High-Voltage Equipment Groups in Heavy Electrical Equipment Manufacturing
- Power Systems Consulting Practices in Industrial Infrastructure Engineering
- Operations and System Protection Teams in National Grid Operators

Learning Objectives

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

- Evaluate the technical trade-offs between AC and DC transmission for bulk energy corridors.
- Specify core converter station components including thyristor valves, converter transformers, and smoothing reactors.
- Design AC and DC harmonic filter systems to minimize grid distortion.
- Develop fault management strategies for line disruptions, converter misoperation, and voltage surges.
- Configure earth electrodes and return pathways for bipolar and monopolar transmission configurations.
- Execute digital simulation studies to validate power flow dynamics and transient system performance.

Course Agenda

Day 1: Fundamentals of HVDC Transmission Schemes

- Line capacity and loss analysis comparing high voltage direct current transmission with alternating current systems
- Topologies of direct current schemes: point-to-point, back-to-back, and multi-terminal systems
- Operating principles of line-commutated converter bridges and switching sequences
- Layout specifications for high-voltage direct current converter terminal yards
- Long-distance transmission economics and break-even distance determination
- Offshore collector platform arrangements and grid interconnection considerations

Day 2: Converter Station Equipment and Filter Design

- Thyristor valve rating, firing angle control, and liquid cooling configurations
- Converter transformer design requirements, insulation stresses, and tap changer mechanics
- Smoothing reactor functions in limiting fault current rate-of-rise and DC ripple
- Tuned AC harmonic filters and high-pass damping configurations
- DC filter configurations for eliminating telephone influence factor and harmonic interference
- Active filtering technologies and dynamic power quality compensation

Day 3: DC Transmission Lines, Cables, and Grounding

- Overhead direct current transmission line corona loss, field effects, and conductor bundling
- High-voltage subsea and underground DC extruded and mass-impregnated cable technologies
- High-speed direct current circuit breakers and isolation switchgear
- Earth electrode site selection, soil resistivity surveys, and design calculations
- Overvoltage protection using metal-oxide surge arresters across station terminals
- Metallic return configuration vs ground return operational constraints

Day 4: Control Strategies, Protection, and System Modeling

- Converter firing angle regulation, current margin control, and extinction angle maintenance
- Protection schemes against AC system faults, commutation failure, and converter short circuits
- Direct current line fault detection, de-energization, and rapid restart sequences
- Digital electromagnetic transient modeling for system dynamic studies
- AC/DC grid interactions, voltage stability, and weak AC network support
- Design documentation protocols and procurement specifications for HVDC equipment

Day 5: Maintenance, Reliability, and Project Delivery

- Converter station planned outage management and thyristor testing schedules
- Reliability, availability, and forced outage rate tracking methodologies
- Offshore wind integration practical challenges and HVDC export cable management
- HVDC project execution stages: engineering studies, procurement, and site commissioning
- HVDC power transmission efficiency analysis and operational loss mitigation
- Long-term asset management protocols for converter transformers and cooling plant

Practical Exercises

Participants apply system parameters and engineering calculations to solve operational scenarios.

- Suggested activity: Calculate break-even transmission distances comparing high-voltage alternating and direct current links.
- Suggested activity: Determine harmonic current frequencies and specify LC filter values for a 12-pulse converter terminal.
- Suggested activity: Formulate an electrode resistance and current distribution model based on soil resistivity data.
- Suggested activity: Develop a commutation failure recovery sequence under symmetrical and asymmetrical AC voltage dips.

FAQs

How does high voltage direct current transmission compare economically with alternating current?

HVDC transmission incurs higher initial terminal converter costs but requires significantly less capital expenditure and lower line losses per kilometre. Beyond a specific break-even distance, typically around six hundred to eight hundred kilometres for overhead lines and fifty kilometres for underground or subsea cables, direct current delivers lower overall lifecycle expenditure.

What converter technologies are examined in this syllabus?

The syllabus provides comprehensive coverage of line-commutated thyristor converter bridge topologies, firing control mechanisms, converter transformer design considerations, and filtering equipment essential for bulk power transfer.

How are fault scenarios and commutation failures evaluated?

Sessions examine protection coordination, surge arrester allocation, high-speed DC switching, and control system responses designed to detect line faults, arrest commutation failure, and restore normal power transfer without grid destabilization.

Conclusion

Engineers and technical planners conclude this programme prepared to evaluate, specify, and manage direct current transmission assets. Equipped with precise design calculations, protection protocols, and equipment sizing techniques, participants ensure high transmission reliability and power quality across high-capacity interconnections.