



Training Program:

**Transformer Operational Principles, Selection &
Troubleshooting**

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Introduction:

Power Transformers are essential devices in electricity supply. Their ratings can vary from small size distribution transformers up to very large power transformers of 1000 MVA or more. In terms of voltage ratings transformers can have operating voltages up to several hundreds of kilovolts. Other types of transformers include: instrument transformers, industrial transformers, testing transformers and other special types. Power and distribution transformers represent a major asset of the power utility. Failure of a transformer can be very costly not only because of the damage to the transformer itself but also because of the ramifications of such failure. This may include disruption of supply, explosions or fire damage. It is therefore paramount that power transformers are properly operated and maintained.

The design of any transformer must fulfill certain requirements in order to withstand the electric, thermal and mechanical stresses during its service life. These requirements are detailed in the relevant standards together with any special conditions outlined in the specifications of the purchaser of the transformer. Tests of transformers according to the relevant standards are intended to ensure that a transformer passing them will give trouble-free service for many years under the conditions it is likely to experience after its installation.

This training course will provide an understanding of Power Transformers, their materials, components and how they operate. It also emphasizes the importance of QAQC in relation to transformers. The course will address in detail all aspects related to transformer principles, calculations, operation, testing and maintenance.

Target Audience:

Engineers and technicians from electricity supply industry - Engineering professionals from companies manufacturing and operating Power and Distribution Transformers
Engineers and technical personnel in power utilities, petrochemical plants, service professionals of buildings and hospitals. Participants need no specific requirements other than basic understanding of electricity and magnetism and circuit theory and general knowledge of nature and operation of Power Transformers

Training Objectives:

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

- Refresh your knowledge of the basic theory of transformers
- Understand the principles of operation of the transformer
- Identify the different features of power transformers, distribution transformers and instrument transformers
- Appreciate the principles of transformer design, ratings, windings, core structure and materials, insulation and cooling methods, insulation and lifetime
- Be familiar with construction of the transformer, transformer winding connections
- Recognize the effects of transformer load changes and off-load and on-load tap changers
- Utilize thermal limits and loading guides of transformers
- Analyze transformer failure modes

- Perform transformer maintenance and transformer testing

Accreditation:

BTS attendance certificate will be issued to all attendees completing minimum of 80% of the total course duration.

Course Outline

Introduction, General Principles and Classification

- General Classification of Transformers: Transformer Construction, Core-Type, Shell-Type, Dry-type Transformers, Oil-filled Transformers, Cooling Techniques
- Transformer Windings, Interconnection of Windings, Advantages and Disadvantages of Principal Connections. Tertiary Windings, Autotransformers
- Harmonics in Transformers, Parallel Operation of Transformers, Loadings of Transformers in Parallel, Paralleling Requirements, Polarity
- Standards for Transformers, Types and Requirements
- Transformer Tappingâ€™s and Connections
- Ability to withstand Short Circuit, Sound Level
- Case studies and workshop discussion

Transformer Constructional Details

- Transformer Oil, Characteristics, Oil Oxidation, Breakdown Voltage, Water Content, Acidity, Oil Testing, Field Oil Testing, Dissolved Gas Analysis, Treatment and Filtering of Oil

- Effect of Oil Expansion, Breathing Action, Buchholz Relay, Explosion Vents
- Instrument Transformers
- Transformers for Industrial Applications: Electro-chemical, Arc and Induction Furnaces, Rectifier Transformers, High Voltage Testing Transformers, Precipitator Transformers, Dry Type Transformers
- Construction And Details, Transformer Cooling, Natural Cooling, Forced Cooling

Transformer Features and Thermal Performance

- Thermal performance and Cyclic Rating of Transformers. Temperature indicators and alarms
- Transformer Impedance, Electromagnetic Forces
- Transformer Construction: Cores, Assembly
- Transformer Windings Construction: Coil Types, Disc Coils, Cross-over Coils, Concentric Coils, Sandwich Coils, Transpositions
- Transformer Tanks and Radiators, Tank Losses, Paint Treatments
- Transformer Fittings: Lifting Lugs, Undercarriages, Jacking Pads, Tie-Down Lugs, Bleed Pipes, Thermometers

Transformer Operation and Maintenance

- Distribution Voltage Adjustment, Off-Load Tap Changing, On-Load Tap Changing

- Switching of high voltage underground cables supplying Distribution Transformers
- Earthing and Over-Current Protection of Distribution Transformers
- Transformer Maintenance: Oil preservation, Deterioration of oil, Breathers, Condition Monitoring, Faults in Transformers, Tappingâ€™s and Windings
- Advanced Transformer Maintenance
- Guidelines on how to care for your Distribution Transformer

Transformer Testing

- Transformer Routine Tests, Measurement of winding resistance
- Measurement of voltage ratio
- Measurement of impedance voltage short-circuit impedance and load loss
- Measurement of No-load loss and current
- Insulation resistance, Harmonics testing
- Separate-source power-frequency voltage withstand test
- Induced overvoltage withstand test
- Transformer Type Tests
- Temperature rise test, Lightning impulse test
- Sound level, Special Tests: Transformer Partial Discharge testing
- Accuracy and Interpretation of test results and of test reports