



Laxmi Associates

Consultancy |Third party Inspection |RLA | Testing & Commissioning |AMC |Project Management |Training

323-324, Sunplaza1, GIDC Road, Makarpura, Vadodara-390010.

lxassociates@gmail.com, www.laxmiassociates.in, 09374076950, 02653267575

LA Engineering Academy

The course content is designed for engineers in the field of Power Generation, Transmission, Distribution. The course also educates the new recruits by providing both practical and theoretical exposures. All course will be delivered by the experts having sound field engineering practice backed by relevant theory and operating principle to enrich the training program. The course structure is designed in 2 level package as mentioned below.

Level 1- Advance Course on Asset Management for T&D system from Expert of the Industry

Level 2- General course on Condition assessment of Equipment

ADVANCE COURSE

SR. No.	Title	Duration
TR-A-1	Life cycle management of Power Transformer by RLA , Asset management, CBRM and PASS 55 application	2 Days
TR-A-2	Life cycle management of MV & HV Switchgear by RLA , Asset management, CBRM and PASS 55 application	2 Days
TR-A-3	Electrical Hazards & Safety management Course	2 Day

GENERAL COURSE

SR. No.	Title	Duration
TR-B-1	Condition Assessment, Diagnostic measurement and Residual life assessment of power Transformer.	2 Days
TR-B-2	Basics of SFRA and Interpretation criteria for condition assessment of Power transformers.	1 Days
TR-B-3	Condition assessment of Current Transformer.	1 Day
TR-B-4	Condition assessment of HV Bushings	1 Day
TR-B-5	Basics of DP and Furan analysis for oil-paper insulation of Power transformers, Current transformer and Bushings.	1 Day
TR-B-6	Moisture Estimation and Dielectric assessment of Power Transformers.	1 Day
TR-B-7	Partial discharge (PD) measurement & and Diagnostic of transformers, motors, generators and cables.	1 Day
TR-B-8	Diagnostic test and Condition assessment of Rotating Machine	1 Day
TR-B-9	Diagnostic test and Condition assessment of Power Cables.	1 Day
TR-B-10	Condition assessment of CVT (Capacitive voltage transformer).	1/2 Day
TR-B-11	Condition assessment of Lightning Arrestor by Offline and online third harmonic leakage current technique	1/2 Day
TR-B-12	Condition assessment of EHV, HV and MV class Circuit Breakers	1 Day
TR-B-13	Condition assessment & Diagnostic test of Motor	1 Day
TR-B-14	Best Maintenance, Safety practice and Isolation procedures for HV and LV System.	1/2 Day
TR-B-15	Substation technology - Developments & future trends ,Gas Insulated Substation (GIS) & Air Insulated Substation – design, testing, monitoring and maintenance of substation equipment	2 Day
TR-B-16	Significance of Quality stage Inspection and type test of Power Transformer in Factory- A quality Aspect.	1 Day
TR-B-17	Design Review of Power Transformer , Onerous conditions and Failure mode	1/2 Day

Life cycle management of Power Transformer by RLA , Asset management, CBRM and PASS 55 application Course

Course Code: TR-A-1, Duration: 2 days

Day 1-1 Methodology for Implementation of RLA & Life Extension

- Condition monitoring (CM) and condition assessment (CA) techniques.
- Performing maintenance plans.
- Aging, health, and end of life assessments.
- Risk management process development
- Updated maintenance processes and procedures
- Creation of a transformer asset management system

Day 1-2 Transformer Fleet Screening & criticality assessment

- Review of historical performance and O&M records
- Operational and condition assessment data

Day 1-3 Review of risk-based inspection and maintenance of transformer components

Day 1-4 Transformer Failure mechanism & FEMA

- High operating temperature
- System faults
- Careless or negligent operation, Leakage
- OLTC failure and Poor Maintenance
- Increased water content
- Heating problems due to accumulated sludge deposits on windings and in cooling ducts.
- Hot connections
- Pump or fan failure including bearings
- Bushing failure
- Winding failure

Day 2-1 Maintenance strategy

- Risk-based maintenance strategies vs traditional strategies
- Components of risk-based maintenance strategies- Condition assessment, , condition-based maintenance & optimized time-based maintenance , continuous On-Line Monitoring
- Risk-based asset life cycle management strategies - Transformer RLA, refurbishment, life extension and replacements

Day 2-2 Mitigating actions – repairs and refurbishment, life extension

- Identification of components requiring replacements, repairs, upgradations /retrofitting.
- On-site procedure for Major Mid-Life Refurbishment
- Low frequency heating technique for on-site drying of solid insulation

Day 2-3 Assessment of remaining life by Residual Life Assessment (RLA) studies.

- Paper aging and its effect
- Solid Insulation and Cellulose degradation
- Furans- Chemical structure and causes
- Analysis of Furanic compound by ASTM Method D 5837 or IEC Method 61198
- Factors influencing the concentration and stability of Furanic compounds
- Basic theory of Degree of Polymerization (DP) and measurements
- Correlation between DP and Furan
- Understanding the Xue Chendong equation and its limitations
- End of life criteria for DP

Day 2-4 Development of asset life cycle management system for transformers

- Transformer asset information management
- Development of processes, methods and application of technologies
- Impact of failure, risk calculation models and methodology
- Developing transformer asset management strategy & plans
- Role of remaining life assessment in risk based asset management
- Implementation of Life Extension Programme by PASS 55

Life cycle management of MV & HV Switchgear by RLA , Asset management, CBRM and PASS 55 application Course

Course Code: TR-A-2, Duration: 2 days

Day 1-1: Life Cycle Management of MV Switchgear- Overview

- Principles of circuit breaker maintenance – mechanisms and mechanical aspects
- Arc characteristics – closing and opening – short circuit testing -standards
- Switchgear ancillaries, measurement CTs, VTs, relays –complex protection
- Up to 220 kV, 3-phase and single phase 275/400kV SF6 arrangements
- Tests to be undertaken during commissioning
- On line check & Inspection
- Tests to be undertaken during and following maintenance
- Diagnostic testing & Condition assesment
- Principles of time and condition based asset management
- Assessment of aged switchgear
- Definition of failure – according to Cigre
- Cigre CB - Failure survey
- Mechanical aspects
- Maintenance aspects
- Health index scale of medium voltage primary switchgear systems
- Medium voltage primary switchgear designed life expectancy and failure issues

Day 1-2: Maintenance engineering strategy for MV Switchgear

- Maintenance approaches
 - Corrective maintenance
 - Periodic / time interval based maintenance
 - Preventative maintenance
 - Condition based maintenance/ predictive maintenance
 - Reliability centered maintenance
- Maintaining oil circuit breakers
 - Cleaning and inspection of oil-filled
 - Tank cleaning techniques
 - Post-fault maintenance of oil circuit-breakers chambers
- Maintaining vacuum circuit breakers
- Maintaining SF6 circuit breakers & GIS
 - -Frequency of maintenance
 - -SF6 parameters - filling pressures and dew point considerations
 - -Decomposition of arced SF6.
- CT and VT check
- Maintenance schedule: Weekly, Monthly, Yearly schedule of maintenance
- Optimisation of maintenance planning & scheduling

Day 1-3: Condition assessment and Diagnostic Testing

On- line Test

- Switchgear inspection methodologies
- Partial discharge measurement and survey
- Thermovision, Oil testing

Off- line Test

- Mechanism testing and auxiliary relay contact circuits –trip coils open/close test
- Contact trip timing tests and record interpretation
- Testing of MV and HV Switchgear-partial discharge diagnostic tests –off line
- Power Factor tests – Tip-up tests
- Primary injection test
- Static & Dynamic resistance measurement (DRM)
- Vibration testing on circuit breaker
- Vacuum bottle test
- SF6 leakage test
- Motion test & Mounting of motion transducer
- Trouble shooting and Fault localization– use of diagrams and manufacturers manuals

Day 2-1: Switchgear Failure Causes and Root cause Analysis

- Switchgear defects and defect control systems
- Mechanisms of deterioration of insulation
- Assessing degradation in specific suspect components
 - Loose/Hot connection on the cable and busbar contacts
 - Low gas pressure
 - Vacuum loss
 - Insulation breakdown
 - Circuit-breaker speed performance
 - Circuit-breaker contact resistance
 - Mechanical alignment of rackable unit
 - Interlock integrity
 - General conditions-Moisture
 - Contact maintenance and Contact wipe
 - PD activity- Surface PD, Internal PD, Corona, Void

- Failure mode of Individual switchgear Component:
 - Main bus insulation
 - Breaker insulation
 - Current transformers
 - Voltage transformers
 - Cable terminations
 - Support insulators
 - Non-shielded cables in contact
- Identifying non –reliable components
- Improving maintenance programs
- Major failures segmented by failure mode
- Precautions for reducing the risk of switchgear failure and injury
- Case histories of failures – Investigation and Root cause analysis

Day 2-2: Asset Management, PASS 55 and FEMA in Switchgear context

- Development of Asset management systems and maintenance strategies
- Phased manner asset plans and policies
 - Phase 1 – Design Review & Maintenance History
 - Phase 2 – Review of On-line off –line Data & assessment procedures
 - Phase 3 – Asset indexing
 - Phase 4 – Review and decision
- Auditing and benchmarking of maintenance and asset performance
- Asset risk assessments and vulnerability studies
- Optimizing spare parts inventories
- Reliability Centred Maintenance / Risk Based Maintenance studies
- Cost/benefit optimisation of maintenance tasks using decision support tools
- Establishing a detailed planning for maintenance, replacement or refurbishment
- End-of-life criteria and condition rating
- Development of FMEA and Worksheet of FMECA.

Electrical Hazards & Safety management Course

Course Code: TR-A-3, Duration: 2 days

Day 1-1 Overview of Electrical Hazards & Safety

- Key Elements of an Effective Electrical Safety Program
- Electrical Hazards: Understanding the Danger
- Electrical Incident Causes
 - Unsafe Switching Acts
 - Not following Operating Procedure
 - Unsafe Working Conditions
 - Not following Maintenance procedures
- Arc Flash Danger Statistics
- Electrical safety equipment for safe isolation purposes
- Effect of Electric Shock
- Electrical Hazard Protections

Day 1-2 Arc Flash Hazard analysis

- Electrical Hazards Analysis
- Determination of Arcing Fault Clearing Time
- Determining Arc Flash Hazard Risk Category
- Incident Energy Exposure Calculations
- Understanding and Applying NFPA 70E Tables
- Shock Protection Boundaries
- Limits of Approach
- Energized Work Permit
- Limited Approach Boundary
- Restricted Approach Boundary
- Prohibited Approach Boundary
- Determining Arc Flash Hazard Risk Category
- Evolution of Arc-Resistant Standards
- OSHA 29 Code of Federal Regulations (CFR) Part 1910, Subpart S
- NFPA 70E-2004, "Standard for Electrical Safety in the Workplace"
- IEEE 1584-2002, "Guide for Arc Flash Hazard Analysis"
- IEEE C37.20.7-2007, IEEE Guide for Testing MV Metal-Enclosed Switchgear for Internal Arcing Faults
- Arc Hazard – pressure, thermal radiation, sound levels and arc blast
- Personal Protective Equipment (PPE) – Types, Tests & Categories
 - NFPA Categories 0 to 4

Day 1-3 Minimizing Arc-Flash and Other Electrical Hazards

- Design a Safer System
- Use and Upgrade to Current-limiting
- Proper Selection of Overcurrent Protective Devices
- Implement an Electrical Safety Program
- Use of Personal Protective Equipment (PPE)
- Use Warning Labels
- Use an Energized Electrical Work Permit
- Establish a Safe Work Practices
- Requirements for Resetting Circuit Breakers
- Arc Flash - Mitigation Techniques
 - Redirecting energy away from workers
 - Reducing the arcing current
 - Increasing the working distance
 - Using remote racking device, remote operating devices incident energy might be reduced
 - Reducing the clearing time
 - Zone selective interlocking
 - Bus bar protection
- Precautions against equipment malfunction such as inadvertent trips

Day 2-1 Electrical isolation and Safety procedures

- Isolation and Switching in LV supply system
- Need of Secondary Isolation & Identifying location of Secondary Isolation
- Secondary Isolation Tagout/Lockout procedure
- Hazards of Improper secondary Isolation
- Regulations relating to secondary isolations
- Various situations requiring secondary isolation with example showing secondary isolation points
 - Inspection, testing & Maintenance of Metering & Protection Circuit
 - Checking the correctness of Bus Wiring
 - IR Tests on Control wiring
 - Functional Checks on Alarm/ Annunciation Scheme
 - Functional and Interlock Checks on Breaker
 - Interlock Check between Feeders
 - Maintenance and Testing of DC Battery system
 - Maintenance Work on the Pilot cable route.& Pilot termination

- Safety procedures required for avoiding fire hazards during Battery charging
- Safety procedures required for preventing fire in LV PVC Cable
- Permit procedures applicable for secondary isolation (entire flow to be discussed)
- Restoration after completion of work and return of permit
- Equipment used in achieving secondary isolation
- Precautions against inherent hazards
 - Planning for secondary isolation
 - Job risk analysis specific to secondary isolation
 - Schematics to be considered while planning
 - Importance of consulting the latest updated documentation
 - Filling in a typical secondary isolation schedule and its approval
 - Special precautions to be observed/importance of correct sequencing during isolation and restoration

Day 2-2 Safety Procedure & Isolation in HV System

- Isolation and Switching in HV supply system
- Secondary Isolation as a part of Maintenance work in HV systems
- High Voltage Access Permit Procedure
- Safety procedures required for work on or near live equipment
- Precautions against Equipment malfunctions in achieving Secondary Isolation
- Safety Features available in Modern Switchgear for Secondary Isolation
- Safe maintenance policies, including safe working practice in switch rooms, indoor and outdoor substations
- The main causes for safety & internal arc are:
 - Operational and maintenance faults
 - Atmospheric and switching over voltages
 - Dielectric faults of solid insulation materials (*e.g. cable terminations, VT, CT*)
 - Overstress of load break switches, circuit breakers , Isolator

Day 2-3 Proper Grounding/Equivalent Bonding practices

- Proper Grounding and Bonding for Safety
- Applicable Standards and Recommended Practices
- Main substation earthing and bonding
- Step and touch potentials – danger to personnel

- Routine testing and certification of substation earthing
- Safe working in a substation environment
- Typical Grounding/Bonding Errors, Problems & Resolutions
- Key Considerations for Performance Grounding
- Ground Loops – Causes & Corrections
- Single Point vs. Multi-Point Grounding
- Grounding and Bonding for Lightning Protection

Day 2-4 CONCLUSION

- Recommended Safety Measures, Live working & risk assessments
 - Job risk analysis specific to secondary isolation
 - Risk assessment and management
 - Developing a strategy for evaluating Arc Flash & Shock Hazards
- Live Case study on Electrical Safety related Hazards

Condition Assessment & RLA of power transformers

Course Code: TR-B-1, Duration: 2 days

- Structure of transformers
- Factory tests
- Aging mechanisms
- Gas-in-oil analysis (DGA)
- Ratio and no-load current measurement and its significance
- Resistance measurement & Tap changer testing
- Capacitance and dissipation factor measurement of the inner insulation
- Capacitance and dissipation factor measurement of high-voltage bushings
- Leakage reactance measurements
- Analysis of Mechanical condition & winding damages with the SFRA method
- Partial discharge measurements of power transformers
- DP and Furan measurement and test data assessment criteria

Basics of SFRA and Interpretation criteria for condition assessment of Power transformers

Course Code: TR-B-2, Duration: 2 days

Session 1: Introduction

- ✚ Introductions
- ✚ Short circuit failures in transformers
- ✚ Competing diagnostic techniques
- ✚ SFRA theory and practice
 - Basic circuit theory EE and expected SFRA responses of RLC network
 - Series and Parallel resonance of RLC circuit SFRA response
 - Modeling of Transformer winding and expected SFRA response in various frequency range.

Session 2: Basic requirement of SFRA measurement.

- ✚ Grounding requirements
- ✚ Recommendations for making good SFRA measurements
- ✚ Typical SFRA responses
- ✚ Repeatability

Session 3: Good Measurement of SFRA

- ✚ Discussion of relevant safety requirements
- ✚ Operation of SFRA instrument software
- ✚ Use of test leads
- ✚ Measurements on a transformer

Session 4: Basic principle of interpretation of SFRA results

- ✚ Review of measurements made during practical session
- ✚ Interpretation strategies: reference, phase, sisters
- ✚ Using Cross-correlation Coefficients to Analyze Transformer SFRA Traces
- ✚ Analysis and interpretation of various fault by SFRA
 - Hoop buckling of inner windings□
 - Axial collapse
 - Failure of clamping
 - Tap lead movement
 - Faulty core ground
 - Shorted turn fault
 - High Impedance fault

Session 5: Advanced features of SFRA interpretation

- ✚ SFRA Test data: Pitfalls in SFRA
- ✚ Effect of Residual measurement
- ✚ SFRA analysis of transformer with and without oil filled
- ✚ Effect of Core Grounding and earth circuit on SFRA
- ✚ SFRA measurement of the transformer with irreversible Tapchanger
- ✚ Field and Factory SFRA plot comparison criteria
- ✚ Using Cross-Correlation Coefficients to Analyze Transformer SFRA Traces

Condition assessment of Current transformers

Course Code: TR-B-3, Duration: 1 days

Overview of the Structure and Type of CT & design parameters

- CT accuracies as per IEC - 60044 -1 (Metering core, Protection core, PS class)
- Live & Dead Tank CTs.
- Knee point voltage
- Insulation Level (Power frequency withstand , Lightning and switching impulse test)
- Partial Discharge limits
- Creep age distance

Factory & Commissioning test of Current Transformer (Procedures as per IEC - 60044)

- Polarity Test
- Magnetization Curve and knee point voltage Test
- Ratio and phase angle error Test
- Composite error and ISF test
- HV Power frequency withstand test and Impulse test
- Partial discharge test
- Capacitance and Power Factor Measurement

Condition monitoring of CT

- Capacitance and Power Factor Measurement (C1 and C2 test and their significance)
- Thermovision Scanning
- DGA and Routine testing of Oil (Norms of DGA interpretation by IEC and CIGRE guideline)
- Reasons of CT failure

• Maintenance schedule and their importance

- Nitrogen Pressure Checking
- Checking of bellow expansion
- Visual inspection for leakage

• Residual life assessment of oil filled CT

- Furan, DGA, acidity & moisture of CT oil
- PDC+FDS method for moisture measurement of paper insulation
- DP test of paper sample from aged and failed CTs
- Capacitance and Power factor measurement & trend analysis
- Partial discharge test by on-line electrical method and acoustic method

• Case studies- CT incipient fault detection by condition based monitoring.

• Investigation of CT failure and finding of design , manufacturing weakness.

Condition assessment of HV Bushings

Course Code: TR-B-4, Duration: 1 days

- **Introduction to the Construction and Type of Bushing**
 - Construction details of condenser type bushing
 - Capacitance grading and Electric field distribution
 - Bushing Test Tap Construction.
 - Bushing Potential Tap Construction.
- **Basic design parameters**
 - Available design of bushing Tap and Tap voltage calculation
 - Difference between Potential Tap and Test Tap of the bushing
 - Insulation Level (Power frequency , Lightning and switching impulse test)
 - Partial Discharge limits
 - Creep age distance
- **Factory test of Bushing**
 - HV Power frequency withstand test and Impulse test
 - Partial discharge test
 - Capacitance and Power Factor Measurement
- **Condition monitoring of Bushing**
 - Capacitance and Power Factor Measurement (C1 and C2 test and their significance)
 - Negative power factor and its significance
 - Thermovision Scanning
 - DGA and Routine testing of Oil (Norms of DGA interpretation by IEC and CIGRE guideline)
 - Partial discharge test
 - Reasons of Bushing failure
- **Residual life assessment of oil filled Bushing**
 - Furan, DGA, acidity & moisture of Bushing oil
 - PDC+FDS method for moisture measurement of paper insulation
 - DP test of paper sample from aged and failed Bushing
 - Capacitance and Power factor measurement & trend analysis
 - Partial discharge test by on-line electrical method and acoustic method
- **Case studies- Bushing incipient fault detection by condition based monitoring.**
- **Investigation of Bushing failure and finding of design , manufacturing weakness.**

Basics of DP and Furan for oil-paper insulation of Power transformers, Current transformer and Bushings.

Course Code: TR-B-5, Duration: 1 days

- **Insulation system structure in Power transformer- An Overview**
- **Paper aging and its effect**
- **Solid Insulation and Cellulose degradation**
- **Furans- Chemical structure and causes**
- **Analysis of Furanic compound by ASTM Method D 5837 or IEC Method 61198.**
- **Factor Influencing the concentration and stability of Furanic compounds**
 - *Effects of oil degassing by partial vacuum*
 - *Effects of oil reclamation*
 - *Effects of oil replacement*
- **Basic theory of Degree of Polymerization (DP) and measurements**
- **Correlation between DP and Furan**
- **Understanding the Xue Chendong Equation and Its Limitations**
- **End of life criteria for DP**
- **Effect of operating temperature**
- **Case studies and Recommendation for analysis**

Moisture Determination and Dielectric Diagnostic at Power Transformers

Course Code: TR-B-6, Duration: 1 days

- Importance of moisture evaluation & Dangerous effects of moisture
- Various State of moisture in Transformer and Relative saturation of oil
- Temperature gradient of transformer and consideration of operating temp for moisture analysis
- Moisture contamination, distribution between cellulose and oil and equilibrium processes
- Measurement by Karl Fischer titration and equilibrium diagrams
- Measurement by online sensors
- Measurement by dielectric diagnostic methods
- Practical application of measurements
- Interpretation of results
- Theory about the dielectric response of insulation materials
- Assessment of moisture concentration as a basis for subsequent actions
- Low frequency heating technique for on-site drying of solid insulation
- Practical application and data analysis using the PDC+FDS method

Partial discharge measurement (PD) of transformers, motors, generators and cables

Course Code: TR-B-7, Duration: 1 days

- Basics and physics of partial discharge
- Functions of partial discharge measurement system,
- Evolution of measurement technology
- Detail study of Acoustic Method, Electrical Method, UHF Method of PD measurement
Interpretation of PD measurement data by Acoustic Method, Electrical Method, UHF Method
- Case Studies: Detection of Incipient fault by PD.

Diagnostic test & Condition assessment of Rotating Machine

Course Code: TR-B-8, Duration: 1 days

- **Overview of the Structure of Rotating Machine**
 - Stator components
 - Types of dry resin insulation used
 - Rotor components
- **Diagnostic testing of stator winding**
 - Stresses acting on stator winding
 - Root cause of stator failure
 - Possible defects for origin of PD
 - Partial discharge test and limitations of the various technique
 - Capacitance and Power factor measurement and limits of PF for various dry type insulation.
 - DC insulation resistance and polarization index limits
- **Diagnostic testing of Stator Core**
 - Stresses acting on Stator Core
 - High Power Ring Flux Test (Thermal Loop)
 - Electro-magnetic Core Imperfection Detector (ELCID) – Case studies of damage core
- **Diagnostic testing of Rotor**
 - Stresses acting on Rotor winding
 - Basic rotor theory
 - Basic construction and location of Air gap search coil (AGSC's)
 - Basic theory behind AGSC's
 - Condition monitoring procedures
 - Root cause of rotor failure
 -
- **Condition assessment criteria of Generator**
- **Case studies- Generator inspection**
 - Minor outage, -Major outage
- **Investigation of Generator failure and finding of design , manufacturing weakness.**

Condition assessment of Power Cable

Course Code: TR-B-9 Duration: 1 days

- **Constructional features and Type of Cable**
 - Single conductor, Shielded and unshielded conductor.
 - Multiconductor, Shielded and unshielded conductor
 - Termination of XLPE cable
 -
- **Failure Pattern for XLPE Cable**
 - Failure path in XLPE cable
 - Effect of bad earthing and cable joints
- **Condition assessment of Cable**
 - Capacitance , Power Factor and Power factor tip-up Measurement
 - Interpretation, Trend monitoring & Limit values for different type of cable
 - Electrical Partial discharge test and location of fault in Cable
 - On line Acoustic Partial discharge test and location of Fault in Cable joints and Termination
 - Low frequency dielectric spectroscopy for moisture assessment.
 - Various Reasons of Cable failure
- **Investigation of Cable failure and finding of design , manufacturing weakness.**

Condition assessment of CVT (Capacitive voltage transformer)

Course Code: TR-B-10 Duration: 1 days

- **Constructional features of CVT**
 - C1 and C2 capacitors.
 - Compensating reactor.
 - EMU Unit
 - Compensating reactor
 - Secondary circuit

- **Condition assessment of CVT**
 - Capacitance and Power Factor Measurement ,C1 and C2 measurement
separately in case of non availability of C2 test tap also.
 - Interpretation, Trend monitoring & Limit values for C1 and C2 test.
 - Secondary voltage monitoring and limitation of the method
 - Ratio tests.
 - Secondary winding IR value
 - Reasons of CVT failure

- **Maintenance schedule and their importance**
 - Temperature of EMU Tank.
 - Oil level check.
 - Visual inspection for leakage

- **Case studies- CVT incipient fault detection by condition based monitoring.**

- **Investigation of CVT failure and finding of design , manufacturing weakness.**

Condition assessment of MV & HV Switchgear

Course Code: TR-B-12 Duration: 1 days

- Introduction to Switchgear
- Switching Phenomena
- Air & Oil Switchgear
- SF6 Switchgear
- Vacuum Switchgear
- Switchgear Mechanisms
- Retrofit Switchgear
- Fault Currents & Fault Level
- Standards & Procurement
- Switchgear Testing
- Auto Reclosing & Network Automation
- Failure Mechanisms & Analysis
- Condition Assessment of Switchgear
- Technology Update

Best Safety practice, Grounding and Isolation procedures for HV and LV System

Course Code: TR-B-14 Duration: 1 days

Electrical isolation and Safety procedures

- Isolation and Switching in LV supply system
- Need of Secondary Isolation & Identifying location of Secondary Isolation
- Secondary Isolation Tagout/Lockout procedure
- Hazards of Improper secondary Isolation
- Regulations relating to secondary isolations
- Safety procedures required for preventing fire in LV PVC Cable
- Permit procedures applicable for secondary isolation (entire flow to be discussed)
- Restoration after completion of work and return of permit
- Equipment used in achieving secondary isolation
- Precautions against inherent hazards

Safety Procedure & Isolation in HV System

- Isolation and Switching in HV supply system
- Secondary Isolation as a part of Maintenance work in HV systems
- High Voltage Access Permit Procedure
- Safety procedures required for work on or near live equipment
- Precautions against Equipment malfunctions in achieving Secondary Isolation
- Safety Features available in Modern Switchgear for Secondary Isolation
- Safe maintenance policies, including safe working practice in switch rooms, indoor and outdoor substations

Proper Grounding/Equivalent Bonding practices

- Proper Grounding and Bonding for Safety
- Applicable Standards and Recommended Practices
- Main substation earthing and bonding
- Step and touch potentials – danger to personnel
- Routine testing and certification of substation earthing
- Safe working in a substation environment
- Typical Grounding/Bonding Errors, Problems & Resolutions
- Key Considerations for Performance Grounding
- Ground Loops – Causes & Corrections
- Single Point vs. Multi-Point Grounding
- Grounding and Bonding for Lightning Protection

Substation technology - GIS & Air Insulated Substation – design, testing, monitoring and maintenance of substation equipment

Course Code: TR-B-15 Duration: 2 days

- Planning and Design
- Layout& Main equipment
- Planning and Design of:
- Communication equipment
- Reactive Power Control equipment
- Protection schemes
- Auxiliary equipment
- Grounding (Earthing)
- Gas insulated switchgear
- Miscellaneous

Contact us for any enquiry related to our Training activity.

Thanks !

Dr. Aradhana Ray

E-mail:rayaradhana@yahoo.com,, Mobile No.09374076950

Laxmi Associates (Engineering consultancy & Service Provider)

323-324, Suplaza 1, Makarpura GIDC Road, Near Vadsar Flyover, Makarpura, Vadodara-390 010

<http://www.laxmiassociates.in/> **Phone: 02653267575,**