



**EE037**

# **Electrical Equipment: Transformers, Inverters, Rectifiers, Uninterruptable Power Systems, Generators**



## Course Introduction:

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This course will provide a comprehensive understanding of the various types of transformers, inverters, rectifiers, uninterruptible power systems and generators. This course will focus on maximizing the efficiency, reliability, and longevity of this type equipment by providing an understanding of the characteristics, selection criteria, common problems and repair techniques, preventive and predictive maintenance.

This course is a MUST for anyone who is involved in the selection, applications, or maintenance of electrical equipment because it covers how this equipment operates, the latest maintenance techniques, and provides guidelines and rules that ensure the successful operation of this equipment.

In addition, this course will cover in detail the basic design, operating characteristics, specification, selection criteria, advanced fault detection techniques, critical components and all preventive and predictive maintenance methods in order to increase reliability of the equipment and reduce the operation and maintenance cost.

This five-day course aimed to provide deep knowledge & experience on the applications of power system generation & distribution in the field of oil & gas industries. Where as a practical based knowledge of electrical generation and equipments could be applied on different case studies and gives a rule of thumb relevant to deal with the Electrical Equipments.

## Course Objectives:

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**Upon successful completion of this course, the delegates will be able to:**

Gain a detailed appreciation of learnt from this training to interact with the power plant equipments & network to identify, evaluate & put the suitable remedies for faults & troubles to get a stable operation and good plan for equipment maintenance **concerning the following:**

- ✓ Different types of generator's prime movers focuses on gas turbines & Diesel engine.
- ✓ Main components, operations, control, protection and load control, starting & stopping sequence
- ✓ Generator theory, main components, types, Excitation system, AVR, Regulation, synchronizing of generators and parallel operations ,load sharing –shedding system, generator protections, fault finding and trouble shootings, typical exercises & Maintenance for generator and its associated Auxiliaries system – operators duties in control room
- ✓ Power transformers; Operational principles, Design guidelines and different types, Maintenance and commissioning procedures, Troubleshooting checklists and failure analysis techniques & Testing procedures
- ✓ Electric power distribution systems; Types of distribution systems.

- ✓ Overview of main components & interconnection of power systems; Standby & emergency (black start generators) power generators - control circuit & protection, automatic changeover, loading & unloading
- ✓ Understand the Theory, operation, troubleshooting and maintenance of Rectifier, Inverter and UPS and understand Critical Load Applications

## Who Should Attend?

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This course is intended for all electrical and power personnel involved in power plants operation & maintenance. The program is based on multi-disciplinary approach, which includes all personnel from Operators, Technicians, Supervisors, New graduated to Senior Engineers.

## Course Outline:

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### Day 1:

#### **GAS TURBINES & TYPES OF PRIME MOVERS**

- Main components & operations of single shaft gas turbines
- Main components & operations of single shaft gas turbines
- Main components & operations of Two shaft gas turbines
- Main components & operations of Diesel Engine
- Starting & stopping sequences
- Protection & load control

#### **PRINCIPLES OF AC GENERATORS**

- General; AC generator theory & principles
- Typical Generator main components, Construction, insulation & cooling Methods
- Behavior under fault
- Capability curve
- Neutral Earthing Resistor
- Insulated Bearings

#### **GENERATOR EXCITATION AND VOLTAGE CONTROL**

- General
- Conventional excitation
- Static Excitation
- Brushless Excitation (General Case)
- Behavior Under Short Circuit
- Brushless Excitation (Without Pilot Exciter)
- Brushless Excitation (With Pilot Exciter)
- The diode bridge

- Regulation response time
- Automatic voltage regulators (AVR)
- AVR set-point

## **GENERATOR INTERNAL IMPEDANCE AND REGULATION**

- General
- D.C. Generator
- A.C. Generator
- Regulation
- Practical Application
- Synchronous Reactance
- Percentage Reactance

### **Day 2:**

## **GENERATOR SPEED CONTROL**

- General
- Mechanical governors
- Modern mechanical governors
- Electronic governors
- Typical single shaft gas turbine governor
- Single shaft over speed protection
- Typical two shaft gas turbine governor
- Two shaft auto and manual speed control
- Two shaft over speed protection
- Load sharing
- Typical fault finding and troubleshooting technique
- Case study & practical exercise

## **DIESEL GENERATOR SETS**

- General
- Basic services
- Availability of basic services generator
- Basic services generator utilities

## **GENERATOR PROTECTION**

- Standard protection
- Special generator protection
- Protection diagrams
- Case studies and workshop discussion

## **GENERATOR MAINTENANCE AND TROUBLESHOOTING**

- Preventive Maintenance of Generator
- Preventive Maintenance of generator's Auxiliaries
- Troubleshooting and fault finding typical practical case study

### **Day 3:**

#### **CONTROL PERSONS MAIN DUTIES IN POWER STATION CONTROL ROOM**

- An Electrical Person operating from a control room specially equipped with system control facilities
- Responsibilities of Authorized Persons

#### **TRANSFORMER; 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
- Parallel Operation of Transformers, Loadings of Transformers in Parallel, Paralleling Requirements, Polarity
- Standards for Transformers, Types and Requirements
- Transformer Tappings 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
- Case studies and Workshop Discussion

### **Day 4:**

#### **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, Tappings and Windings
- Advanced Transformer Maintenance
- Guidelines on how to care for your Distribution Transformer
- Case studies and Workshop Discussion

## **TRANSFORMER TESTING**

- Transformer Routine Tests
- Transformer oil test
- Transformer gas test
- 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
- Analysis of the tests result
- Open session for questions, answers and case studies

### **Day 5:**

## **ELECTRIC POWER DISTRIBUTION SYSTEMS**

- Types of distribution systems
- Overview of main components & interconnection of power systems
- Standby & emergency (black start generators) power generators - control circuit & protection, automatic changeover, loading & unloading
- Open session for questions, answers and case studies

## **BASIC PARTS OF THE CHARGER**

- Transformer
- Rectifier
- Filter
- Regulator
- Processing of an input

## **PRINCIPLE OF RECTIFICATION**

- Diode as a rectifier
- Silicon Control Rectifier (SCR)
- Single phase full wave rectifier

## **INVERTER**

- Evolution of the inverter
- bridge Circuits
- Quasi Square Wave (Second Generation) Inverters
- PWM Inverters

## STATIC SWITCH

- UPS Configuration
- Bypass Arrangements
- UPS Control Logic

## BATTERIES

- Types of Batteries
- Constructions
- Operations
- Grouping of cells
- Battery ratings (specification)
- Battery Hazards and safety precautions
- Battery care and maintenance
- Battery container
- Electrolyte
- Cell Voltage
- Charging
- Battery Do's & Don'ts
- Common causes of failure
- Open session for questions, answers and case studies

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## Course Certificate:

**International Center for Training & Development (ICTD)** will award an internationally recognized certificate(s) for each delegate on completion of training.

## Course Fees:

**To be advised as per the course location.** This rate includes participant's manual, hand-outs, buffet lunch, coffee/tea on arrival, morning & afternoon of each day.

## Course Methodology:

**A variety of methodologies will be used during the course that includes:**

- (30%) Based on Case Studies

- (30%) Techniques
- (30%) Role Play
- (10%) Concepts
- Pre-test and Post-test
- Variety of Learning Methods
- Lectures
- Case Studies and Self Questionnaires
- Group Work
- Discussion
- Presentation

## Course Timings:

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### Daily Course Timings:

08:00 - 08:20	Morning Coffee/Tea
08:20 - 10:00	First Session
10:00 - 10:20	Coffee/Tea/Snacks
10:20 - 12:20	Second Session
12:20 - 13:30	Prayer & Lunch
13:30 - 15:00	Last Session

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