

MATREX TRAINING

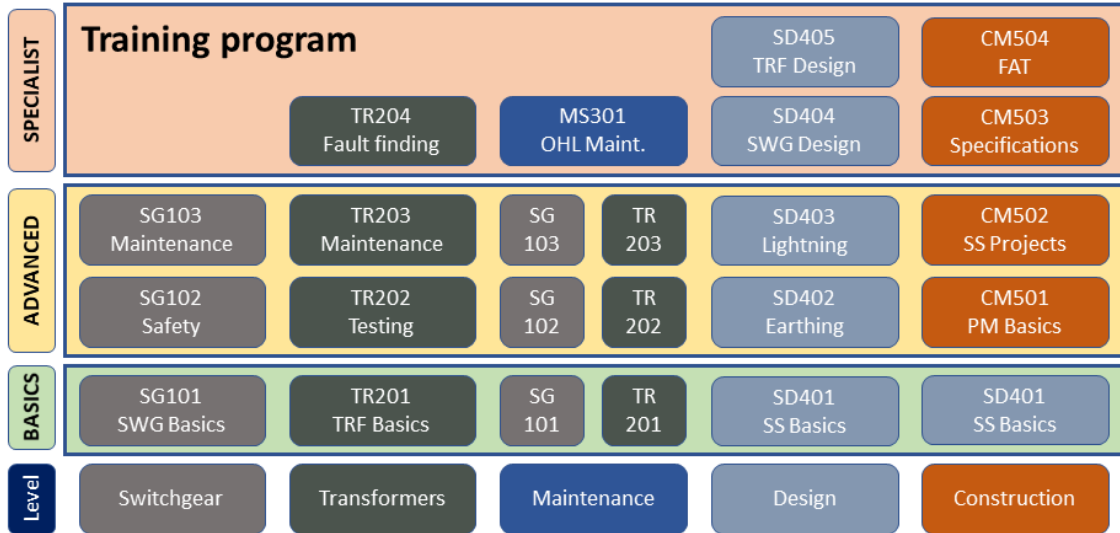


Welcome to MATREX training!

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Training Program

MATREX Training Program consists of 18 one-day courses, covering all aspects of engineering asset management of transmission and distribution systems: design, construction, operation and maintenance.



The courses are grouped into five major areas of expertise: MV/HV switchgear, power transformers, substation maintenance, substation design and construction management. Each group contains a number of one-day courses, from basic to specialist, to allow you to choose courses that best suit your own personal development and career aspiration.

Job Matrix

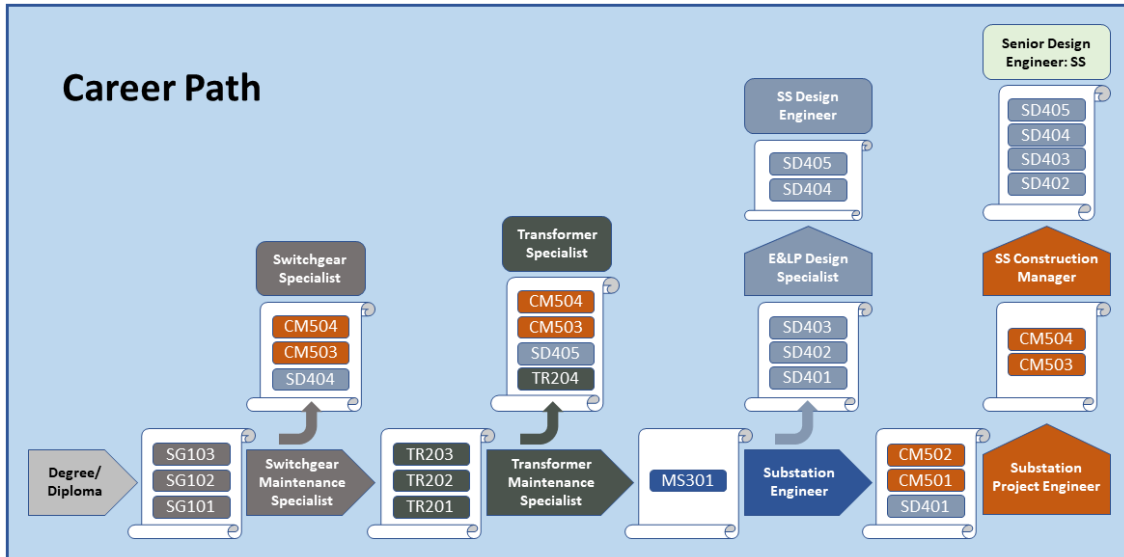
MATREX has linked its training program with specific job requirements in the power engineering industry, as shown in the following Job Matrix. If you want to work in the industry, the matrix will help you choose the courses needed to progress your career. The courses that provide useful knowledge to your particular job are also recommended.

Job Title	Required Training courses																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	SG101	SG102	SG103	TR201	TR202	TR203	TR204	MS301	SD401	SD402	SD403	SD404	SD405	CM501	CM502	CM503	CM504
Switchgear Maintenance Specialist	✓	✓	✓										*				
Transformer Maintenance Specialist				✓	✓	✓							*				
MV/HV Switchgear Specialist	✓	✓	✓										✓	*	*	✓	✓
Power Transformer Specialist				✓	✓	✓	✓							✓	*	*	✓
Substation Engineer	✓	✓	✓	✓	✓	✓	*	✓	*		*			*	*	*	*
E&LP Design Specialist									✓	✓	✓						
Substation Design Engineer									✓	✓	✓	✓	✓	*	*	*	*
Substation Project Engineer									✓					✓	✓	*	*
Substation Construction Manager									✓	✓	✓	✓	✓	✓	✓	✓	✓
Senior Design Engineer: Substations	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

✓ Required knowledge for this job * Useful knowledge for this job
 Basic level
 Advanced level
 Specialist level

Career Path

Your career path includes the skills you need to obtain in order to achieve your ultimate career goal. It doesn't need to be a straight line, nor does it need to span a specific time frame. You can easily identify your career goal and come up with your personal development plan. This is especially important for those pursuing their professional registration.



MATREX Training program was not only built around an engineering subject, it was purposefully built to progress your career. You can start in a lower-lever job in a career path and, with more training and experience, move further along the path. Each day of MATREX Training will take you one step higher on your career path.

If you already have a certain level of knowledge and experience, you can skip the basic training and attend the courses appropriate for your current skill level.

MATREX Training Program will help you to further your career in the area of your interest, climb the corporate ladder or to simply obtain the CPD points required to maintain your professional registration.

This document contains detailed description of the courses and how they can support your development plan. The dates of each course, for the current calendar year, can be found in the Schedule.

If you want to attend a particular course please register on line at www.matrex-e.com or via email training@matrex-e.com.

Follow us on Facebook or LinkedIn or subscribe to our email to receive event updates.

For more information and for in-house training please contact us on training@matrex-e.com.

MV/HV Switchgear

Expertise summary:

Switchgear has an important role in the transmission and distribution of electrical power, as most customers are directly linked to the network. If there are any problems in the network, which cannot be managed properly, the customers may experience huge problems due to outages.

The courses in this area of expertise provide insight into basic operating principles, different interrupting technologies, application and categorisation of switchgear devices. It explains typical switchgear configurations and arrangements, typical problems encountered in the field and means of extending the life of MV switchgear. The courses also highlights safety considerations and provide practical guidance for operation, maintenance and testing of MV switchgear.

The following courses fall in this group:

SG101 SWITCHGEAR OPERATING PRINCIPLES

SG102 SWITCHGEAR SAFETY AND PROTECTIVE MEASURES

SG103 SWITCHGEAR LIFE EXTENSION AND MAINTENANCE

Who should attend?

These courses are suggested for all technical personnel involved with operations and/or maintenance of switchgear installations; in particular for all technicians, engineers, supervisors and managers who work in transmission, distribution, maintenance and operation of municipal, industrial and commercial transmission and distribution systems.

Career opportunities:

Switchgear Maintenance Specialist

Attendees that complete all three courses in this group (SG101 - 103) would obtain skills required to work on MV/HV switchgear maintenance, as Switchgear Maintenance Specialists.

MV/HV Switchgear Specialists

Attendees that complete all courses in this group (SG101 – 103) and additional courses on Switchgear Design (SD404), Tender Specifications (CM504) and Factory Acceptance Tests (CM505) would obtain skills required to become a MV/HV Switchgear Specialists.

Substation Engineer

Attendees that complete all courses in the Switchgear group (SG101 – 103), the first three courses in Transformer group (TR201, TR201 and TR203), and additional courses on Overhead Line Maintenance (MS301) and Basics of Relay Protection (MS302) would obtain skills required to work on substation maintenance, as Substation Engineers.

SG101 – SWITCHGEAR OPERATING PRINCIPLES

Course Synopsis:

In an electric power system, switchgear is the combination of electrical disconnect switches, fuses or circuit breakers used to control, protect and isolate electrical equipment. Switchgear is used both to de-energize equipment to allow work to be done and to clear faults downstream. This type of equipment is directly linked to the reliability of the electricity supply.

This course provides insight into basic operating principles, different interrupting technologies, application and categorisation of switchgear devices. It provides practical guidance for identifying and locating various MV switchgear components.

Learning outcomes:

- Become familiar with the role and standard terminology of switchgear
- Learn about basic operating principles and different interrupting techniques
- Understand different types of switchgear and their application
- Learn how to identify and locate various MV switchgear components
- Understand the role of protective relays.

Who should attend?

Suggested for all technical personnel involved with operations and/or maintenance of switchgear installations; in particular for all technicians, engineers, supervisors and managers who work in maintenance and operation of municipal, industrial and commercial transmission and distribution systems.

Requirements:

This is a basic level course. Only a basic electrical knowledge of voltage, current and power is required.

Course Content:

Terminology, classification and application

- The role of switchgear in modern world
- Switchgear terminology
- Classification of switching devices
- Switchgear application

Interrupting techniques for air, oil, vacuum and SF6 insulation mediums

Basic operating principles and purpose of switching devices

- Circuit breakers (air, oil, vacuum and SF6)
- Disconnectors; Switch and switch-disconnector
- Earthing switches
- Contactors
- Fuses
- IS limiters
- Surge Arresters
- Instrument transformers

Protective Relays

Types of switchgear and its applications

- Indoor/outdoor
- HV and MV
- AIS – Air Insulated Switchgear
- GIS – Gas Insulated Switchgear
- HIS – Highly Integrated Switchgear
- PASS – Plug And Switch System

Indoor MV switchgear

- Metal-enclosed / Metal-clad
- Fixed / Withdrawable
- Gas insulated switchgear (GIS)

Location and identification of switchgear components

SG102 – SWITCHGEAR SAFETY AND PROTECTIVE MEASURES

Course Synopsis:

Proper maintenance of electrical switchgear is essential in preventing the equipment failures that cause interruption of power supply to customers and users. However the maintenance work itself, if not done properly and in a safe manner, may lead to accidents causing serious bodily injuries or even death. Without implementing and following a safe system of work, operators engaged in electrical switchgear maintenance are vulnerable to various safety and health hazards.

This course provides insight into danger to the operators of MV switchgear and explains various protective and safety measures that can be used to protect the personnel and improve the safety of the operating environment. It also explain safe racking procedures and the implementation of interlocking.

Learning outcomes:

- Understand the danger to the operators and the safety requirements for operating rooms.
- Learn about types of operating areas and means for making them safe.
- Consolidate your knowledge about protective measures for personnel and how to enforce them.
- Become familiar with standard racking procedures for MV switchgear.
- Learn the purpose of interlocking, standard interlocking requirements and application.

Who should attend?

Suggested for all technical personnel involved with operations and/or maintenance of switchgear installations; in particular for all technicians, engineers, supervisors and managers, commissioning engineers, maintenance personnel and inspectors of MV/HV switchgear.

Requirements:

This is an advanced level course. A basic knowledge of switchgear is required. If you do not have the relevant working experience, you should complete course SG101 first.

Course Content

Danger to the operators

Types of operating areas

- Closed operating rooms
- Ordinary workrooms

Safety measures for operating rooms

- Requirements for indoor switchgear design
- Requirements for switchgear accessible to the public
- Special requirements for GIS installations
- Protection against the effects of arc faults
- Switchgear arc flash solutions

Protective measures for personnel

- Protection against direct and indirect contact
- Safety considerations during maintenance
- Qualified and Authorised person
- Work permits

Racking in and out of service

- Switching; Isolating; Testing; Earthing & Reinstating the circuit
- Checklist for operating switchgear
- Remote racking

Interlocking

- Purpose of interlocking
- Standard requirements for interlock design
- Types and application of interlocking design
- Control circuits in interlocking systems

SG103 – SWITCHGEAR LIFE EXTENSION AND MAINTENANCE

Course Synopsis:

Switchgear failures account for vast amount of money in damage and lost business every year. Performing proper maintenance on a facility's electrical equipment can reduce the risk of an unplanned outage and help extend useful life of the asset. In today's economy, budget constraints on capital improvement projects will mean more reliance on existing equipment maintenance.

This course provides insight into main causes of switchgear failure, typical problems and means of eradicating them. It provides practical guidance for inspecting and testing the switchgear and discusses standard maintenance procedures for MV switchgear.

Learning outcomes:

- Understand the main causes of switchgear failure, typical problems and means of eradicating them.
- Learn how to undertake switchgear inspections on energised and de-energised equipment.
- Explore various tools available for diagnosing switchgear problems.
- Become familiar with standard maintenance and testing procedures for MV switchgear.

Who should attend?

Suggested for all technical personnel involved with operations and/or maintenance of switchgear installations; in particular for all technicians, engineers, supervisors and managers who work in maintenance and operation of municipal, industrial and commercial transmission and distribution systems.

Requirements:

This is an advanced level course. A basic knowledge of switchgear is required. If you do not have the relevant working experience, you should complete course SG101 and SG102 first.

Course Content

Life extension of MV switchgear equipment

- Top five causes of switchgear failure
- Typical problems and means of eradicating them
- Corona and its manifestations
- Tracking phenomenon and how to cease it

Practical guide to switchgear inspection

- Purpose and scope of visual inspections
- Inspection of energized and de-energized equipment
- Extended diagnostics: IR, UV, Ultrasonic and PD, Gas analysis
- Comparative review of extended diagnostic tests

Switchgear and circuit breakers maintenance

- Scheduling
- Guidelines for switchgear maintenance
- General maintenance procedures for MV switchgear
- Circuit breaker testing
- Megger Test,
- Tan- δ /Power factor test
- High Potential Insulation Test

Power Transformers

Expertise summary:

Contemporary transmission and distribution systems are very extensive and greatly dependent on transformers. Modern transformers are much more efficient, but much less robust than they were half a century ago. Purchasing, operating and maintenance decisions must be made in order to spend the least amount of money while still yielding the most performance of a unit.

The courses in this area of expertise provide a comprehensive insight into main aspects of transformer design, required testing regime and effective maintenance program. It provides very practical guidance for choosing design parameters, troubleshooting faults and interpreting test results, maintenance scheduling, operational and testing procedures to achieve long service life of power and distribution transformers.

The following courses fall in this group:

TR201 TRANSFORMER CONSTRUCTION

TR202 TRANSFORMER TESTING & MONITORING

TR203 TRANSFORMER OPERATION & MAINTENANCE

TR204 TRANSFORMER FAULT FINDING

Who should attend?

These courses are suggested for all technical personnel involved with operations and/or maintenance of power and distribution transformers; in particular for all engineers, supervisors and managers who work in maintenance and operation of municipal, industrial and commercial transmission and distribution systems.

Career opportunities:

Transformer Maintenance Specialist

Attendees that complete the first three courses in this group (TR201, TR202 and TR203) would obtain skills required to work on power transformer maintenance, as Transformer Maintenance Specialists.

Power Transformer Specialists

Attendees that complete all courses in this group (TR201 – 204) and additional courses on Transformer Design (SD405), Tender Specifications (CM504) and Factory Acceptance Tests (CM505) would obtain skills required to become a Power Transformer Specialists.

Substation Engineer

Attendees that complete the first three courses in Transformer group (TR201, TR201 and TR203), all courses in the Switchgear group (SG101 – 103) and additional courses on Overhead Line Maintenance (MS301) and Basics of Relay Protection (MS302) would obtain skills required to work on substation maintenance, as Substation Engineers.

TR201 – TRANSFORMER CONSTRUCTION

Course Synopsis:

This course provides a comprehensive insight into main aspects of transformer construction and most critical operational parameters. It provides practical guidance for identifying and understanding the operation of main and auxiliary components of power and distribution transformers. It explains the role of transformers, the transformer operating principle and shows the construction process.

A one-hour workshop is included in the course for assignments and real scenario problem solving.

Learning outcomes:

- Become familiar with the role and operating principles of transformers
- Learn about main and auxiliary components of the transformer.
- See how the transformers are manufactured.
- Understand most critical transformer parameters and learn how to interpret the transformer plates.

Who should attend?

Suggested for all technical personnel involved with operations and/or maintenance of power and distribution transformers; in particular for all technicians, engineers and supervisors that work on maintenance and operation of municipal, industrial and commercial distribution and transmission systems.

Requirements:

This is a basic level course. Only a basic electrical knowledge of voltage, current and power is required.

Course Content:

Role of transformers

Transformer's Main components

- Core and windings
- Tappings and tapchanger
- Tank
- Bushings

Aux equipment & fittings

- Conservator
- Breather
- Oil indicators
- Protective devices

Insulation system and cooling

- Function of mineral oil
- Function of solid insulation
- Oil impregnated paper
- Cooling equipment

Transformer manufacturing

Understanding transformer nameplates

Most critical transformer parameters

- Rated power; Impedance
- Basic insulation level
- Tapchanger
- Class; Pressure range;
- Serial number; Instructions;
- Cooling system marking symbols

Assignments:

- Mark various transformer parts on the provided drawing
- Read transformer parameters from the provided plate

TR202 – TRANSFORMER TESTING AND MONITORING

Course Synopsis:

This course discusses various types of field testing and their applications. Through a number of case studies, it provides guidance on what are the key parameters that should be checked during testing, what kind of results should be expected and how to interpret the test results. This course was specifically designed to improve the diagnostic skills and to enable the attendees to make informed decision for appropriate corrective action.

Practical guide for testing procedures and interpreting transformer test results is incorporated in the course to teach real scenario problem solving.

Learning outcomes:

- Understand the various types of tests, what is their purpose and application.
- Learn a number of procedures for various tests used during factory testing, commissioning, maintenance and fault finding process.
- Learn how to interpret the test results to identify the problem and take appropriate course of action.
- Understand limitations of monitoring and diagnostic tests and how to overcome them.

Who should attend?

Suggested for all technical personnel involved with operations and/or maintenance of power and distribution transformers, engineers that work in the transformer testing facilities, commissioning engineers, maintenance personnel and inspectors of power and distribution transformers.

Requirements:

This is an advanced level course. A basic knowledge of transformers is required. If you do not have the relevant working experience, you should complete course TR201 first.

Course Content

Types of transformer tests & their applications

Oil testing & interpretation of oil test results

- Essential oil tests
- Interpreting oil tests results

Gas-in-oil analysis and diagnostics

- Dissolved-gas-analysis (DGA) principles
- Key gas analysis
- Guidelines for combustible gas concentration
- Basic gas ratios; Rogers Ratio
- Total Dissolved Combustible Gases
- Dissolved key gas concentration limits

Electrical testing procedures for monitoring purposes

- Winding insulation resistance
- Voltage ratio and tap changer test
- Measurement of magnetic currents
- Winding resistance
- Polarity check of CTs built into transformers
- Core earthing test
- Power factor/Tan-delta measurements
- Induced overvoltage withstand test

Condition monitoring inspections

- External visual inspection
- Infrared scanning

Online condition monitoring

- Transformers
- Bushings

Complete physical examination

Workshop / case studies

Discuss most common transformer problems and how to identify them. This interactive workshop will enable the delegates to practically apply the knowledge presented during the course.

Practical guide for interpreting transformer test results

- Interpreting Oil Test results
- Diagnostics with Gas-in-oil analysis
- Range of expected results for electrical testing.
- Limitations of monitoring and diagnostic tests
- Developing an effective monitoring program

TR203 – TRANSFORMER OPERATION AND MAINTENANCE

Course Synopsis:

Transformer failures, when they occur, are usually of a very serious nature and require costly repairs and long downtime. The best policy against transformer failure is to ensure that they are properly operated and maintained. For all practical purposes transformer life expectancy beyond 20 years significantly depends on the quality of maintenance applied to it.

This course is focusing on critical issues that should be considered in establishing good operating practices and implementing an effective transformer maintenance program.

A three-hour workshop is included in the course to provide practical guidance for maintenance scheduling, operational and testing procedures to achieve long service life of power and distribution transformers.

Learning outcomes:

- Learn about aspects of proper transformer operation and how operating conditions affect transformer life expectancy.
- Understand what causes transformer aging and how to control aging accelerators.
- Explore various maintenance strategies, technical and organisational aspects of maintenance and maintenance activities that would ensure an effective transformer maintenance program.
- Learn about oil sampling and oil preserving procedures and understand how to implement them.
- Discuss various case studies and a typical maintenance schedule through an interactive workshop.

Who should attend?

Suggested for all technical personnel involved with operations and/or maintenance of power and distribution transformers; in particular for all technicians, engineers and supervisors that work on maintenance and operation of municipal, industrial and commercial distribution and transmission systems.

Requirements:

This is an advanced level course. A knowledge of transformer testing and monitoring is required. If you do not have the relevant working experience, you need to complete courses TR201 and TR202 first.

Course Content

Aspects of proper transformer operation

- Normal and Special service conditions
- Parallel operation
- Temperature rise
- Transformer overload capability
- Transformer aging

Maintenance program

- Objective of transformer maintenance
- Maintenance strategies
- Technical and organisational aspects

Maintenance activities

- General maintenance activities
- Inspections for maintenance purposes
- Monitoring and diagnostic tests
- Oil management
- Bushings maintenance
- Tap-changer maintenance

Transformer life extension

- Controlling aging accelerators
- Dehydrating transformers
- Reclaiming oil
- Confronting the sludge problem

Workshop / case studies

Interactive discussion on various maintenance related issues. This three-hour workshop will enable the delegates to practically apply the knowledge presented during the course.

Practical guide for transformer maintenance

- Oil sampling procedure
- Oil preserving procedures
- Degree of maintenance required based on oil test results
- Degree of maintenance required based on total dissolved combustible gas level
- Energised and de-energised maintenance activities broken down per maintenance intervals

TR204 – TRANSFORMER FAULT FINDING

Course Synopsis:

Any transformer fault must be expediently identified and rectified. Incorrect decisions may result in further damages and inevitable increase in the cost of repairs and extended downtime. This course was specifically designed to improve the diagnostic skills of the attendees and to enable them to make a correct decision.

This course explains main risk factors and causes of transformer failure, what are the types of faults and tests that can be used in the fault finding process and how to set up a proper fault investigation.

A four-hour workshop is included in the course to provide practical guidance on how to lead a fault investigation and interpret the test results.

Learning outcomes:

- Understand the main causes of transformer failure, examine various types of faults and their effect on transformers and how to diagnose them.
- Learn about field tests and special diagnostic tests and how to use them for fault finding purposes.
- Learn how to interpret the test results to identify a probable cause of failure and make informed decisions on the appropriate course of action.
- Discuss investigation procedures, various case studies and most common transformer failures through an interactive workshop.

Who should attend?

This course is designed to increase the fault finding skills of all technical personnel involved with operations and maintenance of power transformers, in particular for all engineers, supervisors and managers who work in transmission, distribution, maintenance and operation of utilities, industrial and commercial distribution. Inspectors of power and distribution transformers, will find this course extremely beneficial.

Requirements:

This is a specialist level course. Advanced knowledge on transformers is required. If you do not have the relevant working experience, you need to complete relevant courses TR201 – TR203 first.

Course Content

Importance & reliability of transformers

- Transformer life expectancy
- Probability and time distribution of transformer failures

Factors influencing transformer reliability

- Weakness in specification or defective design
- Manufacturing deficiency or material defects
- Adverse operating conditions
- Improper maintenance practices
- Transformer aging

Types of transformer faults

- Internal faults: Winding to ground faults, Inter-turn faults, Core faults, Tank faults, Phase to phase
- External system conditions: Overload, Overvoltages, System failures, Reduced system frequency

Typical transformer failures

- Electrically induced failures
- Mechanically induced failures
- Thermally induced failures
- Failure modes, stressors and their effects on transformers

Overview of oil testing and DGA

Electrical tests for troubleshooting purposes

Specialised diagnostic tests

- Infrared scanning; Frequency response (SFRA)
- Acoustic analysis; Vibration analysis; Noise level test
- Evaluation of transformer solid insulation (DP level and Furan)

Workshop / case studies

Interactive discussion on various fault finding issues. This four-hour workshop will enable the delegates to practically apply the knowledge presented during the course.

Practical guide for transformer fault investigation

- Conducting transformer failure investigation
- Transformer diagnostic guide: 15 most common transformer failures and their probable causes.
- Review common failure modes and typical gases generated in each case.
- Review 5 investigation cases, which will cover all main causes of transformer failure (bad specification, bad manufacturing, bad installation, bad operation and bad maintenance).

Substation Maintenance

Expertise summary:

Substation maintenance involves periodic planned inspections, checking, testing and troubleshooting, to ensure the correct operation of all components and their interaction. Typical inspection and diagnosis processes include, among others, transformers, breakers, protection relays, overhead lines and switchgear in general. In order to perform these actions, extensive knowledge is required on the operation and maintenance of these components.

The courses in this area of expertise provide a comprehensive insight into operation of switchgear, transformers, overhead lines and relay protection, required testing regime and effective maintenance program for each of the substation components. It provides very practical guidance for safety, maintenance scheduling, operational and testing procedures, troubleshooting and interpreting test results, required to achieve long service life and uninterrupted operation of substations.

The following courses fall in this group:

SG101 SWITCHGEAR OPERATING PRINCIPLES

SG102 SWITCHGEAR SAFETY AND PROTECTIVE MEASURES

SG103 SWITCHGEAR LIFE EXTENSION AND MAINTENANCE

TR201 TRANSFORMER CONSTRUCTION

TR202 TRANSFORMER TESTING & MONITORING

TR203 TRANSFORMER OPERATION & MAINTENANCE

MS301 OHL MAINTENANCE

Who should attend?

These courses are suggested for all technical personnel involved with operations and/or maintenance of substation equipment; in particular for all engineers, supervisors and managers who work in maintenance and operation of municipal, industrial and commercial transmission and distribution systems.

Career opportunities:

Switchgear Maintenance Specialist

Attendees that complete first three courses in this group (SG101 - 103) would obtain skills required to work on MV/HV switchgear maintenance, as Switchgear Maintenance Specialists.

Transformer Maintenance Specialist

Attendees that complete all transformer related courses in this group (TR201, TR202 and TR203) would obtain skills required to work on power transformer maintenance, as Transformer Maintenance Specialists.

Substation Engineer

Attendees that complete all courses in this group would obtain skills required to work on substation maintenance, as Substation Engineers.

SWITCHGEAR

The courses in this area of expertise provide insight into basic operating principles, different interrupting technologies, application and categorisation of switchgear devices. It explains typical switchgear configurations and arrangements, typical problems encountered in the field and means of extending the life of MV switchgear. The courses also highlights safety considerations and provide practical guidance for operation, maintenance and testing of MV switchgear.

The following courses fall in this group:

SG101 SWITCHGEAR OPERATING PRINCIPLES

SG102 SWITCHGEAR SAFETY AND PROTECTIVE MEASURES

SG103 SWITCHGEAR LIFE EXTENSION AND MAINTENANCE

See [MV/HV Switchgear](#) for detailed program on these courses.

POWER TRANSFORMERS

The courses in this area of expertise provide a comprehensive insight into main aspects of transformer design, required testing regime and effective maintenance program. It provides very practical guidance for choosing design parameters, troubleshooting faults and interpreting test results, maintenance scheduling, operational and testing procedures to achieve long service life of transformers.

The following courses fall in this group:

TR201 TRANSFORMER CONSTRUCTION

TR202 TRANSFORMER TESTING & MONITORING

TR203 TRANSFORMER OPERATION & MAINTENANCE

See [Power Transformers](#) for detailed program on these courses.

MS301 – OVERHEAD LINE MAINTENANCE

Course Synopsis:

Overhead line structures and their components suffer stress due to electrical, mechanical and environmental factors, which lead to defects and eventual failures. Maintaining reliability, extending the useful life of lines, preventing failures and ensuring employee and public safety are all at the forefront of transmission line maintenance. To ensure high reliability and availability of the overhead lines, cost effective maintenance strategies are essential.

This course outlines general problems with respect to overhead line structures, conductors, insulators and various hardware components. It also discusses line inspection techniques, performance of typical maintenance materials, general corrosion protection and environmental management practices.

Learning outcomes:

- Understand the critical issues that should be considered in establishing and implementing effective maintenance of overhead lines
- Explore underlying causes of failures, how to investigate and prevent failures through inspections, testing and preventive maintenance
- Learn how to do proper assessment of OHL lines and their components including condition monitoring
- Explore technical, organisational and operational aspects and safety consideration in establishing an effective maintenance program.

Who should attend?

Suggested for all technical personnel involved with operations and/or maintenance of overhead line installations; in particular for all technicians, engineers, supervisors and managers who work in maintenance and operation of municipal, industrial and commercial transmission and distribution systems.

Requirements:

This is a specialist level course. A basic knowledge of transmission or distribution lines is required.

Course Content:

OHL performance and categories of fault

OHL inspection

- Main reasons for inspections
- Condition assessment inspections
- Servitude condition, tower foundations and tower base
- Clearance of phase conductors to ground level
- Condition of the tower structure; shield wire and phase conductor
- Condition of live-side hardware and phase conductor insulation

Insulators, conductors & hardware

- Types of insulators
- Insulator type related problems
- Pollution related problems
- Insulator condition monitoring

Corrosion problem

- Root causes of corrosion
- Corrosion assessment

Overview of environmental management

- Vegetation management
- Management of wildlife interaction
- Management of ground erosion

Workshop / case studies

Interactive discussion on various OHL maintenance issues. This four-hour workshop will enable the delegates to practically apply the knowledge presented during the course.

Practical guide for OHL maintenance program

- Setting performance targets for OHL
- Technical aspects
- Safety aspects
- Maintenance of insulators, conductors, shield wire & hardware
- Corrosion protection
- Foundation maintenance
- Wooden poles maintenance
- Concrete poles maintenance

Substation Design

Expertise summary:

All substations contain switchgear, transformers, earthing and lightning protection systems and follow certain bus arrangements. A correctly planned and designed substation is vital for the consistent operation of the national grid. The main issues facing a power engineer are reliability and cost. A good design attempts to strike a balance between these two, to achieve reliability without excessive cost.

The courses in this area of expertise are laying out the basics of substation design, including the requirement for relevant system studies, defining the space requirements and design criteria, selection of appropriate transformers and switchgear etc. It also provides practical guidance for substation earthing and lightning protection design.

The following courses fall in this group:

SD401 SUBSTATION DESIGN BASICS

SD402 SUBSTATION EARTHING DESIGN

SD403 SUBSTATION LIGHTNING PROTECTION

SD404 SWITCHGEAR SELECTION AND DESIGN

SD405 TRANSFORMER DESIGN

Who should attend?

These courses are suggested for all technical personnel involved with substation design; in particular for all engineers, technicians, managers and project managers who work in the substation design and construction of municipal, industrial and commercial transmission and distribution systems.

Career opportunities:

Earthing & Lightning Protection Specialist

Attendees that complete first three courses in this group (SD401 – 403) would obtain skills required to design the earthing and lightning protection systems for substations, as E&LP Specialists.

Substation Design Engineer

Attendees that complete all courses in this group (SD401 – 405) would obtain skills required to work on various aspects of substation design, as Substation Design Engineers.

Senior Design Engineer: Substations

Attendees that have experience in substation maintenance and complete all courses in this group (SD401 – 405) and all courses in the Construction Management group (CM501 – 504) would obtain skills required to perform duties of a Senior Design Engineer: Substations.

SD401 – SUBSTATION DESIGN BASICS

Course Synopsis:

Substation design is one of the most complex electrical engineering disciplines. It requires close cooperation and interaction of various engineering disciplines: electrical, civil and mechanical. The designer must understand system requirements, choose appropriate configurations and calculate equipment parameters to ensure trouble free operation over a number of decades.

This course outlines the basics of substation design, including the requirement for relevant system studies, defining the space requirements and various design criteria. It also provides an overview of main primary equipment, various bus arrangements and the main components of substation design.

Learning outcomes:

- Learn about different types of substations and their roles.
- Understand different system studies required for establishing substation design parameters.
- Become familiar with main primary equipment, different bus arrangements and their application.
- Explore design consideration, space requirements and various components of substation design.

Who should attend?

These courses are suggested for all technical personnel involved with substation design; in particular for all engineers, technicians, managers and project managers who work on the substation design and construction of municipal, industrial and commercial transmission and distribution systems.

Requirements:

This is a basic level course. Basic electrical engineering knowledge is required. If you do not have electrical engineering background, courses SG101 and TR201 should be attended first.

Course Content:

Types of substations

Need determination

Studies required for establishing design parameters

- Load flow study
- System stability study
- Short circuit analysis
- Geotech and soil resistivity studies
- Other calculations normally performed for substation design

Design considerations

- Security of supply; Extensibility, Maintainability; Operational flexibility
- Protection arrangement; Short circuit limitations, Land area and Cost

Space requirements

- Safety clearances
- Phase-phase and phase-earth clearances

Substation layout based on its bus arrangement

- Single bus arrangement
- Double bus- double breaker arrangement
- Main and transfer bus arrangement
- Double bus- single breaker arrangement
- Ring bus arrangement
- Breaker-and-a-half arrangement
- Bus arrangement comparison

Overview of main primary equipment

- HV switchgear
- MV switchgear
- Power transformers

Components of substation design

- Primary design
- Secondary design
- Civil and structural design
- Earthing and lightning protection systems

SD402 – SUBSTATION EARTHING DESIGN

Course Synopsis:

Inadequate earthing causes unexplained system outages, but if it remains unchecked and non-rectified it may cause serious or irreparable damage to the equipment and plant, and maybe even loss of life. Even the best-designed earthing systems may become unsafe through deterioration of material and changes to the power grid. A substation must have a well-designed and reliable earthing and lightning protection systems to provide a reasonable protection to the equipment and a safe environment for personnel.

This course provides basic understanding of the issues pertinent to safe earthing practices and designing a safe earthing grid. It also discusses various measurements and assessments methods critically important in achieving a safe earthing design.

Learning outcomes:

- Identify factors that can lead to the loss of equipment, power supply or life due to incorrect earthing.
- Become familiar with basic concepts, underlying principles and techniques of designing an effective earthing systems for substations.
- Learn how to test, evaluate and maintain the existing earthing systems.
- Explore different measurements and assessment methods critically important to the earthing design.

Who should attend?

These course is suggested for all technical personnel involved with substation design; in particular for all engineers, technicians, managers and project managers who work on the substation design and construction of municipal, industrial and commercial transmission and distribution systems.

Requirements:

This is an advanced level course. Basic electrical engineering knowledge is required. If you do not have substation engineering background, course SD401 should be attended first. This course works in conjunction with SD403 Substation Lightning Protection course and both courses should be attended in order to understand all aspects of designing an effective earthing system for HV installations.

Course Content:

Substation earthing

- Reasons for installing an earthing system
- Categories of electrical installations
- Conditions of danger

Tolerable body currents and dangerous voltages

- Permissible body current limits; Ground Potential Rise (GPR)
- Step and Touch Potential; Typical shock situations

Critical system and site parameters

- Maximum grid current; Fault clearing time
- Soil resistivity; Surface layer; Available grid area

Measurement of soil resistivity – Wenner Array

Parameters determined during the design

- Safety criteria; Soil structure and modelling
- Estimation of the grid resistance
- Grid geometry; Conductor sizing; Connections to the grid

Designing an earthing system

- Design procedure
- Preliminary design
- Refinement of preliminary design
- Design in difficult conditions
- Special areas of concern

Measurement of earth resistance

- Fall of potential method (general procedure & procedure for large substations)
- Assessment of field measurements for safe design

Earthing grid safety assessment methods

- Field survey of potential contours, touch & step voltages
- Simulated personnel method
- Earthing integrity test

SD403 – SUBSTATION LIGHTNING PROTECTION

Course Synopsis:

A purpose of a lightning protection system is to protect the equipment and ensure safety of the personnel from lightning strikes. Inadequate lightning protection causes system outages and may cause serious or irreparable damage to the equipment and plant, and maybe even loss of life. A substation must have a well-designed and reliable earthing and lightning protection systems to provide a reasonable protection to the equipment and a safe environment for personnel.

This course provides basic understanding of the issues pertinent to safe earthing practices and designing a safe earthing and adequate lightning protection systems. It also advises, through various case studies, how to avoid typical design mistakes and how to evaluate the existing protection systems.

Learning outcomes:

- Explore different earthing designs, principal design considerations and methods of lightning protection in high voltage electrical installations.
- Learn how to test, evaluate and maintain the existing earthing and lightning protection systems and apply practices to mitigate problems for various sites and soil conditions.
- Discuss case studies and typical problems in an interactive workshop environment

Who should attend?

Suggested for all technical personnel involved with substation design; in particular for all engineers, technicians, managers and project managers who work on the substation design and construction of municipal, industrial and commercial transmission and distribution systems. Maintenance personnel might find this course beneficial.

Requirements:

This is an advanced level course. Basic electrical engineering knowledge is required. If you do not have substation engineering background, course SD401 should be attended first. This course works in conjunction with SD402 Substation Earthing Design course and both courses should be attended in order to understand all aspects of designing an effective E&LP systems for HV installations.

Course Content:

Effects of lightning strikes

Lightning Protection Design

- Lightning protection design problem
- Need for lightning protection
- Lightning protection levels
- Zones of protection
- Positioning of air-termination systems
- Earthing of lightning protection systems

HV Surge Protection

- Surge Arresters (operating principles)
- Application and selection of surge arresters

Evaluation of existing E&LP systems

- Visual inspections
- Periodic checks of earthing resistance
- Periodic reevaluation of earthing and lightning design

Workshop / case studies

Interactive discussion on various earthing and lightning protection issues. This four-hour workshop will enable the delegates to practically apply the knowledge presented during the SD402 and 403 courses.

Practical guide for substation earthing & lightning protection design

- Case study: from soil measurements to a soil model
- Case study: an example of a good earthing design
- Case study: evaluating and upgrading an existing substation earthing grid
- Case study: substation lightning protection – roll of sphere and fixed angle design

SD404 – SWITCHGEAR DESIGN

Course Synopsis:

Medium-voltage networks have an important role in the distribution of electrical power, as most customers are directly linked to this network. When specifying and planning medium voltage switchgear for a substation, functions and influencing factors must be matched and an economically efficient solution must be found among the offerings of manufacturers.

This course provides basic design guide for MV switchgear and criteria for bus-bar and circuit breaker selections. It explains typical switchgear configurations and arrangements of MV switchgear.

Learning outcomes:

- Understand the basic function and classification of switchgear and gain insight into main switchgear parameters.
- Learn how to implement the criteria for the selection of bus-bar and circuit breaker.
- Explore typical configurations and arrangements of switchgear.

Who should attend?

Suggested for all technical personnel involved with substation design; in particular for all engineers, technicians, managers and project managers who work on the substation design and construction of municipal, industrial and commercial transmission and distribution systems.

Requirements:

This is a specialist level course. Basic electrical engineering knowledge is required. If you do not have substation engineering background, courses SG101-103 and SD401 should be attended first.

Course Content

MV switchgear design guide

- Basic function of switchgear
- Classification of metal-enclosed switchgear
- Standard switchgear parameters as per IEC
- IEC standardised voltages
- Coordinated values for MV switchgear

Criteria for bus-bar and circuit breaker selection

- Operating voltage, Rated voltage and Insulation level
- Operating current and Rated normal current
- Short circuit power and Short circuit currents
- Calculation of Short circuit currents
- Impedance method for short circuit calculation

Typical configurations of switchgear

- Standard electrical symbols for switching devices
- Criteria for busbar system selection
- Single, Double and Transfer busbar
- Unit substation

Typical switchgear arrangements

- Incomers and Feeders;
- Bus sections and Bus couplers;
- T-off; Metering; Special arrangements
- Typical primary and secondary distribution arrangement

Workshop / case studies

Interactive discussion on various switchgear design issues. This two-hour workshop will enable the delegates to practically apply the knowledge presented during the course.

Practical guide for short circuit current calculation

- Short circuit currents calculation for transformer
- Short circuit currents calculation for synchronous generator
- Short circuit currents calculation for asynchronous motor
- Example of impedance method for short circuit calculation
- Example of short circuit currents calculation for various network configurations

SD405 – TRANSFORMER DESIGN

Course Synopsis:

Availability of new materials and good workmanship improved operating efficiency and transformer life expectancy, but new transformers are built less robust than before. Their reliability, availability, life cycle cost and residual life expectancy depend to a significant extent on how they are designed and built.

This course provides a comprehensive insight into main aspects of transformer construction and most critical design parameters. It provides practical guidance for transformer sizing, calculating transformer losses and efficiency and understanding transformer overload capability.

A two-hour workshop is included in the course for case studies and real scenario problem solving.

Learning outcomes:

- Become familiar with transformer design, basic components, transformer terminology and materials that are used in the manufacturing of transformers.
- Learn basic theory of transformers, their classification and the materials used for their construction.
- Identify the causes of transformer losses, learn how to calculate them and how to minimise them.
- Understand the overload capability of transformers and how to utilise them safely.

Who should attend?

Suggested for all technical personnel involved with substation design; in particular for all engineers, technicians, managers and project managers who work on the substation design and construction of municipal, industrial and commercial transmission and distribution systems.

Requirements:

This is a specialist level course. Basic electrical engineering knowledge is required. If you do not have substation engineering background, courses TR201-203 and SD401 should be attended first.

Course Content:

Theory of transformers

- Transformer function; Equivalent diagram

Vector groups

- Star, Delta, Interconnected star (zigzag),
- Selection of vector groups

Classification of transformers based on

- Mode of operation
- Type of application
- Type of cooling/insulation
- Construction (winding/core configuration)

Transformer components and basic materials

- Main components; Aux equipment & fittings; Insulation system
- Cooling systems and their designations;
- Transformer materials

Most critical transformer parameters and transformer sizing

- Rated power; Impedance; Basic insulation level;
- Rated voltage for windings; Rated voltage ratio;
- Rated frequency; Tapchanging; Class; Transformer sizing

Transformer losses and efficiency

- No-load losses
- Load-losses
- Transformer efficiency

Transformer overload capability

- Normal loading
- Planned overloading
- Emergency overloading

Workshop / case studies:

Discuss transformer design issues and calculate critical transformer parameters. This two-hour workshop will enable the delegates to practically apply the knowledge presented during the course.

Practical guide for calculating critical transformer parameters

- Voltage drop calculation
- Calculating transformer losses and efficiency
- Parallel operation with different secondary voltages
- Parallel operation with different rated impedance voltages

Construction Management

Expertise summary:

Managing everyday tasks is different from managing projects. Project management for substations is about developing electromechanical and civil design and building a new facility within a predetermined time frame, budget and quality parameters. Construction management requires the skills and expertise of a traditional project manager but applied to the construction industry. A substation construction manager must possess a large array of experience and know-how to handle diverse teams and meet assorted objectives.

The courses in this area of expertise lay the foundation on substation design theory, provide insight into project management principles and how to apply them on substation capital projects in order to complete them at required quality, on time and within budget. They also explain the purpose of technical specifications and factory acceptance tests and their role in the evaluation process.

The following courses fall in this group:

CM501 PROJECT MANAGEMENT BASICS

CM502 MANAGING SUBSTATION PROJECTS

CM503 TENDER SPECIFICATION AND PURCHASING

CM504 FACTORY ACCEPTANCE TESTS

Who should attend?

These courses are suggested for all technical personnel involved with substation construction; in particular for all engineers, technicians, managers and project managers who work in the substation design and construction of municipal, industrial and commercial transmission and distribution systems.

Career opportunities:

Substation Project Manager

Attendees that complete SD401 and first two courses in this group (CM501 and CM502) would obtain skills required to manage substation projects, as Substation Project Managers.

Substation Construction Manager

Attendees that complete all courses in this group (CM501 – 504) and all courses in the Substation Design group (SD401 – 405) would obtain skills required to work as Substation Construction Managers.

Senior Design Engineer: Substations

Attendees that have experience in substation maintenance and complete all courses in this group (CM501 – 504) and all courses in the Substation Design group (SD401 – 405) would obtain skills required to perform duties of a Senior Design Engineer: Substations.

Substation Construction Managers that complete all courses on substation maintenance (SG101-103; TR201-204 and MS301) would obtain skills required to become a Senior Design Engineer: Substations.

CM501 – PROJECT MANAGEMENT BASICS

Course Synopsis:

Electric utility engineering staffs have grown leaner to accommodate rising costs and the number of experienced employees who retire each year; however, the demand for electric utility projects continues to grow, which means engineers will have to manage more new projects.

This course provides insight into basic project management principles and how to apply them on substation capital projects in order to complete them on time and within budget.

A two-hour workshop is included in the course for case studies and real scenario problem solving.

Learning outcomes:

- Learn about basic project management principles and management techniques.
- Understand different project phases, their processes and potential pitfalls.
- Become familiar with key elements of project planning and their role in overall success of the project.
- Learn how to assess risk, manage quality and incorporate safety into the project outputs.

Who should attend?

Suggested for consultants, engineers and managers involved with planning, operations and/or maintenance of electrical power systems. Project managers, operational managers and other personnel responsible for purchasing, commissioning and inspecting equipment used in industrial and commercial distribution systems, will find this course extremely beneficial.

Requirements:

This is an advanced level course. Basic electrical engineering knowledge is required. If you do not have substation engineering background, course SD401 should be attended first. This course works in conjunction with CM502 Managing Substation Projects course and both courses should be attended in order to understand all aspects of substation project management.

Course Content:

Introduction to Project Management

- Key aspects of project management
- Stakeholder' expectations and project management constraints
- The role and key skills of project managers
- Most common project management types
- Organisation of a project

Project phases

- Initiation – understanding stakeholders and scoping capital projects
- Planning requirements for successful implementation
- Project execution and interaction with planning and monitoring
- Importance of monitoring and control
- Project closing – the most neglected phase

Key elements of project planning

- Project scheduling and activity sequencing
- Risk identification, risk assessment and response planning
- Quality management – joint owner and contractor responsibility
- Incorporating safety into the design of the project
- Utilising project documentation to manage the project

Basics of construction management

- Main characteristics of construction management
- Types of construction projects
- Parties involved in construction project
- Project delivery methods

CM502 – MANAGING SUBSTATION PROJECTS

Course Synopsis:

Substation projects require interfacing and close coordination of multiple engineering disciplines: electrical, mechanical, civil and structural. Managing substation projects carry unique challenges, which need to be understood and addressed during the planning phase and later managed during construction.

This course provides insight into the challenges linked to the substation projects, specifics of the substation design and construction phases, how to manage specific risks and ensure quality.

A two-hour workshop is included in the course for case studies and real scenario problem solving.

Learning outcomes:

- Become familiar with unique challenges in managing substation projects.
- Consolidate your knowledge on various stages of the project and the required design documentation.
- Learn about project success criteria and understand why projects fail.
- Obtain practical knowledge on scoping, scheduling, risk assessment and QA planning for substation projects through various exercises done in an interactive workshop.

Who should attend?

Suggested for consultants, engineers and managers involved with planning, operations and/or maintenance of electrical power systems. Project managers, operational managers and other personnel responsible for purchasing, commissioning and inspecting equipment used in industrial and commercial distribution systems, will find this course extremely beneficial.

Requirements:

This is an advanced level course. Basic electrical engineering knowledge is required. If you do not have substation engineering background, course SD401 should be attended first. This course works in conjunction with CM501 Project Management Basics course and both courses should be attended in order to understand all aspects of substation project management.

Course Content:

SS Design, construction and commissioning process

Unique challenges and management of substation projects

- Scoping substation projects
- Site selection
- Tendering approach and its effect on project management
- Design phase – the foundation of the project
- Defining activities and their duration for construction phase
- Main risks for substation projects
- Quality assurance through inspections, FAT and commissioning

Project success criteria

- Major reasons why projects fail
- Critical success factors in project management
- Identifying critical success factors

Workshop / case studies:

Discuss issues specific to the management of substation related projects. This four-hour workshop will enable the delegates to practically apply the knowledge presented during the course.

Practical guide to managing substation projects

- Substation project scoping – use SLD and a brief to come up with a scope of work.
- Scheduling exercise – use SOW to define activities and estimate their duration.
- Risk register exercise – brain storming activity to identify major risks, judge their probabilities and suggest potential response.
- Quality assurance plan – discuss typical quality assurance activities that need to be executed during the life of a substation project.
- Design documentation – discuss typical manufacturer’s drawings, concept design and for construction drawings to understand their difference and impact on the outcome of the project.

CM503 – TENDER SPECIFICATION AND PURCHASING

Course Synopsis:

Purchasing decisions must be made to spend the least amount of money while still obtaining the required performance. However the lowest cost option up front often results in a highest cost option over time. Decision makers need to better understand their options and requirements in order to make purchasing decisions that would give them the best return for their investment.

This course is focusing on technical and economic issues that should be considered before purchasing substation equipment. It provides guidance on writing an effective tender specification and running a competent selection process to ensure that the best purchasing decision is made.

A two-hour workshop is included in the course for case studies and real scenario problem solving.

Learning outcomes:

- Identify key aspects of equipment requisition and learn how to provide adequate input into technical specifications and design.
- Learn how to calculate and specify critical design parameters, how to choose appropriate transformer type, cooling system, components and fittings, etc.
- Understand the purpose and objective of technical specifications and what aspects of installation, transformer testing and service conditions need to be specified.
- Understand transformer losses and efficiency, how they impact on the total cost of owning a transformer and how to evaluate the bidders based on this total cost.

Who should attend?

Suggested for consultants, engineers and managers involved with planning, operations and/or maintenance of electrical power systems. Project managers, operational managers and other personnel responsible for purchasing, commissioning and inspecting equipment used in industrial and commercial distribution systems, will find this course extremely beneficial.

Requirements:

This is a specialist level course. Advanced knowledge on substations is required. If you do not have relevant working experience, you need to complete courses SD401 and CM501 – 502 first.

Course Content:

Developing technical specifications

- Misconception about the “standard” design
- Specification purpose and objectives;
- Preparing technical specification
- Normal and Special information
- Useful tips for compiling technical specifications

Main considerations for installation

- Site selection, Transport; Preparations; Field assembly; Inspections;
- Vacuum filling; Energising; Loading; Warranty

Testing requirements

- Testing philosophy based on actual service conditions
- General site conditions and normal operating conditions
- Factory acceptance tests, commissioning and acceptance tests
- Specifying testing requirements and responsibilities

Economic considerations

- Capitalisation of losses
- Specifying to minimise owning cost
- Economics of energy efficient transformers

Workshop / case studies

Calculate critical transformer parameters. Discuss typical technical specifications, tender evaluation and selection process. This two-hour workshop will enable the delegates to practically apply the knowledge presented during the course.

Practical guide for developing and evaluating technical specifications

- Example of calculating capitalisation losses
- Tendering and selection process
- Economics of transformer parallel operation
- Typical technical specification for transformers
- Typical technical specification for switchgear
- Introduction to IEEE/IEC standards

CM504 – FACTORY ACCEPTANCE TESTS

Course Synopsis:

A series of testing is necessary to ascertain that the equipment will withstand the most onerous conditions that can arise in service and that it will be able to perform reliably for 30 years or more of service. These tests are known as Factory Acceptance Tests or simply FAT.

This course discusses various types of testing and their applications. It covers detailed testing procedures and standard IEC/IEEE testing requirements. A two-hour workshop provides practical guidance on what are the key parameters that should be checked during testing and what kind of results should be expected.

Learning outcomes:

- Understand the purpose and objective of factory acceptance tests and what aspects of testing and service conditions need to be specified.
- Identify key aspects of factory acceptance testing and how to use it to obtain the adequate information relevant to technical specifications and design.
- Learn a number of procedures for electrical testing used during transformer FAT, how to interpret the test results and confirm if they comply with relevant standard requirements.
- Become familiar with the factory acceptance testing requirements and procedures for MV switchgear.

Who should attend?

This course is suggested for consultants, engineers and managers involved with planning, operations and/or maintenance of electrical power systems. Project managers, operational managers and other personnel responsible for purchasing, commissioning and inspecting transformers in industrial and commercial distribution systems, will find this workshop extremely beneficial.

Course Content:

Testing philosophy and categories of transformer tests

- Factory acceptance tests (routine, type and special tests)
- Commissioning and Acceptance tests

General testing requirements

- Normal service conditions and Testing conditions
- Minimum air clearance and flash over distance

Routine tests for power transformers

- Winding resistance
- Voltage ratio and tap changer test
- Measurement of no-load current and no-load losses
- Impedance voltage, short -circuit impedance and load loss
- Separate-source voltage withstand test
- Induced overvoltage withstand test
- Lightning and switching impulse withstand test

Type tests for power transformers

- Temperature-rise test
- Adjusted temperature rise

Special tests for power transformers

- Winding insulation resistance
- Magnetising currents
- Polarity check of CTs built into transformers
- Zero-sequence impedance on three-phase transformers
- Noise level test
- Power factor/Tan Delta
- Core earthing test
- Short circuit withstand test

Factory acceptance testing for switchgear

- Routine tests
- Visual and Mechanical Inspection
- Electrical Tests

Workshop

Interactive discussion on various FAT issues. This course is presented in a form of an interactive workshop that will enable the delegates to practically apply the knowledge presented during the course.

Practical guide for planning FAT

- List of transformer tests & their applications
- Introduction to IEEE/IEC power transformer standards
- FAT procedures for transformers

About MATREX

MATREX is a power engineering company that has brought together expertise and experience to provide professional services in the field of electrical engineering. Our core services are engineering, consulting and specialised training.

MATREX provides comprehensive engineering and consulting services required for building new substations and for renovation, modernisation and extension of existing substations. Our main strength is high efficiency in providing cost effective, customised, end-to-end solutions. Our business strategy is to provide skills and services at the level of the most reputable international companies, at competitive prices.

MATREX has developed and successfully presented a number of courses in the field of electrical engineering. The following courses were validated by Engineering Council of South Africa (ECSA) and South African Institute of Electrical Engineers (SAIEE) to date:

1. Transformer Fault Finding SAIEE-0823-V
2. MV Switchgear Operation and Maintenance SAIEE-0721-V
3. Substation Earthing and Lightning Protection Systems SAIEE-0713-RV1
4. Transformer Operation & Maintenance SAIEE-0684-RV1
5. Transformer Design Planning, Installation & Procurement SAIEE-0450-V
6. Analysing and Managing Transformer Oil SAIEE-0417-V
7. Transformer Testing SAIEE-0361-V
8. Earthing and Lightning Protection for HV Installations SAIEE-0181-V
9. HV&MV Switchgear Application and Maintenance SAIEE-0179-V
10. Transformer Operation & Maintenance SAIEE-0166-V
11. Principles of the Maintenance of Electrical Switchgear SAIEE-0137-V

About the Authors



Aleksandar Milin IEng(UK) is a Power Engineering Consultant, MD of MATREX and a member of the IET and CIGRE. He completed Electrical Engineering at the University of Belgrade, Serbia, where he also completed two years of post-graduate studies for Power transmission & distribution in 1987.

His first employment was with MINEL Transformer Factory in Belgrade, as Manager of HV Laboratory . He continued his line of work at SABS – NETFA. In 1994 he joined Siemens, SA as a Transformer Design Engineer. After completing two specialisations with Siemens, Germany, he was appointed as Engineering Manager: HV/MV department in 1996. He established his own consultancy business in 1999.

He has built an impressive portfolio of projects, which were implemented in over 20 countries throughout Europe, Africa, Asia, South America and Australia and has been sharing his knowledge and experience through a number of courses in the field of electrical engineering.



Soraya Milin is a Strategic Management Consultant and one of the Directors of MATREX. She received her Electrical Engineering degree at the University of Belgrade, Serbia, where she also completed two years of post-graduate studies for Microwave Telecommunications in 1990.

Her career started as a research engineer at the Institute for Microwave Electronics in Belgrade. In 1995 she joined Multichoice as Operations Manager and part of the technical team that launched the digital satellite television in Africa. In 1999 she was appointed General Manager: Strategic Support.

In 2002 she joined MATREX to apply her business skills in sustaining the continuous growth of the company. Through her career, she contributed to the development of a number of national standards at South African Bureau of Standards (SABS) and served on the Digital Broadcasting Advisory Body for the Department of Communications. Her articles were published by IEEE and she presented on various conferences.

Course Material

A comprehensive course material is provided to enables the attendees to digest the subject matter in their own time. The material for our courses consists of a course transcript (80 - 90 pages), handouts (over 85 pages) and slide presentation (over 190 slides).

We also provide detailed daily timing and pre and post quiz to evaluate the level of knowledge and benefit of the course. The presentation includes video clips and numerous graphs and photos to effectively present the subject to the attendees.