# AC Electric Motors and Variable Frequency Drives: Protection, Testing and Troubleshooting

31 May – 4 June 2027
Paris - Right Bank business hotel



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**Ref:** 178_10543 **Date:** 31 May – 4 June 2027 **Location:** Paris - Right Bank business hotel **Fees:** 23500 SAR

## Introduction:

AC electric motors and variable frequency drives power most plant loads, yet burnt windings, nuisance drive trips, bearing fluting and wrong protection settings still cause unplanned outages and wasted energy. This Core Concept course gives electrical engineers and technicians a working method to read nameplates and efficiency classes, choose a starting method, set up drive parameters, coordinate motor protection, test insulation and windings, and trace faults to their root cause. Participants build a Motor and Drive Condition Assessment and Fault-Finding Chart for machines from their own site.

## Course Objectives:

- Interpret motor nameplate data, torque-speed curves and IEC 60034-30 efficiency classes to select or replace induction and synchronous motors
- Compare direct-on-line, star-delta, soft starter and drive starting on inrush current, starting torque and supply impact
- Configure variable frequency drive parameters for V/Hz and vector control and assess harmonic distortion against IEEE Standard 519 limits
- Set thermal overload, earth fault and winding temperature protection so motors trip on real faults and not on normal starts
- Perform and interpret insulation resistance, polarization index, surge and motor circuit analysis tests to rank winding condition
- Diagnose electrical and mechanical motor faults, including drive-induced bearing currents, and estimate energy savings from speed control

## Target Audience:

- Electrical engineers who specify, commission and approve motors, starters and drives for plant loads
- Maintenance electricians who install, test and repair low and medium voltage motors in the field
- Electrical and instrument technicians who configure drive parameters and clear drive fault codes
- Condition monitoring staff who collect insulation, current and vibration data on motor fleets
- Motor workshop supervisors who manage rewinds, bearing replacement and repair quality records

## Course Outline:

### Day 1: Induction and Synchronous Motor Principles and Nameplate Data

- Rotating Magnetic Field, Synchronous Speed and Slip Calculation
- Squirrel-Cage Versus Wound Rotor Construction and Application Choice
- Torque-Speed Curve: Locked-Rotor, Pull-Up and Breakdown Torque Points
- Synchronous Motor Excitation, Power Factor Correction and Pull-Out Behaviour
- Nameplate Decoding: Service Factor, Insulation Class, Duty Type and IEC 60034-30 Efficiency Class

### Day 2: Motor Starting Methods and Variable Frequency Drive Architecture

- Direct-On-Line Starting Inrush Current and Voltage Dip Check
- Star-Delta and Autotransformer Reduced-Voltage Starter Wiring and Transition
- Solid-State Soft Starter Ramp, Current Limit and Bypass Contactor Setup
- Drive Power Stages: Six-Pulse Diode Rectifier, DC Link Capacitor and IGBT Inverter
- Pulse-Width Modulation Carrier Frequency and Its Effect on Motor Heating and Noise

### Day 3: Drive Parameter Setup, Motor Protection and Insulation Testing

- V/Hz, Sensorless Vector and Direct Torque Control Mode Selection
- Drive Commissioning Sequence: Motor Data Entry, Auto-Tuning, Ramps and Current Limits
- Thermal Overload Relay Trip Class and Motor Protection Relay Setting Worksheet
- Earth Fault, Phase Unbalance and PTC Thermistor Winding Temperature Protection
- Insulation Resistance Megger Test and Polarization Index Ratio Interpretation

### Day 4: Harmonics, Bearing Currents, Winding Diagnostics and Energy Savings

- Harmonic Distortion Assessment Against IEEE Standard 519 with Line Reactors, Filters and Active Front End
- Common-Mode Voltage Bearing Currents: Shaft Grounding Brushes, Insulated Bearings and Shielded Cables
- NEMA MG-1 Part 31 Inverter-Duty Motor Insulation and Long Cable Reflected Wave Control
- Surge Comparison Testing and Motor Circuit Analysis for Turn-to-Turn and Rotor Bar Faults
- Variable-Torque Load Affinity Calculation for Fan and Pump Drive Energy Savings

### Day 5: Motor and Drive Inspection Walkthrough and Fault-Finding Chart Build

- Motor Inspection Walkthrough: Terminal Box, Cooling Path, Bearing Temperature and Current Balance
- Drive Fault Code Case Diagnosis: Overcurrent, DC Bus Overvoltage and Earth Fault Trips
- Motor Vibration Signatures: Electrical Versus Mechanical Fault Separation
- Repair, Rewind or Replace Decision Matrix Using Efficiency Class and Life Cycle Cost
- Motor and Drive Condition Assessment and Fault-Finding Chart Drafting and Peer Review

## Skills You Will Gain:

- Nameplate Interpretation
- Starter Selection
- Drive Commissioning
- Motor Protection Setting
- Insulation Condition Assessment
- Harmonic Mitigation
- Bearing Current Prevention
- Drive Fault Diagnosis

## Why Attend This Course:

- Return with a Motor and Drive Condition Assessment and Fault-Finding Chart built for machines from your own site
- Cut repeat winding burnouts and nuisance drive trips by linking each symptom to a test result and a setting
- Justify repair, rewind or replace decisions and drive retrofits with efficiency class and energy figures
- Compare motor and drive practice with electrical peers from oil and gas, utilities, water, mining and manufacturing

## Conclusion:

AC electric motors and variable frequency drives stay reliable when they are chosen for the duty, started correctly, protected with sound settings and tested before faults become failures. The course moves from motor principles and nameplate data, through starting methods and drive architecture, to drive setup, protection and insulation testing, then to harmonics, bearing currents, winding diagnostics and energy savings. Participants leave with a Motor and Drive Condition Assessment and Fault-Finding Chart ready for their next maintenance review.