High Voltage Testing and Measurement

Course Outlines

Module (1) Introduction:

1.1 Development of Power Systems and Required High-Voltage Test Systems.
1.2 The International Electrotechnical Commission and Its Standards
1.3 Insulation Coordination and Its Verification by HV Testing
1.4 Tests and Measurements in the Life Cycle of Power Equipment

Module (2) Basics of High-Voltage Test Techniques

2.1 External and Internal Insulations in the Electric Field
   2.1.1 Principles and Definitions
   2.1.2 HV Dry Tests on External Insulation Including Atmospheric Correction Factors
   2.1.3 HV Artificial Rain Tests on External Insulation
   2.1.4 HV Artificial Pollution Tests on External Insulation
   2.1.5 HV Tests on Internal Insulation
   2.1.6 Hints to Further Environmental Tests and HV Tests of Apparatus
   2.1.7 Equipotential surfaces

2.2 HV Test Systems and Their Components
2.3 HV Measurement and Estimation of the Measuring Uncertainty
   2.3.1 HV Measuring Systems and Their Components
   2.3.2 Approval of a HV Measuring System for an Accredited HV Test Field
   2.3.3 Calibration by Comparison with a Reference Measuring System
   2.3.4 Estimation of Uncertainty of HV Measurements
   2.3.5 HV Measurement by Standard Air Gaps According to IEC 60052:2002
   2.3.6 Field Probes for Measurement of High Voltages and Electric Field Gradients

2.4 Breakdown and Withstand Voltage Tests and Their Statistical Treatment
   2.4.1 Random Variables and the Consequences
   2.4.2 HV Tests Using the Progressive Stress Method
2.4.3 HV Tests Using the Multiple-Level Method
2.4.4 HV Tests for Selected Quantiles Using the Up-and-Down Method
2.4.5 Statistical Treatment of Life-Time Tests
2.4.6 Standardized Withstand Voltage Tests
2.5 Grounding high voltage test areas and warning signs

Module (3) Tests with High Alternating Voltages

3.1 Generation of HVAC Test Voltages
   3.1.1 HVAC Test Systems Based on Test Transformers (ACT)
   3.1.2 HVAC Test Systems Based on Resonant Circuits (ACR)
   3.1.3 HVAC Test Systems for Induced Voltage Tests of Transformers (ACIT)
3.2 Requirements to AC Test Voltages and Selection of HVAC Test Systems
   3.2.1 Requirements for AC Test Voltages
   3.2.2 Test Systems for Multi-purpose Application
   3.2.3 AC Resonant Test Systems (ACRL; ACRF) for Capacitive Test Objects
   3.2.4 HVAC Test Systems for Resistive Test Objects
   3.2.5 HVAC Test Systems for Inductive Test Objects: Transformer Testing
3.3 Procedures and Evaluation of HVAC Tests
   3.3.1 HVAC Tests for Research and Development
   3.3.2 HVAC Quality Acceptance Tests and Diagnostic Tests
3.4 HVAC Test Voltage Measurement
   3.4.1 Voltage Dividers
   3.4.2 Measuring Instruments.
   3.4.3 Requirements for Approved Measuring Systems
3.5 Very Low Frequency VLF

Module (4) Partial Discharge Measurement

4.1 Special Faraday cages for partial discharge measurements
4.2 PD Models
   4.2.1 Capacitive PD Model
   4.2.2 Dipole Model
4.3 PD Pulse Charge Measurements
   4.3.1 Decoupling of PD Signals
   4.3.2 PD Measuring Circuits According to IEC 60270
4.3.3 PD Signal Processing
4.3.4 PD Measuring Instruments
4.3.5 Calibration of PD Measuring Circuits
4.3.6 Performance Tests of PD Calibrators
4.3.7 Maintaining the Characteristics of PD Measuring Systems
4.3.8 PD Test Procedure
4.4 PD Fault Localization
4.5 Noise Reduction
4.5.1 Sources and Signatures of Noises
4.5.2 Noise Reduction Tools
4.6 Acoustic PD Detection

Module (5) Measurement of Dielectric Properties

5.1 Dielectric Response Measurements
5.2 Loss Factor and Capacitance Measurement
5.2.1 Schering Bridge
5.2.2 Automatic C-tan Bridges

Module (6) Tests with High Lightning and Switching Impulse Voltages

6.1 Generation of Impulse Test Voltages
6.1.1 Classification of Impulse Test Voltages
6.1.2 Basic and Multiplier Circuits for Standard LI/SI Test Voltages
6.1.3 Circuits for Oscillating Impulse Voltages
6.1.4 OSI Test Voltage Generation by Transformers
6.1.5 Circuits for Very Fast Front Impulse Voltages
6.2 Requirements to LI/SI Test Systems and Selection of Impulse Voltage Test Systems
6.2.1 LI Test Voltage and the Phenomenon of Over-shoot
6.2.2 SI Test Voltages
6.3 Procedures and Evaluation of LI/SI Voltage Tests
6.3.1 Breakdown Voltage Tests for Research and Development
6.3.2 LI/SI Quality Acceptance Tests
6.4 Measurement of LI and SI Test Voltages
6.4.1 Dynamic Behaviour of Voltage Dividers
6.4.2 Design of Voltage Dividers
6.4.3 Digital Recorders
Module (7) High-Voltage Test Laboratories

7.1 Requirements and Selection of HV Test Systems
   7.1.1 Objective of a Test Field
   7.1.2 Selection of Test Equipment
   7.1.3 Clearances and Test Area
   7.1.4 Control, Measurement and Communication

7.2 HV Test Building Design
   7.2.1 Required Rooms and Principle Design
   7.2.2 Grounding and Shielding
   7.2.3 Power Supply and High-Frequency Filtering
   7.2.4 Auxiliary Equipment for HV Testing
   7.2.5 Auxiliary Equipment and Transportation Facilities
   7.2.6 Safety Measures

7.3 Outdoor HV Test Fields
7.4 Updating of Existing HV Test Fields
   7.4.1 Updating of HV Test Systems
   7.4.2 Improvement of HV Test Rooms

- Course summary and conclusion